Natural for Mainframes

Database Management System Interfaces

Version 4.2.6 for Mainframes (Update)

February 2010

Natural

This document applies to Natural Version 4.2.6 for Mainframes (Update).

Specifications contained herein are subject to change and these changes will be reported in subsequent release notes or new editions.

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Table of Contents

1 Database Management System Interfaces

This documentation provides an overview of the Natural database management system interfaces and a short summary of their functions.

The following topics are covered:

	Natural for DB2	The Natural interface to DB2 enables Natural users to access data in a DB2 database. Natural for DB2 is supported under the TP monitors Com-plete, CICS, IMS TM, in batch mode, and TSO.
	Natural for SQL/DS	The Natural interface to SQL/DS enables Natural users to access data in an SQL/DS database. Natural for SQL/DS is supported under the TP monitor CICS and in batch environments under z/VSE.
	Natural SQL Gateway	The Natural SQL Gateway enables a Natural user residing on z/OS to access data in an SQL database residing either on a Linux, UNIX or Windows system.
	Natural for VSAM	The Natural interface to VSAM enables Natural users to access data stored in VSAM files.
	Natural for DL/I	The Natural interface to DL/I enables Natural users to access and update data stored in a DL/I database. The Natural user can be executing in batch mode or under the control of the TP monitor CICS or IMS TM.

Note: See also *Accessing Data in an Adabas Database* (in the *Programming Guide*) on how to access data in Adabas.

2 Natural for DB2

This documentation describes the functionality and the use of Natural for DB2 **Version 4.3.1**, which is a Natural interface required to access data in a DB2 database.

Note: Information on Natural for DB2 **Version 4.2.6** can be found in the earlier edition of the Natural Version 4.2.6 documentation on Software AG's Empower web site at *https://empower.softwareag.com/*.

General Information	Information such as purpose, environment-specific considerations, integration with Software AG's Data Dictionary Predict, incompatibilities and constraints, error messages related to DB2, and terms used in this documentation.
Installing Natural for DB2	Installation of Natural for DB2 and description of the Natural for DB2 parameter module.
Accessing a DB2 Table	Enable access to a DB2 table with a Natural program.
Using Natural Tools for DB2	Invoke Natural Tools for DB2 and edit within the utilities available. Information on global PF-key settings and global maintenance commands.
Application Plan Maintenance	Maintain DB2 application plans online.
Catalog Maintenance	Maintain the DB2 catalog.
Interactive SQL	Process SQL statements that are not embedded.
Retrieval of System Tables	Display/print DB2 objects and user authorizations.
Environment Setting	Execute SQL statements and display special register values.
Explain PLAN_TABLE	Interpret your `PLAN_TABLE`.
File Server Statistics	Display statistics on the generation and use of the file server.

DB2 Commands Execution	Issue DB2 commands from Natural.
Using Natural System Commands for DB2	Use Natural system commands that have been incorporated into the Natural Tools for DB2.
Generating Natural Data Definition Modules (DDMs)	Generation of Natural data definition modules (DDMs) using the ***SQL Services*** function of the Natural `SYSDDM` utility.
Dynamic and Static SQL Support	Internal handling of dynamic statements, creation and execution of static DBRMs, mixed dynamic/static mode, and application plan switching in the various supported environments.
Using Natural Statements and System Variables	Special considerations on Natural DML statements, Natural SQL statements, and Natural system variables with DB2. In addition, the Natural for DB2 enhanced error handling is discussed.
Processing Natural Stored Procedures and UDFs	Processing Natural stored procedures and Natural user-defined functions (UDFs).
Interface Subprograms	Several Natural and non-Natural subprograms to be used for various purposes.
Natural File Server for DB2	Description of the Natural File Server for DB2 in the various supported environments.

Related Documentation

For the various aspects of accessing data in a database with Natural, see also *Accessing Data in a Database* in the Natural *Programming Guide*.

For information on logging SQL statements contained in a Natural program, refer to *DBLOG Trace Screen for SQL Statements* in the *DBLOG Utility* documentation.

3 General Information

Purpose

Natural for DB2 is a Natural interface designed to access data in a DB2 database.

In general, there is no difference between using Natural with DB2 and using it with Adabas, VSAM or DL/I. The Natural interface to DB2 allows Natural programs to access DB2 data, using the same Natural native data manipulation (DML) statements that are available for Adabas, VSAM, and DL/I. Therefore, programs written for DB2 tables can also be used to access Adabas, VSAM, or DL/I databases. In addition, Natural SQL DML statements are available.

All operations requiring interaction with DB2 are performed by Natural for DB2.

Environment-Specific Considerations

Natural for DB2 is supported in the following environments:

- Natural for DB2 under Com-plete
- Natural for DB2 under CICS
- Natural for DB2 under IMS TM
- Natural for DB2 under TSO
- Natural for DB2 Using CAF
- Natural for DB2 Using DB2 DL/I Batch Support

Natural for DB2 under Com-plete

DB2 is supported by Com-plete. Programs running under Com-plete can access DB2 databases through the DB2 Call Attachment Facility (CAF). This facility, together with the Com-plete interface to DB2, allows fully conversational access to DB2 tables.

If the DB2 plan created during the installation process is not specified in your DB2 `SERVER` parameter list for Com-plete, you must explicitly call `NATPLAN` before the first SQL call to allocate this plan.

Natural for DB2 under CICS

CICS/DB2 Attachment Facility

Under CICS, Natural uses the CICS/DB2 Attachment Facility to access DB2. Therefore, ensure that this attachment is started. If not, the Natural session is abnormally terminated with the CICS abend code `AEY9`, which leads to the Natural error message NAT0954 if the Natural profile parameter `DU` is set to `OFF`.

CICS DB2 Plan Selection

If the Natural CICS transaction ID is not assigned to any DB2 plan in the RCT by `DB2ENTRY` and `DB2TRAN` definitions, you must explicitly execute `NATPLAN` before the first SQL call to specify the required DB2 plan and define `NDBUEXT` as dynamic plan selection exit (`PLANExit` attribute). The actual plan allocation is performed by the dynamic plan selection exit.

CICS Pseudo-Conversational Mode

Under CICS, a Natural program usually runs in pseudo-conversational mode (Natural profile parameter `PSEUDO` set to `ON`, default value). In this case, at the end of the CICS transaction, the DB2 transaction is commited and all open DB2 cursors are closed implicitly and there is usually no way to resume open Natural `FIND/SELECT` database access loops after the terminal I/O.

To circumvent the problem of CICS terminating a pseudo-conversational transaction during loop processing and thus causing DB2 to close all cursors and lose all selection results, Natural for DB2 uses the file server to support the Natural transaction logic. If you intend to operate in CICS pseudo-conversationl mode, specify the Natural for DB2 parameter `FSERV=ON` and provide a file server file in the CICS region.

CICS Conversational Mode

If you do not provide a file server file in the CICS region and the Natural for DB2 parameter `CONVERS` is set to `ON`, Natural for DB2 switches to conversational mode whenever a terminal I/O takes place during an open database loop. This means the CICS transaction is spawned across terminal I/O as long as there are open database loops. This could cause DB2 deadlocks, as DB2 resources are allocated across terminal I/Os.

CICS Conversational Mode 2

In order to support applications, which do not deploy the implicit commit at CICS terminal I/O and which instead code explicit `ROLLBACK` or `COMMIT` to end their database transaction, a conversational mode 2 has been introduced.

Conversational mode 2 means that a DB2 update transaction is spawned across CICS terminal I/Os until an explicit `COMMIT` or `ROLLBACK` is issued.

Conversational mode 2 could be requested by the Natural for DB2 parameter `CONVRS2=ON` or it can dynamically set or rest by calling the `CALLNAT` program `NDBCONV`.

Caution: These kinds of application tend to tie up CICS and DB2 resources, as the resources are not freed across terminal I/O!

File Server under CICS

The usage of the file server depends on the `FSERV` parameter in the `NDBPARM` parameter module.

In a CICS environment, the file server is an optional feature to relieve the problems of switching to conversational processing. Before a screen I/O, Natural detects if there are any open cursors and if so, saves the data contained by these cursors into the file server. With the file server, database loops can be continued across terminal I/Os, but database modifications made before a terminal I/O can no longer be backed out.

For a detailed description of the file server, refer to the section ***Natural File Server for DB2***.

Natural for DB2 under IMS TM

Under IMS TM, Natural uses the IMS DB2 Attachment Facility to access DB2. Therefore, ensure that this attachment is started.

In IMS TM transaction processing environments, DB2 closes all cursors and thereby loses all selection results whenever the program returns to the terminal to send a reply message. This operation mode is different from the way DB2 works in CICS conversational mode or TSO environments, where cursors can remain open across terminal communication and therefore selected rows can be retained for a longer time.

File Server under IMS TM MPP

The usage of the file server depends on the `FSERV` parameter in the `NDBPARM` parameter module.

The file server is required to support the Natural for DB2 cursor management, while IMS TM issues an implicit end-of-transaction to DB2 after each terminal I/O operation. With the file server, database loops can be continued across terminal I/Os, but database modifications made before a terminal I/O can no longer be backed out.

For a detailed description of the file server, refer to the section ***Natural File Server for DB2***.

Natural for DB2 under TSO

Natural for DB2 can run under TSO without requiring any changes to the Natural/TSO interface.

Apart from z/OS Batch, the batch environment for Natural can also be the TSO background, which invokes the TSO terminal monitor program by an `EXEC PGM=IKJEFT01` statement in a JCL stream.

Both TSO online or batch programs can be executed either under the control of the DSN command or by using the Call Attachment Facility (CAF); the CAF interface is required if plan switching is to be used.

File Server under TSO

The usage of the file server depends on the `FSERV` parameter in the `NDBPARM` parameter module.

In a TSO environment, the file server is an optional feature to be able to emulate during development status a future CICS or IMS TM production environment.

With each terminal I/O, Natural issues a `COMMIT WORK` command to simulate CICS or IMS TM Syncpoints. Therefore, database modifications made before a terminal I/O can no longer be backed out.

For a detailed description of the file server, refer to the section ***Natural File Server for DB2***.

Natural for DB2 Using CAF

If you run Natural for DB2 under TSO or in batch mode and use the CAF interface, you must explicitly call `NATPLAN` before the first SQL call to allocate the required DB2 plan.

`NATPLAN` can be edited to specify the appropriate DB2 subsystem ID.

Natural for DB2 Using DB2 DL/I Batch Support

If you want to access DB2 and DL/I in the same Natural session in batch mode (not BMP), you can use the DB2 DL/I batch support facility, which allows you to coordinate recovery of both DB2 and DL/I database systems.

If you want to use this facility, you must execute the `DLIBATCH` procedure to run the `DSNMTV01` module as the application program. `DSNMTV01` in turn executes the Natural batch nucleus which must be linked with the DB2 interface `DFSLI000`.

If your PSB is generated with `CMPAT=YES`, all Syncpoints are executed and you must issue an `END TRANSACTION` statement before you end your Natural session; otherwise, any database modifications are lost, because Natural implicitly issues a `BACKOUT TRANSACTION` statement at the end of the session.

If your PSB is generated with `CMPAT=NO`, all Syncpoints are ignored.

Integration with Predict

Predict, Software AG's open, operational data dictionary for fourth-generation-language development with Natural, is a central repository of application metadata and provides documentation and cross-reference features. Predict lets you automatically generate code from definitions, enhancing development and maintenance productivity.

Since Predict supports DB2, direct access to the DB2 catalog is possible via Predict and information from the DB2 catalog can be transferred to the Predict dictionary to be integrated with data definitions for other environments.

DB2 databases, tables and views can be incorporated and compared, new DB2 tables and views can be generated, and Natural DDMs can be generated and compared. All DB2-specific data types and the referential integrity of DB2 are supported. See the relevant Predict documentation for details.

In addition, the Predict active references support static SQL for DB2 as described in ***WITH XREF Option*** in ***Preparing Programs for Static Execution***.

Integration with Natural Security

When run in an environment that is controlled by Natural Security, the use of certain features of Natural for DB2 can be restricted by the security administrator, for example:

- **Natural Tools for DB2**

  Access to the Natural system library `SYSDB2`

  Individual functions

- **Static SQL**

  Static generation can be disallowed by

  - restricting access to the Natural system library `SYSDB2`,
  - disallowing the module CMD,
  - restricting access to the libraries that contain the relevant Natural objects,
  - disallowing one of the Natural system commands `CATALOG` or `STOW` for a library that contains relevant Natural objects.

  If a library is defined in Natural Security and the DBID and FNR of this library are different from the default specifications, the static generation procedure automatically switches to the DBID and FNR specifications defined in Natural Security.

For further information, ask your security administrator.

Incompatibilities and Constraints

This section lists the known incompatibilities and constraints against DB2 when using Natural for DB2 to access data from DB2.

- **Data Type DECIMAL or NUMERIC**

  Most SQL database systems support packed decimal numbers with a maximal precision of 31 digits and a scale (fractional part of the number) of up to 31 digits. The scale has to be positive and not greater than the precision. Natural allows only a precision of 29 digits and the scale could not be greater than 7.

Messages Related to DB2

The message number ranges of Natural system messages related to DB2 are 3275 - 3286, 3700-3749, and 7386-7395.

For a list of error messages that may be issued during static generation, see *Static Generation Messages and Codes Issued under NDB/NSQ* in the Natural *Messages and Codes* documentation.

Terms Used in this Documentation

Term	Explanation
DB2	DB2 refers to IBM's DB2 UDB for z/OS.
DBRM	Database request module
DDM	Data definition module.
DML	Data manipulation language (Natural).
File Server	In this document, the term “file server” refers to the **Natural file server** for DB2.
NDB	This is the product code of Natural for DB2. In this documentation the product code is often used as prefix in the names of datasets, modules, etc.
SQL/DS	SQL/DS refers to IBM's DB2 Server for VSE and VM.

4 Installing Natural for DB2

This section describes how to install Natural for DB2 in the various environments supported.

The installation procedures contain a number of options that depend on the TP monitor being used as well as on other site requirements.

This section covers the following topics:

Notation vrs or vr: If used in the following document, the notation `vrs` or `vr` stands for the relevant version, release, system maintenance level numbers. For further information on product versions, see *Version* in the *Glossary*.

Installation Jobs

The installation of Software AG products is performed by installation jobs. These jobs are either created manually or generated by System Maintenance Aid (SMA).

For each step of the installation procedure described later in the section Installing Natural for DB2, the job number of a job performing the respective task is indicated. This job number refers to an installation job generated by SMA. If you are not using SMA, an example job of the same number is provided in the job library on the Natural for DB2 installation tape; you must adapt this example job to your requirements. Note that the job numbers on the tape are preceded by the product code "NDB" of Natural for DB2 (for example, `NDBI070`).

Using System Maintenance Aid

For information on the use of Software AG's System Maintenance Aid for the installation process, refer to the *System Maintenance Aid* documentation.

Prerequisites

- Base Natural must be installed first; you cannot install Natural and Natural for DB2 at the same time.
- The Software AG Editor must be installed (see *Installing the Software AG Editor* in the *Installation* documentation).

For special considerations on the various environments supported by Natural for DB2, see ***Environment-Specific Considerations***.

Further product/version dependencies are specified under *Natural and Other Software AG Products* and *Operating/Teleprocessing Systems Required* in the current Natural *Release Notes*.

Installation Tape for Natural for DB2

The installation tape contains the datasets listed in the table below. The sequence of the datasets is shown in the *Report of Tape Creation* which accompanies the installation tape.

Dataset Name	Contents
`NDBvrs.SRCE`	Natural for DB2 source modules
`NDBvrs.LOAD`	Natural for DB2 load modules
`NDBvrs.INPL`	Natural for DB2 utility programs in `INPL` format
`NDBvrs.ERRN`	Natural for DB2 error messages
`NDBvrs.JOBS`	Natural for DB2 installation jobs
`NDBvrs.LDEL`	Instructions to delete Natural for DB2 objects of Version 4.1

Copying the Tape Contents to a z/OS Disk

If you are using SMA, refer to the *System Maintenance Aid* documentation (included in the current edition of the Natural documentation CD).

If you are *not* using SMA, follow the instructions below.

This section explains how to:

- Copy dataset `COPY.JOB` from tape to disk.
- Modify this dataset to conform to your local naming conventions.

The JCL in this dataset is then used to copy all datasets from tape to disk.

If the datasets for more than one product are delivered on the tape, the dataset `COPY.JOB` contains the JCL to unload the datasets for all delivered products from the tape to your disk.

After that, you will have to perform the individual install procedure for each component.

- Step 1 - Copy Dataset COPY.JOB from Tape to Disk
- Step 2 - Modify COPY.JOB on Your Disk

- Step 3 - Submit COPY.JOB

Step 1 - Copy Dataset COPY.JOB from Tape to Disk

The dataset `COPY.JOB` (Label 2) contains the JCL to unload all other existing datasets from tape to disk. To unload `COPY.JOB`, use the following sample JCL:

```
//SAGTAPE JOB SAG,CLASS=1,MSGCLASS=X
//* ---------------------------------
//COPY EXEC PGM=IEBGENER
//SYSUT1 DD DSN=COPY.JOB,
// DISP=(OLD,PASS),
// UNIT=(CASS,,DEFER),
// VOL=(,RETAIN,SER=tape-volume),
// LABEL=(2,SL)
//SYSUT2 DD DSN=hilev.COPY.JOB,
// DISP=(NEW,CATLG,DELETE),
// UNIT=3390,VOL=SER=volume,
// SPACE=(TRK,(1,1),RLSE),
// DCB=*.SYSUT1
//SYSPRINT DD SYSOUT=*
//SYSIN DD DUMMY
//
```

where:

`hilev` is a valid high level qualifier
`tape-volume` is the tape volume name, for example: T12345
`volume` is the disk volume name

Step 2 - Modify COPY.JOB on Your Disk

Modify the `COPY.JOB` on your disk to conform to your local naming conventions and set the disk space parameters before submitting this job:

- Set `HILEV` to a valid high level qualifier.
- Set `LOCATION` to a storage location.
- Set `EXPDT` to a valid expiration date.

Step 3 - Submit COPY.JOB

Submit `COPY.JOB` to unload all other datasets from the tape to your disk.

Installation Procedure for Natural for DB2

This section describes how to install Natural for DB2 in various environments:

This section covers the following topics:

Common Installation Steps

The following steps are required to install Natural for DB2 in all supported environments.

Step 1: Allocate the DBRM Library for Use with Natural for DB2

Allocate a PDS as database request module (DBRM) library. The size of this dataset and the number of directory entries depend on the particular site (5 tracks and 20 directory blocks must be adequate for most environments). The PDS must have a fixed-block record format and a record length of 80.

Any standard dataset name can be used for this DBRM library; however, this installation procedure assumes that the name `SAGLIB.DB2DBRM` is used.

Step 2: Generate the Natural for DB2 I/O Module NDBIOMO

Job I055, Step 1600

By executing a standard Natural batch job, this step generates the assembly source for `NDBIOMO` from the member `NDBIOTM`.

This batch job invokes the Natural program `NDBGENI`, which is loaded with `INPL` during the base Natural installation. `NDBGENI` contains the following two parameters, which you can modify to meet your specific requirements:

- the DB-environment parameter, which must be set to:

  - DB2V7 if you are running DB2 Version 7
  - DB2V8 if you are running DB2 Version 8
  - DB2V9 if you are running DB2 Version 9 or higher
- the number of parallel dynamic prepared DB2 statements.

NDBIOMO (see also the relevant section in *Internal Handling of Dynamic Statements*) performs the dynamic access to DB2 and contains all necessary EXEC SQL statements. In addition, it contains some special SQL statements which cannot be executed in dynamic mode.

An output report is created by this job. Check the report for successful job completion. In addition, a condition code of 0 indicates normal completion.

Step 3: Assemble and Link NDBIOMO

Job I055, Step 1610

Precompile, assemble and link NDBIOMO.

Note: The link-edit step receives a condition code of 4 because of unresolved references for DSNHLI. This is normal and can be ignored.

Step 4: Bind the DBRM NDBIOMO into a Package

Job I055, Step 1620

If desired, change library names to meet site requirements.

Step 5: Create the DB2 Plan for Use with Natural for DB2

Job I055, Step 1630

If desired, change library names and plan name to meet site requirements.

Step 6: Modify, Assemble and Link the Natural for DB2 Parameter Module

Job I055, Steps 1640/1650 or 1660/1670 or 1675/1676

The Natural for DB2 parameter module NDBPARM contains the macro NDBPRM with parameters specific to Natural for DB2.

You can generally use the default values for all parameters. Modify only the values of the parameters whose default values do not suit your requirements.

The individual parameters are described in the section *Parameter Module NDBPARM*.

- **When the file server is not to be used:**
  Execute the Steps 1640 and 1650; the resulting parameter module is called `NDBPARM`.
- **When the file server is to be used:**
  Execute the Steps 1660 and 1670; the resulting additional parameter module is called `NDBPARMF`.
- **When the file server uses the Software AG Editor buffer pool as the storage medium:**
  Execute the Steps 1675 and 1676; the resulting additional parameter module is called `NDBPARME`.

Step 7: Link-Edit NATGWDB2

Job I055, Step 1680

Link-edit the environment-independent Natural for DB2 nucleus `NATGWDB2`.

Verify that the `INCLUDE` cards refer to the corresponding DD names for the load libraries.

Step 8: Modify, Assemble and Link the Natural Parameter Module

Adapt your Natural parameter module `NATPARM` by adding parameters specific to Natural for DB2 (see ***Natural Parameter Modification for DB2***) and reassemble `NATPARM`.

Step 9: Relink your Natural Nucleus

Natural for DB2 basically consists of:

- An environment-independent nucleus, which can be shared by multiple environments.
- Environment-dependent components, which must be linked to the appropriate Natural environment-dependent interface.

Modify the JCL used to link your Natural shared nucleus by adding the following `INCLUDE` card:

`INCLUDE SMALIB(NATGWDB2)`	Environment-independent Natural for DB2 nucleus from ***Step 7: Link-Edit NATGWDB2***

Modify the JCL used to link your Natural environment-dependent nucleus by adding the following `INCLUDE` cards and the corresponding DD statements:

`INCLUDE SMALIB(NDBPARM)`	Natural for DB2 parameter module created in ***Step 6: Modify, Assemble and Link the Natural for DB2 Parameter Module***
`INCLUDE SMALIB(NDBIOMO)`	Natural for DB2 I/O module created in ***Step 3: Assemble and Link NDBIOMO***
`INCLUDE DSNLIB(DSNTIAR)`	SQL Error Message Module
`INCLUDE` *xxxxxxxx*`(`*yyyyyyyy*`)`	Environment-dependent DB2 interface (see below)

If you want to use the **Natural File Server** for DB2, include `SMALIB(NDBPARMF)` or `SMALIB(NDBPARME)` instead of `SMALIB(NDBPARM)`; see also ***Step 6: Modify, Assemble and Link the Natural for DB2 Parameter Module***.

Depending on your environment(s), `INCLUDE` the appropriate environment-specific language interface *yyyyyyyy* in the library *xxxxxxxx* as shown in the following table:

Interface	Library	Environment
DSNALI	DSNLIB	Under TSO and in batch mode without running under the control of the DSN command processor (that is, with CAF).
DSNRLI	DSNLIB	WLM (Workload Manager) stored procedure address space and Natural Development Server (NDV) (recommended). Also usable in TSO and batch environments.
DSNELI	DSNLIB	Under TSO and in batch mode when running under the control of the DSN command processor.
DSNCLI	DFHLIB	Under CICS
DFSLI000	IMSLIB	Under IMS TM (MPP and BMP) and in batch mode by using the DB2 DL/I batch support (DSNMTV01).
NDBCOM	NDBLIB	Under Com-plete.

Note: If you want to use Natural for DB2 in various environments (that is, with different TP monitors), you must repeat this step for each of these environments.

Instead of link-editing your Natural nucleus in the way described above, you have the following alternatives:

1. If you do not use a Natural shared nucleus, all modules must be included in the link-edit of the Natural nucleus.
2. Remove `NATGWDB2` from the link-edit of the Natural shared nucleus and run it as a separate module with the mandatory entry name `NATGWDB2`. You can modify the name of the module created in ***Step 7: Link-Edit NATGWDB2***. However, if you use a name different from `NATGWDB2`, this name must be specified as an alias name in an `NTALIAS` macro entry of the Natural parameter module. This way of link-editing only applies if the Natural Resolve CSTATIC Addresses feature (RCA) is used.
3. Include all modules in the link-edit job of a separate Natural parameter module with the mandatory entry name `CMPRMTB`. The name of the resulting module is arbitrary. This way of link-editing only applies if an alternative parameter module (`PARM` profile parameter) is used. If link-editing is done in this way, you can install Natural for DB2 without having to modify your Natural nucleus or driver.

If link-editing is done according to number [2] or [3], the following applies:

TP Monitor	Requirement
CICS	The resulting module must be defined via a PPT entry or RDO. PPT entry: `DFHPPT TYPE=ENTRY,PROGRAM=module-name,PGMLANG=ASSEMBLER`
Com-plete	The resulting module must be defined as `RESIDENTPAGE` or reside in the LPA/(E)LPA.

Step 10: Delete Natural for DB2 Objects

Job I061, Step 0016

This step is optional but recommended to avoid data inconsistencies.

If you are using a Version 4.1 Natural `FNAT` system file, delete obsolete Version 4.1 Natural for DB2 objects by loading the `NDBvrs.LDEL` data set with the Natural INPL utility.

See also the corresponding step *Delete Natural System Objects* in *Installation Procedure for Natural under z/OS* in the *Installation* documentation.

Step 11: Load Natural for DB2 Objects into the System File

Job I061, Step 1610

Before executing this step, change the `CMWKF01` DD statement to point to the `NDBnnn.INPL` dataset.

In this step, the Natural for DB2 system programs, maps and DDMs are loaded into the Natural system files. The `INPL` job loads objects into the Natural system libraries `SYSDDM`, `SYSTEM` and `SYSDB2`.

The Natural for DB2 system programs *must* be loaded into the `FNAT` system file.

Caution: Ensure that your newly created `SYSDB2` library contains all necessary Predict interface programs, which are loaded into `SYSDB2` when installing Predict (see the relevant Predict documentation).

Step 12: Load Natural for DB2 Error Messages into the System File

Job I061, Step 1620

Before executing this step, change the `CMWKF02` DD statement to point to the `NDB`*nnn*`.ERRN` dataset.

This step executes a batch Natural job that runs an error load program by using the `NDB`*nnn*`.ERRN` dataset as input. The `ERRLODUS` job loads error messages into the library `SYSERR` in the `FNAT` system file.

The Natural for DB2 error messages *must* be loaded into the `FNAT` system file.

Step 13: Create the Natural for DB2 Server Stub

Job I070, Steps 1604,1606,1608,1610

Create server stubs to execute Natural stored procedures and Natural user-defined functions. Natural for DB2 server stubs are interface modules between the DB2 database system and the Natural server. In order to execute Natural stored procedures and Natural user-defined functions, the server stub needs to be installed.

There are two types of server stub (*vr* in the stub name stands for the current product version and release numbers):

1. **Natural for DB2 server stub (module `NDB`*vr*`SRV`, Steps 1604 and 1606)**
   The server stub is used to execute Natural stored procedures and Natural user-defined functions.

   The IBM LE (Language Environment) runtime modules required must be linked to the Natural for DB2 server stub module. Use the `CALL` option of the linkage editor and assign the LE runtime library as `SYSLIB`.
2. **Natural for DB2 start server stub (module `NDB`*vr*`STR`, Steps 1608 and 1610)**
   The start server stub is used to start the Natural server environment(s) explicitly.

   The IBM LE (Language Environment) runtime modules required must be linked to the Natural for DB2 start server stub module. Use the `CALL` option of the linkage editor and assign the LE runtime library as `SYSLIB`. Additionally, include the modules `NDBSTRP` (delivered with Natural for DB2) and `NATCONFG` (delivered with Natural) from `NDB`*nnn*`.LOAD` and `NAT`*nnn*`.LOAD`.

Natural for DB2 server stubs are generated from the `NDBSTUB` macro. You can generally use the default values for all parameters. Modify only the values of the parameters whose default values do not suit your requirements. The individual parameters are described in the section ***Natural for DB2 Server Stub***.

The resulting load modules have to be placed into a steplib library of the JCL used to execute the DB2 stored procedure address space.

For DB2 UDB, each Natural stored procedure or Natural user-defined function must be defined by a DB2 `CREATE PROCEDURE` or DB2 `CREATE FUNCTION` statement, where the name of the Natural for DB2 server stub module `NDB`*vr*`SRV` generated is specified as `EXTERNAL NAME`.

Step 14: Bind the DBRM ROUTINEN into a Package

Job I070, Step 1615

Bind the DBRM `ROUTINEN` into a package. The DBRM `ROUTINEN` is contained in the collection `SAGNDBROUTINENPACK` and delivered with Natural for DB2. Natural for DB2 needs this collection for accessing the DB2 catalog and retrieving the parameter descriptions of Natural stored procedures and Natural user-defined functions.

Installation Steps Specific to CICS

This section describes how to install Natural for DB2 in a CICS environment.

Ensure that your Natural/CICS thread size is large enough to contain the `DB2SIZE`; if you use the Natural Tools for DB2, an additional storage of 8 KB is required.

Natural for DB2 uses the CICS DB2 attachment facility to access DB2 for z/OS from a CICS environment. This requires the DB2 plan containing the SQL statements performed from Natural for DB2 have to be defined in the CICS resource definition. For this purpose, CICS DB2 provides three types of resource definitions:

- `DB2CONN`
  Defines the connection between CICS and DB2 for z/OS.
- `DB2ENTRY`
  Define threads used for access from CICS to DB2 for z/OS and their associated necessary resources, such as the DB2 plan.
- `DB2TRAN`
  Associate CICS transactions with a `DB2ENTRY` definition.

There are two ways to select the DB2 plan for the transaction used by Natural for DB2:

- **Fixed DB2 plan definition**
  Fixed DB2 plan definition is achieved by defining the `PLAN` attribute as the DB2 plan for the `DB2ENTRY` which is associated with the CICS transaction used by Natural for DB2.
- **Dynamic DB2 plan exit**
  Dynamic DB2 plan exit is a CICS program which is invoked by the CICS DB2 attachment facility to determine the plan to be used for the thread at execution time.

  Dynamic DB2 plan exit is achieved by defining the `PLANExit` attribute as the DB2 plan exit program for the `DB2ENTRY` which is associated with the CICS transaction used by Natural for

DB2. Natural for DB2 provides the NDBUEXT program as DB2 plan exit. NDBUEXT provides the plan to CICS DB2, which has been previously set by executing the NATPLAN program.

This section covers the following topics:

- Using Plan Selection by CICS RCT Entry Threads

Using Plan Selection by CICS RCT Entry Threads

If you want fixed assignment of your transaction code to the DB2 plan, add an additional entry to your RCT, or define a DB2Entry with RDO.

Perform one of the following alternative steps:

- **Modify, assemble and link CICS RCT**

  Modify your RCT as follows (for any other parameters, refer to the relevant DB2 literature by IBM):

```
DSNRCT TYPE=ENTRY,PLAN=plan-name,TXID=(transaction-ID)
```

- **Define a DB2Entry with RDO**

  For parameters, refer to the relevant CICS literature by IBM.

```
 DEFINE DB2ENTRY
 OVERTYPE TO MODIFY                                          CICS RELEASE = 0650
 CEDA  DEFine DB2Entry(          )
  DB2Entry       : DB2ENTR
  Group          : NCI
  DEscription    :
 THREAD SELECTION ATTRIBUTES
  TRansid        : transaction-id

 THREAD OPERATION ATTRIBUTES
  ACcountrec     : None               None ! TXid ! TAsk ! Uow
  AUTHId         :
  AUTHType       : Userid             Userid ! Opid ! Group ! Sign ! TErm
                                      ! TX
  DRollback      : Yes                Yes ! No
  PLAN           : plan-name
  PLANExitname   :
  PRIority       : High              High ! Equal ! Low
  PROtectnum     : 0005               0-2000
  THREADLimit    : 0005               0-2000
  THREADWait     : Pool               Pool ! Yes ! No
```

The *plan-name* must be the same as the name used to create the DB2 plan for Natural for DB2: see *Common Installation Steps*.

Using Plan Selection by Dynamic Plan Exit

If you want to perform plan selection by using the dynamic plan exit, perform the following steps:

Step 1: Assemble the CICS Dynamic Plan Selection Exit Module NDBUEXT

Job I070, Step 1630

The sample exit NDBUEXT can be modified to use a default plan name if none has been specified prior to the first SQL call. Review the source code in the module NDBUEXT for details about specifying a default plan name.

Optionally modify the source module NDBUEXT.

Precompile, assemble and link NDBUEXT for CICS.

Note: This step receives a condition code of 4 because of an unresolved external reference for DFHEAI0 and DFHEI1. This is normal and can be ignored.

Step 2: Link-Edit the CICS Dynamic Plan Selection Exit Module NDBUEXT

Job I075, Step 1640

The resulting module NDBUEXT must be linked to the CICS load library and defined via a corresponding PPT entry or RDO.

PPT entry:

```
DFHPPT TYPE=ENTRY,PROGRAM=NDBUEXT,PGMLANG=ASSEMBLER
```

Step 3: Modify, Assemble and Link the CICS RCT or Define a DB2Entry

Perform one of the following alternative steps:

- **Modify your RCT**

  Modify your RCT as follows (for any other parameters, refer to the relevant DB2 literature by IBM):

```
DSNRCT TYPE=POOL,PLNPGME=NDBUEXT,PLNEXIT=YES
```

  The parameter `PLNPGME` must specify the same program as the `NAME` statement of ***Step 2: Link-Edit the CICS Dynamic Plan Selection Exit Module NDBUEXT***.

- **Define a `DB2Entry` with RDO**

  For parameters, refer to the relevant CICS literature by IBM.

```
 DEFINE DB2ENTRY
 OVERTYPE TO MODIFY                                        CICS RELEASE = 0530
 CEDA  DEFine DB2Entry(          )
  DB2Entry       : DB2ENTR
  Group          : NCI
  DEscription    :
 THREAD SELECTION ATTRIBUTES
  TRansid        : transaction-id

 THREAD OPERATION ATTRIBUTES
  ACcountrec     : None               None ! TXid ! TAsk ! Uow
  AUTHId         :
  AUTHType       : Userid             Userid ! Opid ! Group ! Sign ! TErm
                                      ! TX
  DRollback      : Yes                Yes ! No
  PLAN           :
  PLANExitname   : NDBUEXT

  PRIority       : High              High ! Equal ! Low
  PROtectnum     : 0005               0-2000
  THREADLimit    : 0005               0-2000
  THREADWait     : Pool               Pool ! Yes ! No
```

  The parameter `PLANExitname` must specify the same program as the `NAME` statement of ***Step 2: Link-Edit the CICS Dynamic Plan Selection Exit Module NDBUEXT***.

  Alternatively or additionally, you can specify the plan exit program `NDBUEXT` with the `PLANExitname` parameter of `POOL THREAD ATTRIBUTES` of the `DB2Conn` resource definition of CICS TS.

Using the File Server with VSAM

If you want to use the Natural File Server with VSAM system files, perform the following additional steps:

Step 1: Define a VSAM Dataset for the File Server

Job I008, Step 1610

Specify the size and the name of the VSAM RRDS that is to be used as the file server (see also *Preparations for Using the File Server* in *Natural File Server for DB2*).

Step 2: Format the File Server Dataset

Job I075, Step 1610

Specify the five input parameters required to format the file server dataset (see also *Preparations for Using the File Server* in *Natural File Server for DB2*).

Step 3: Modify, Assemble and Link the CICS Tables

Shown below are sample additional CICS table entries needed for the file server and for the DB2 components of Natural:

FCT entry:

```
CMFSERV  DFHFCT TYPE=DATASET,                        X
               ACCMETH=VSAM ,                        X
               BUFND=5,                              X
               BUFNI=4,                              X
               DATASET=CMFSERV,                      X
               DISP=SHR,                             X
               DSNAME=SAGLIB.NCIDB2.SERVER,          X
               FILSTAT=(ENABLED,CLOSED),             X
               JID=NO,                               X
               LOG=NO,                               X
               LSRPOOL=NONE,  1-8 ONLY FOR XA; NONE  X
               RECFORM=(FIXED,BLOCKED),              X
               RSL=PUBLIC,                           X
               SERVREQ=(ADD,UPDATE,DELETE,BROWSE),   X
               STRNO=4
```

Step 4: Restart CICS

Restarting CICS is required, because of the additional FCT entry above.

Installation Steps Specific to Com-plete

Under Com-plete, the installation procedure of Natural for DB2 continues with the adaptation of your Com-plete environment.

Ensure that the changes required for DB2 have been applied to your Com-plete environment (see the relevant Com-plete documentation).

Installation Steps Specific to IMS TM

This section describes how to install Natural for DB2 in an IMS TM environment.

Ensure that the thread of your Natural IMS TM Interface is large enough to contain the `DB2SIZE`; if you use the Natural Tools for DB2, an additional storage of 8 KB is required.

Below is information on:

- Bind Default DB2 Plans for Different IMS TM Environments
- Using Plan Selection with IMS TM Resource Translation Table
- Using the File Server with VSAM

Bind Default DB2 Plans for Different IMS TM Environments

- Job I055 / Steps 1631, 1632, 1633, 1634 for IMS MPP conversational, IMS BMP, IMS MPP non-conversational, OBMP

If desired, change library names and plan names to meet site requirements.

Using Plan Selection with IMS TM Resource Translation Table

If the name (or any `ALIAS`) of your environment-dependent Natural nucleus does not match the name of your DB2 plan, you must use an Resource Translation Table (RTT).

Below is information on:

- **Modify, assemble and link the IMS TM Resource Translation Table**

  Add an additional `DSNMAPN` macro to your Resource Translation Table (RTT) as follows (for any other parameters, refer to the relevant DB2 literature by IBM):

`DSNMAPN` macro:

```
DSNMAPN APN=load-module,PLAN=plan-name
```

The *`load-module`* represents the environment-dependent Natural nucleus (that is, the IMS TM application program) and the *`plan-name`* is the same as the one used in the `BIND` **step**.

Using the File Server with VSAM

Be aware that database loops cannot be continued across terminal I/Os without using the File Server.

If you want to use the Natural File Server with VSAM system files, perform the following additional steps:

1. **Define the VSAM dataset for the file server**

   Job I008, Step 1600

   Specify the size and the name of the VSAM RRDS that is to be used as the file server (see also ***Preparations for Using the File Server*** in ***Natural File Server for DB2***).

2. **Format the file server dataset**

   Job I075, Step 1600

   Specify the five input parameters required to format the **file server** dataset (see also ***Preparations for Using the File Server*** in ***Natural File Server for DB2***).

3. **Update the JCL for the MPP region**

   Include the `DD` statement `CMFSERV` to define the file server dataset.

   Increase the `REGION` parameter if necessary.

4. **Restart the MPP region used by your Natural IMS TM Interface**

   Restart your MPP region, because of the additional `DD` statement.

Installation Steps Specific to TSO

This section describes how to install Natural for DB2 in a TSO environment:

- Using the File Server with VSAM
- Sample JCL for Starting and Using Natural for DB2 under CAF

- Sample JCL for Starting and Using Natural for DB2 under DSN

Using the File Server with VSAM

If you want to use the Natural File Server with VSAM system files, perform the following additional steps:

1. **Modify NDBFSRV in NATTSO**

   Set the `NDBFSRV` parameter in the `NATTSO` macro to `YES` and reassemble and relink your Natural/TSO interface `NATTSO`.

2. **Define the VSAM dataset for the file server**

   Job I008, Step 1620

   Specify the size and the name of the VSAM RRDS that is to be used as the file server (see also ***Preparations for Using the File Server*** in ***Natural File Server for DB2***).

3. **Format the file server dataset**

   Job I075, Step 1620

   Specify the five input parameters required to format the file server dataset (see also ***Preparations for Using the File Server*** in ***Natural File Server for DB2***).

Sample JCL for Starting and Using Natural for DB2 under CAF

To test the TSO installation of Natural for DB2 under CAF, perform the following steps:

1. **Adapt CLIST NDBCAF**

   Job I070, Step 240C

   Change the library and program names in the CLIST `NDBCAF` to meet site requirements. If you do not use the file server, remove the `ALLOC` and `FREE` statements for `CMFSERV`.

2. **Invoke Natural**

   Invoke Natural by executing the CLIST created in the **previous step**. Ensure that DB2 tables can be accessed and that plan switching can be performed.

   Before the first SQL call you must call `NATPLAN` to explicitly allocate the plan. The plan name must be the same as the name used in ***Step 5: Create the DB2 Plan for Use with Natural for DB2***. `NATPLAN` can be edited to specify the appropriate DB2 subsystem ID.

Sample JCL for Starting and Using Natural for DB2 under DSN

To test the TSO installation of Natural for DB2 under DSN, perform the following steps:

1. **Adapt CLIST NDBTSO**

   Job I070, Step 240B

   Change the subsystem ID as well as the library, plan and program names in the CLIST `NDBTSO` to meet site requirements. If you do not use the file server, remove the `ALLOC` and `FREE` statements for `CMFSERV`.

2. **Invoke Natural**

   Invoke Natural by executing the CLIST created in the previous step. Ensure that DB2 tables can be accessed. The plan name must be the same as the name used in the `BIND` **step**. For an explanation of the `DSN` and `RUN` commands, refer to the relevant IBM literature for DB2 TSO and batch users.

Installation Verification

This section provides example batch jobs and online methods for verifying the installation of Natural for DB2:

- Test Batch Natural for DB2 under CAF - Job NDBBATCA
- Test Batch Natural for DB2 under DSN - Job NDBBATTB
- Test DSNMTV01 - Job NDBMTV01
- Online Verification Methods

Test Batch Natural for DB2 under CAF - Job NDBBATCA

`NDBBATCA` contains sample JCL to test Natural for DB2 in batch mode by using the Call Attachment Facility (CAF) interface.

Modify the sample JCL to meet site requirements.

Before the first SQL call you must call `NATPLAN` to explicitly allocate the plan. The plan name must be the same as the name used in ***Step 5: Create the DB2 Plan for Use with Natural for DB2***. `NATPLAN` can be edited to specify the appropriate DB2 subsystem ID.

Test Batch Natural for DB2 under DSN - Job NDBBATTB

NDBBATTB contains sample JCL to test Natural for DB2 in batch mode by using the DSN command processor. Modify the sample JCL to meet site requirements.

The plan name must be the same as the name used in *Step 5: Create the DB2 Plan for Use with Natural for DB2*. For an explanation of the DSN and RUN commands, refer to the relevant IBM literature for DB2 TSO and batch users.

Test DSNMTV01 - Job NDBMTV01

NDBMTV01 contains a sample JCL to execute Natural by using the DB2 DL/I batch support.

Modify the sample JCL to meet site requirements.

The plan name must be the same as the name used in *Step 5: Create the DB2 Plan for Use with Natural for DB2*.

Online Verification Methods

To verify the installation of Natural for DB2 online, you can use either SQL Services or DEM2 example programs:

- Using SQL Services
- Using DEM2* Example Programs

Using SQL Services

To verify and check the Natural for DB2 installation by using the SQL Services of the Natural SYSDDM utility

1. Invoke Natural.
2. Invoke SYSDDM.
3. On the SYSDDM main menu enter Function Code B to invoke the **SQL Services** function.

   Enter Function Code S to select all DB2 tables.

   The communication between Natural and DB2 works if all existing DB2 tables are displayed.

   For one of the tables, generate a Natural DDM as described in the section *Generate DDM from an SQL Table* in *Generating Natural Data Definition Modules (DDMs)*.
4. After you have generated a DDM, access the corresponding DB2 table with a simple Natural program:

Example:

```
FIND view-name WITH field = value
 DISPLAY field
LOOP
END
```

If you receive the message NAT3700, enter the Natural system command `SQLERR` to display the corresponding SQL return code. .

Using DEM2* Example Programs

To verify and test your installation you can also use the example programs `DEM2*` in the Natural system library `SYSDB2` provided on the installation tape.

Using these example programs, you can create a DB2 table by using `DEM2CREA` and create the corresponding DDM using the Natural `SYSDDM` utility.

You can then store data in the created table by using `DEM2STOR` and retrieve data from the table by using `DEM2FIND` or `DEM2SEL`.

You can also drop the table by using program `DEM2DROP`.

Natural Parameter Modification for DB2

This section covers the following topics:

- Natural Profile Parameter Settings
- Performance Considerations for the DB2SIZE Parameter

Natural Profile Parameter Settings

To set the Natural profile parameter

1 Add the following Natural profile parameter to your NATPARM module:

```
DB2SIZE=nn
```

The DB2SIZE parameter can also be specified dynamically. It indicates the size of the DB2 buffer area, which must be set to at least 6 KB.

The setting of DB2SIZE also depends on whether you use the file server or not. If the file server is *not* used, the setting can be calculated according to the following formula:

```
((1064 + n1 * 40 + n2 * 120) + 1023) / 1024 KB
```

If the file server is used, the setting can be calculated according to the following formula:

```
((1160 + n1 * 40 + n2 * 160 + n3 * 8) + 1023) / 1024 KB
```

The variables *n1*, *n2* and *n3* correspond to:

n1	the number of statements for dynamic access as specified as the second parameter in Job I055, Step 1600;
n2	the maximum number of nested database loops as specified with the MAXLOOP parameter in NDBPARM;
n3	the maximum number of file server blocks to be allocated per user specified as the fifth parameter in Job I075, Step 1620 or the EBPMAX parameter of NDBPARM, if you decided to use the Software AG Editor buffer pool as file server.

Important: Ensure that you have also added the Natural parameters required for the Software AG Editor; see the relevant installation description in the section *Installing the Software AG Editor* of the Natural *Installation* documentation.

As DB2SIZE applies to Natural for DB2 and Natural for SQL/DS, it must be set to the maximum value if you run more than one of these environments.

2 Add an NTDB entry specifying the list of logical database numbers that relate to DB2 tables. All Natural DDMs that refer to a DB2 table must be cataloged with a DBID from this list. DBIDs can be any number from 1 to 254; a maximum of 254 entries can be specified. For most user environments, one entry is sufficient.

Important: Ensure that all DB2 DDMs used when cataloging a given program have a valid DB2 DBID. Also ensure that the DBIDs selected in the NTDB macro for DB2 do not conflict with DBIDs selected for other database systems.

The DBID for SQL/DS used when cataloging a Natural program does not have to be in the `NTDB` list of DBIDs used when executing this program. Therefore, when executing existing Natural programs, DBID 250 is not mandatory. Two sample `NTDB` macros follow:

```
NTDB DB2,250
```

```
NTDB DB2,(200,250,251)
```

Performance Considerations for the DB2SIZE Parameter

During execution of an SQL statement, storage is allocated dynamically to build the SQLDA for passing the host variables to DB2.

In previous Natural for DB2 versions, this storage was always obtained from the TP monitor or operating system. For performance reasons, it is now first attempted to meet the storage requirements by free space in the Natural for DB2 buffer (`DB2SIZE`). Only if there is not enough space available in this buffer, the TP monitor or operating system is invoked.

To take advantage of this performance enhancement, you must specify your `DB2SIZE` larger than calculated according to the **formula**; see ***Natural Profile Parameter Settings***.

Depending on the SQL execution mode and on the usage of the Natural file server, the additional storage requirements (in bytes) can be calculated as follows:

- Dynamic Mode
- Static Mode
- Storage Requirements for the File Server
- Sample Calculation for Dynamic Mode without Using the File Server
- Considerations for VARCHAR Fields

Dynamic Mode

- With sending fields:

```
80 + n * 56
```

With sending fields including LOB columns:

```
80 + 2 * n * 56
```

where *n* is the number of sending fields in an SQL statement.

The storage is freed immediately after the execution of the SQL statement.

- With receiving fields (that is, with variables of the `INTO` list of a `SELECT` statement):

```
80 + n * 56 + 24 + n * 2
```

With receiving fields including LOB columns:

```
80 + 2 * n * 56 + 24 + n * 2
```

where *n* is the number of receiving fields in an SQL statement.

The storage remains allocated until the loop is terminated.

Static Mode

- With sending fields:

```
80 + n * 24
```

With sending fields including LOB columns:

```
80 + 2 * n * 56
```

where *n* is the number of sending fields in an SQL statement.

The storage is freed immediately after the execution of the SQL statement.

- With receiving fields (that is, with variables of the `INTO` list of a `SELECT` statement):

```
80 + n * 24 + 24 + n * 2
```

With receiving fields including LOB columns:

```
80 + 2 * n * 56 + 24 + n * 2
```

where *n* is the number of receiving fields in an SQL statement.

The storage remains allocated until the loop is terminated.

Storage Requirements for the File Server

When using the file server, additional storage is required for each database loop that contains positioned `UPDATE` and/or `DELETE` statements.

For each of such loops, a buffer is allocated to save the contents of all receiving fields contained in the `INTO` list. Therefore, the size of this buffer corresponds to the total length of all receiving fields:

```
20 + 4 + sum (length (v1), ..., length (vn))
```

where `v1 ... vn` refers to the variables contained in the `INTO` list.

The buffer remains allocated until the loop is terminated.

Sample Calculation for Dynamic Mode without Using the File Server

If you use the default value 10 for both variables (*n1* and *n2*), the calculated `DB2SIZE` will be 2208 bytes. However, if you specify a `DB2SIZE` of 20 KB instead, the available space for dynamically allocated storage will be 18272 bytes, which means enough space for up to either 325 sending fields or 313 receiving fields.

Since space for receiving fields remains allocated until a database loop is terminated, the number of fields that can be used inside such a loop is reduced accordingly: for example, if you retrieve 200 fields, you can update about 110 fields inside the loop.

Considerations for VARCHAR Fields

When using `VARCHAR` fields (that is, fields with either an accompanying `L@` field in the Natural view or an explicit `LINDICATOR` clause), additional storage is allocated dynamically if the `L@` or `LINDICATOR` field is not specified directly in front of the corresponding base field. Therefore, always specify these fields in front of their base fields.

Parameter Module NDBPARM

The source module NDBPARM is used in several Natural add-on products. It contains parameter macros specific to an SQL environment:

- NDBPRM
- NDBID

These macros are described below.

Parameter Macro NDBPRM

The default values of the parameters contained in this macro can be modified to meet site-specific requirements (see the **corresponding step** in *Common Installation Steps*). The values of the parameters cannot be dynamically overwritten.

Below is a description of all parameters contained in the NDBPRM macro:

BTIGN | CONVERS | CONVRS2 | DDFSERV | DELIMID | EBPFSRV | EBPPRAL | EBPSEC | EBPMAX | ETIGN | FSERV | MAXLOOP | NNPSF | PSCIGN | REFRESH | RETRYPO | RWRDONL | STATDYN

BTIGN - Ignore BACKOUT TRANSACTION Error

This parameter is enables you to ignore the error which results from a BACKOUT TRANSACTION statement that was issued too late for backing out the current transaction, because an implicit Syncpoint has previously been issued by the TP monitor.

Possible Values:

Value	Explanation
ON	The error after a late BACKOUT TRANSACTION is ignored. This is the default value.
OFF	The error after a late BACKOUT TRANSACTION is *not* ignored.

CONVERS - Conversational Mode under CICS

This parameter is used to enabled conversational mode in CICS environments where no Natural for DB2 file server is used.

Possible Values:

Value	Explanation
ON	Conversational mode is allowed. This is the default value.
OFF	Conversational mode is *not* allowed.

If this parameter is set to OFF and no Natural file server is used, you cannot continue database loops across terminal I/Os; if so, the DB2 SQL codes -501, 504, 507, 514, or 518 may occur.

If you are using the ***SYSDDM SQL Services*** in a CICS environment without Natural for DB2 file server, you must specify CONVERS=ON, otherwise you get the errors mentioned above.

CONVRS2 - Allow Conversational Mode 2 under CICS

This parameter is used to allow conversational mode 2 in CICS environments.

Possible Values:

Value	Explanation
ON	Conversational mode 2 is allowed.
OFF	Conversational mode 2 is *not* allowed. This is the default value.

This parameter is used to control conversational mode 2 in CICS environments. Conversational mode 2 means that update transactions are spawned across terminal I/Os until either an explicit COMMIT or explicit ROLLBACK has been issued (Caution: DB2 and CICS resources are kept across terminal I/Os!). This means CONVRS2=ON has the same effect as the Natural parameter PSEUDO=OFF, except that the conversational mode is entered after an DB2 update statement (UPDATE, DELETE, INSERT) and left again after a COMMIT or ROLLBACK, while PSEUDO=OFF causes conversational mode for the total Natural session.

See also CALLNAT subprogram NDBCONV, which allows setting or resetting conversational mode 2 dynamically.

DDFSERV - Alternate DD Name for Natural File Server

This parameter specifies a DD name for the Natural for DB2 file server module other than CMFSERV.

Possible Values:

Value	Explanation
DD-name	Any valid DD name. There is no default value.

DELIMID - Escape Character for Delimited Identifiers

This parameter determines the escape character to be used for generating delimited SQL identifiers for the column names and table names in SQL statements. A delimited identifier is a sequence of one or more characters enclosed in escape characters. You must specify a delimited identifier if you use SQL-reserved words for column names and table names, as demonstrated in the *Example of DELIMID* below.

Possible Values:

Value	Explanation
"	Double quotation mark
'	Single quotation mark
None	No value: Delimited identifiers are not enabled. This is the default value.

To enable generation of delimited identifiers, `DELIMID` must be set to double quotation mark (“”) or single quotation mark (').

The escape character specified for `DELIMID` and the SQL `STRING DELIMITER` are mutually exclusive. This implies that the mark (double or single quotation) used to enclose alphanumeric strings in SQL statements must be different from the value specified for `DELIMID`. If you enable delimited identifiers, ensure that the value specified for `DELIMID` also complies with the SQL `STRING DELIMITER` value of your DB2 installation.

See also the `RWRDONL` parameter to determine which delimited identifiers are generated in the SQL string.

Example of DELIMID:

In the following example, a double quotation mark (“”) has been specified as the escape character for the delimited identifier:

Natural statement:

```
SELECT FUNCTION INTO #FUNCTION FROM XYZ-T1000
```

Generated SQL string:

```
SELECT "FUNCTION" FROM XYZ.T1000
```

EBPFSRV - Editor Buffer Pool for Natural File Server

This parameter is used to determine whether the Natural file server uses the Software AG Editor buffer pool as the storage medium.

Possible Values:

Value	Explanation
ON	The Software AG buffer pool is to be used as the storage medium for the Natural file server. ON *must* be set if the file server is to be used in a Parallel Sysplex environment. In this case, your Natural session must use the auxiliary editor buffer pool (see also *Support of a z/OS Parallel Sysplex Environment* in the *Installation* documentation).
OFF	A VSAM file is to be used as the storage medium for the Natural file server. This is the default value.

EBPPRAL - Editor Buffer Pool Primary Allocation

This parameter specifies the number of blocks to be allocated primarily to each user of the Natural file server, if the Software AG Editor buffer pool is used as the storage medium.

Possible Values:

Value	Explanation
0 - 32676	Number of blocks to be allocated primarily.
20	This is the default value.

If the EBPFSRV parameter is set to OFF, EBPPRAL is not used at runtime.

EBPSEC - Editor Buffer Pool Secondary Allocation

This parameter specifies the number of blocks to be allocated secondarily to each user of the Natural file server if the Software AG Editor buffer pool is used as the storage medium. The secondary allocation is used to allocate buffer pool blocks to the user if the primary allocation amount is already exhausted.

Possible Values:

Value	Explanation
`0 - 32676`	Number of blocks to be allocated secondarily.
`10`	This is the default value.

If the `EBPFSRV` parameter is set to `OFF`, `EBPSEC` is not used at runtime.

EBPMAX - Editor Buffer Pool Maximum Allocation

This parameter specifies the maximum number of blocks to be allocated to each user of the Natural file server if the Software AG Editor buffer pool is used as the storage medium. This parameter serves as upper limit for the allocation of buffer pool blocks to a single user.

Possible Values:

Value	Explanation
`0 - 32676`	Maximum number of blocks to be allocated.
`100`	This is the default value.

If the `EBPFSRV` parameter is set to `OFF`, `EBPMAX` is not used at runtime.

ETIGN - Ignore END TRANSACTION Error

This parameter is relevant in IMS MPP and message-oriented BMP environments only.

It is used to handle `END TRANSACTION` statements in a message-driven IMS region (MPP or message-oriented BMP).

In such a region, an `END TRANSACTION` cannot be executed by the Natural IMS TM Interface and is therefore ignored without any notification. In such situations, the `ETIGN` parameter can be used to issue an error message instead.

Possible Values:

Value	Explanation
ON	The END TRANSACTION error is ignored and processing is continued. This is the default value.
OFF	The END TRANSACTION error is *not* ignored.

FSERV - Activate Natural File Server

This parameter determines whether the Natural file server is to be used and whether it can be disabled in the case of an initialization error.

Possible Values:

Value	Explanation
ON	Natural file server is to be used.
OFF	Natural file server is not to be used. This is the default value.
DIS	Natural file server is to be used but is to be disabled if it cannot be initialized.

If FSERV is set to ON and the Natural file server is not operational, the initialization of Natural for DB2 is terminated with a corresponding Natural error message. The Natural interface to DB2 is disabled and any SQL call is rejected with a corresponding error message.

MAXLOOP - Maximum Number of Nested Program Loops

This parameter specifies the maximum possible number of nested database loops accessing SQL databases.

Possible Values:

Value	Explanation
1 - 99	Maximum possible number of nested database loops.
10	This is the default value.

NNPSF - Set Natural Numerics' Positive Sign to F

This parameter changes the sign character of positive Natural variables which have format N, if they are filled from the SQL database system. Usually these variables have the `C` as positive sign character. If the parameter `NNPSF` is set to `ON`, `F` is used as positive sign character.

Possible Values:

Value	Explanation
`ON`	Positive numbers put into Natural numeric variables by the SQL database system get the sign `F`.
`OFF`	Positive numbers put into Natural numeric variables by the SQL database system remain unchanged. This is the default value.

PSCIGN - Treat Positive Sqlcodes as Slqcode 0

This parameter influences the treatment of positive sqlcodes returned from the SQL database system. If the parameter `PSCIGN` is set to `OFF`, a NAT3700 error message is issued. If the parameter `PSCIGN` is set to `ON`, positive sqlcodes are treated as if they were zero, that is, no NAT3700 error message is issued.

Possible Values:

Value	Explanation
`ON`	Positive sqlcodes are treated as zero.
`OFF`	Positive sqlcodes cause a NAT3700 error message. This is the default value.

REFRESH - Refresh Setting of DB2 Server and Package Set

This parameter is used to automatically set the DB2 server and package set to the values that applied when the last transaction was executed. Server and package set are refreshed by using the `CONNECT TO server-name` and `SET CURRENT PACKAGESET = 'package-name'` SQL statements of DB2.

Possible Values:

Value	Explanation
`ON`	An automatic refresh is performed every time before a database transaction starts and if a server or package set has been specified.
`OFF`	No automatic refresh is performed. This is the default value.

RETRYPO - Number of Positioning Retries

This parameter delimits the number of retries done by Natural for DB2 in order to reposition a dynamic scrollable cursor in a pseudo-conversational environment (IMS MPP or CICS).

Possible Values:

Value	Explanation
`0 - 2147483648`	Number of retries done by Natural for DB2.
`10`	This is the default value.

This parameter applies only for dynamic scrollable cursors.

In pseudo-conversational environments, cursors are closed at terminal I/O. For dynamic scrollable cursors the current absolute position number and the current key column values are saved. After terminal I/O the dynamic scrollable cursor is opened again and positioned absolutely to the position of the saved absolute position. The contents of the key columns are compared with the saved values. If they match, processing continues with the next requested database operation.

If the contents of the key columns do not match the saved values, the next rows are fetched and compared with the saved values until either the values match or no row is found or the `RETRYPO` count is exhausted. In the latter cases the cursor is repositioned to the saved position and the prior rows are fetched and compared until either the values match or no row is found or the `RETRYPO` count is exhausted. In the latter cases a NAT3703 error message is issued. If a row is fetched whose key columns matches the saved values, processing continues with the next database instruction.

`RETRYPO` delimits the retries in each direction (*next* or *prior*).

If `RETRYPO` is zero no repositioning takes place.

RWRDONL - Generate Delimited Identifiers for Reserved Words Only

This parameter determines which identifiers are generated as delimited identifier in an SQL string. `RWRDONL` only takes effect if the setting of the `DELIMID` parameter allows delimited identifiers.

Possible Values:

Value	Explanation
`ON`	Only identifiers that are reserved words are generated as delimited identifiers. The list of reserved words is contained in the `NDBPARM` macro. This list has been merged from the lists of reserved words for DB2 for z/OS, DB2 for VSE/VM, DB2 for LINUX, OS/2, Windows and UNIX, and ISO/ANSI SQL99. This is the default value.
`OFF`	All identifiers are generated as delimited identifiers.

STATDYN - Allow Static to Dynamic Switch

This parameter is used to allow dynamic execution of statically generated SQL statements if the static execution returns an error.

Possible Values:

Value	Explanation
`NEVER`	Dynamic execution is never allowed. This is the default value.
`ALWAYS`	Dynamic execution is always allowed after an error.
`SPECIAL`	Dynamic execution is allowed after special errors only. These special errors are: ■ NAT3706: Load module not found ■ SQL -805: DBRM (database request module) does not exist in plan ■ SQL -818: Mismatch of timestamps

Parameter Macro NDBID

The parameter macro `NDBID` determines the database type of an SQL DBID.

The `NDBID` macro is specified as follows:

1. Default Database Definition

   The default database type is specified as follows. It applies to all database IDs not explicitly specified by `NDBID`.

   ```
   NDBID=database-type
   ```

2. Single Database Definition

   A single database ID and its type is specified as follows:

   ```
   NDBID=database-type,database-id
   ```

3. Multiple Database Definition

Multiple database IDs of the same database type can be specified together, enclosed in parentheses:

```
NDBID=(database-type,database-id1,database-id2,...)
```

database-type

Possible Values	Explanation
DB2	Databases are accessed via Natural for DB2. This is the default value.

database-id

Possible Values
1-254

Special Requirements for Natural Tools for DB2

To be able to use the Natural Tools for DB2 (see ***Using Natural Tools for DB2***), consider the following requirements and recommendations:

- Retrieval and Explain Functions
- LISTSQL and Explain Functions

Retrieval and Explain Functions

In order to be independent of DB2 versions, the Natural Tools for DB2 Retrieval and Explain functions have been designed not to access the DB2 catalog tables directly, but to access identical tables qualified by the creator name SYSSAG.

Thus, before you can use the Retrieval or Explain functions, you must create these tables. The SYSSAG tables must have the same columns as the DB2 catalog tables and they must be created as ALIAS, VIEW, or TABLE.

To help you create these tables, sample SQL code is provided in the member DEMSQL4 in the Natural system library SYSDB2. By default, it creates an ALIAS SYSSAG.*xxx* for the corresponding SYSIBM table.

For some catalog tables no indexes are defined. For performance reasons, consider creating copies of these tables with appropriate indexes.

For the following tables it is recommended to work with copies of the catalog tables:

SYSCOLAUTH

```
SYSDBRM
SYSFOREIGNKEYS
SYSINDEXPART
SYSKEYS
SYSSTMT
SYSSYNONYMS
SYSTABLEPART
SYSVIEWS
```

The CREATE TABLE and CREATE INDEX statements required are included as comments in the sample SQL member DEMSQL4. In addition, DEMSQLUP includes sample SQL code to update the data in the copies of the catalog tables.

For any other table, it is recommended that you create an ALIAS or a VIEW that points to the corresponding SYSIBM table.

Note: The sample SQL members can be executed with the ISQL part of SYSDB2. ISQL enables you to read SQL members from the Natural system library SYSDB2. To save an SQL member in any other library, you can use the command LIBRARY MYLIB in the ISQL input screen to switch to another library and then save the SQL member. You cannot save SQL members in the library SYSDB2.

LISTSQL and Explain Functions

These functions access DB2 PLAN_TABLEs.

To use these functions

- Add an LFILE definition for logical file 101 to the NATPARM parameter module:

  ```
  LFILE=(101,bdid,2)
  ```

  where *bdid* is your DBID for DB2

  A PLAN_TABLE must exist for your SQLID.

For the layout of the PLAN_TABLE, see the relevant DB2 documentation by IBM of the EXPLAIN command.

It is recommended that you create an index on the following columns of the PLAN_TABLE:

```
APPLNAME
PROGNAME
COLLID
QUERYNO
TIMESTAMP
```

```
DESC
QBLOCKNO
PLANNO
MIXOPSEQ
```

Natural for DB2 Server Stub

A Natural for DB2 server stub is an interface module needed to communicate between the DB2 database system and the Natural server. The server stub module determines, sets up and invokes a Natural server environment for executing Natural stored procedures and Natural user-defined functions.

As mentioned in the Installation Procedure, there are two types of server stubs: the Natural for DB2 start server stub (STR) and the Natural for DB2 server stub (SRV). Both stubs are generated from the `NDBSTUB` macro.

- Natural for DB2 Start Server Stub
- Natural for DB2 Server Stub
- JCL Procedure
- Macro NDBSTUB

Natural for DB2 Start Server Stub

The Natural for DB2 start server stub is used for setting up the Natural server environments desired. The start server stub must be the main execution program in the Stored Procedure Address Space (SPAS). After the start server stub has established the Natural server environments, it passes control to the appropriate DB2 program (`DSNX9WLM` for WLM SPAS and `DSNX9STP` for DB2 SPAS). When SPAS terminates, the DB2 program returns control to the start server stub. The start server stub stops the Natural server environments and returns control to the operating system.

The Natural for DB2 start server stub reads the names and parameters of the Natural server to be started from the `CMSRVIN` dataset. `CMSRVIN` must be specified with `DDNAME CMSRVIN`.

The `CMSRVIN` dataset is a sequential file that contains all information required to start the desired Natural servers. For each server to be started, one `START` entry must be provided. The parameters used for the `START` entries are identical to the parameters that apply to the `NDBSTUB` macro. Enclose the contents of each `START` entry in brackets and delimit comments by the following signs: `/*` and `*/`.

Example of START Entries:

```
START=(SERVER=WDB42SRV,NATURAL=NATBAT4R,CMPRMIN=CMPRMIN,
        CMPRINT=CMPRINT,CMTRACE=CMTRACE,THREADSIZE=768,
        THREADNUMBER=2,TRACE=ON)
 START=(SERVER=WDB4SSRV,NATURAL=NATBAT4R,CMPRMIN=CMPRMIN,
        CMPRINT=CMPRINT,CMTRACE=CMTRACE,THREADSIZE=768,
        THREADNUMBER=2,TRACE=ON)
/*  START=(SERVER=QE42SRV,NATURAL=NATBAT41,CMPRMIN=QAPARM4, */
/*        CMPRINT=CMPRINT,CMTRACE=CMTRACE,THREADSIZE=700, */
/*        THREADNUMBER=2,TRACE=OFF) */
```

If the start server dataset is missing or has not been assigned, the start server stub will start a Natural server environment with the parameters that derive from the parameters defined for the start server stub itself.

Natural for DB2 Server Stub

The Natural for DB2 server stub is the link between DB2 and Natural stored procedures or Natural user-defined functions (Natural UDFs). Specify the Natural for DB2 server stub as `EXTERNAL NAME` in the `SYSIBM.SYSROUTINES` table row that refers to the Natural stored procedure or Natural UDF. The server stub is started by DB2/WLM when the Natural stored procedures or Natural UDFs are invoked. The Natural for DB2 server stub creates a Natural session in the Natural server environment and invokes the Natural subprogram comprising the Natural stored procedure or the Natural UDF.

A Natural session created for executing a Natural stored procedure terminates when the corresponding Natural subprogram ends and control returns to DB2 and to the calling client.

A Natural session created for executing a Natural UDF stays active for multiple function invocations if the `PARALLEL` attribute is set to `D` and the `FINAL CALL` attribute is set to `Y`. The session invoked for a Natural UDF function is terminated by the server stub if it detects a termination call.

JCL Procedure

The JCL procedure of the Stored Procedure Address Space (SPAS) must specify the Natural for DB2 start server stub as program in the `EXEC` statement.

The Natural for DB2 start server stub and the Natural for DB2 server stub must reside in a library contained in the steplib concatenation of the JCL procedure of the SPAS.

Example JCL:

```
//*************************************************************
//*    JCL FOR RUNNING THE WLM-ESTABLISHED STORED PROCEDURES
//*    ADDRESS SPACE
//*       RGN     -- MVS REGION SIZE FOR THE ADDRESS SPACE.
//*       DB2SSN  -- DB2 SUBSYSTEM NAME.
//*       NUMTCB  -- NUMBER OF TCBS USED TO
//*                  PROCESS END USER REQUESTS.
//*       APPLENV -- MVS WLM APPLICATION ENVIRONMENT
//*                  SUPPORTED BY THIS JCL PROCEDURE.
//*
//*************************************************************
//DB27ENV2 PROC RGN=0K,APPLENV=DB27ENV2,DB2SSN=DB27,NUMTCB=8
//IEFPROC EXEC PGM=WDB42STR,REGION=&RGN,TIME=NOLIMIT,  /*  start server stub

//*IEFPROC EXEC PGM=DSNX9WLM,REGION=&RGN,TIME=NOLIMIT,
//        PARM='&DB2SSN,&NUMTCB,&APPLENV'
//STEPLIB  DD  DISP=SHR,DSN=DSN710.RUNLIB.LOAD
//         DD  DISP=SHR,DSN=CEE.SCEERUN
//         DD  DISP=SHR,DSN=DSN710.SDSNLOAD
//        DD  DISP=SHR,DSN=NATURAL.V2.TEST.NUCLEUS    /* Library containing stubs
and Natural nucleus
//CMPRMIN  DD  DISP=SHR,DSN=SAG.SYSF.SOURCE2(TDB31PRM) /* Dynamic Natural parameters.

//CMSRVIN  DD  DISP=SHR,DSN=SAG.SYSF.SOURCE2(CMSRVIN)  /* Servers to be started.

//CEEDUMP  DD  SYSOUT=X
//SYSOUT   DD  SYSOUT=X                               /* Traces records of server
stub

//RMTRACE  DD  SYSOUT=X
//CMPRINT  DD  SYSOUT=X
//SYSPRINT DD  SYSOUT=X
//SYSERROR DD  SYSOUT=X
//SYSUDUMP DD  SYSOUT=X
```

Macro NDBSTUB

The `NDBSTUB` macro is used to generate the Natural for DB2 server stub and Natural for DB2 start server stub. You can parameterize `NDBSTUB` to create different stubs.

Below are the parameters available with `NDBSTUB`:

`CMPRINT` | `CMPRMIN` | `CMTRACE` | `GTRACE` | `GTRCID` | `MAIN` | `MODE` | `NATURAL` | `SERVER` | `THREADNUMBER` | `THREADSIZE` | `TRACE` | `WLM`

CMPRINT - DDNAME of CMPRINT Dataset

`CMPRINT` specifies the DDNAME of the `CMPRINT` dataset to which the primary report output is written. If an asterisk (*) is specified, a unique DDNAME `P`*`nnnnnnn`* is built whenever a Natural stored procedure is invoked.

Possible Values:

Value	Explanation
ddname	8 character DDNAME
`CMPRINT`	This is the default value.

CMPRMIN - DDNAME of CMPRMIN Dataset

`CMPRMIN` specifies the DDNAME of the `CMPRMIN` dataset during startup to read the input `PROFILE` parameter for this server.

Possible Values:

Value	Explanation
ddname	8 character DDNAME
`CMPRMIN`	This is the default value.

CMTRACE - DDNAME of CMTRACE Dataset

`CMTRACE` specifies the DDNAME of the `CMTRACE` dataset to which the primary report output is written. If an asterisk (*) is specified, a unique `DDNAME P`*`nnnnnnn`* is built whenever a Natural stored procedure is invoked which makes it possible to store each output separately.

Possible Values:

Value	Explanation
ddname	8 character DDNAME
`CMTRACE`	This is the default value.

GTRACE - Natural for DB2 Server Stub to Execute GTRACE Calls

`GTRACE` specifies whether or not the server stub executes `GTRACE` macro calls for tracing purposes.

Possible Values:

Value	Explanation
`ON`	The generated server stub executes `GTRACE` macros in order to document its processing.
`OFF`	The generated server stub does not execute `GTRACE` macros during its processing cycle. This is the default value.

GTRCID - GTRACE ID to be Used

`GTRCID` specifies the event ID recorded with the trace data created by the Natural for DB2 server stub.

Possible Values:

Value	Explanation
`event-id`	Decimal number from `0` to `1023`
`203`	This is the default value.

MAIN - No Longer Relevant and only Maintained for Compatibility Reasons

The value of `MAIN` is no longer evaluated. The Natural for DB2 server stubs check whether they are invoked as IBM LE (Language Environment) main program or as IBM LE subprograms and react accordingly.

Value	Explanation
`YES`	The generated server stub operates as IBM Language Environment main program. This is the default value.
`NO`	The generated server stub operates as IBM Language Environment sub program.

MODE - Operating Mode of Natural for DB2 Server Stub

`MODE` determines the operating mode of the Natural for DB2 server stub generated.

Value	Explanation
`STR`	The generated Natural for DB2 server stub operates as Natural for DB2 start server stub that sets up the Natural server environment.
`SRV`	The generated Natural for DB2 server stub operates as Natural for DB2 server stub that invokes the associated Natural stored procedure or Natural user defined function (UDF). This is the default value.

NATURAL - Name of Server Front-End or Natural Server

`NATURAL` denotes the name of the server front-end or Natural server load module which will be loaded by the Natural for DB2 server stub if the external `CMSTART` is not already resolved by the linkage editor during creation of the server stub. The named load module has to be present in any steplib of the stored procedure address space.

Value	Explanation
name	Any valid load module name
`NATBAT`*vr*	This is the default value.

where *vr* is the current product version number.

SERVER - Server Name for Natural Server Environment

Server names suffixed with the three characters `SRV` denote the names of the servers used by the server front-end in order to identify the Natural server. These names must be unique within one address space.

Value	Explanation
server-name	Up to 5 characters
`NDB`*vr*	This is the default value.

where *vr* is the current product version number.

THREADNUMBER - No Longer Relevant and only Maintained for Compatibility Reasons

`THREADNUMBER` determines the number of Natural threads used by the Natural server. This number limits the number of Natural stored procedures and Natural UDFs concurrently active in the Natural server.

Note: The value of `THREADNUMBER` is no longer evaluated. Instead, the Natural for DB2 start server stub uses the `NUMTCB` parameter of the SPAS JCL procedure as `THREADNUMBER` value. For further details, see the relevant DB2 literature by IBM.

Value	Explanation
number	Decimal number
10	This is the default value.

THREADSIZE - Size of Natural Threads for Natural Server

`THREADSIZE` determines the size of the Natural threads to be used by the Natural server. The size is specified in units of kilobytes.

Value	Explanation
threadsize	Decimal number
768	This is the default value.

TRACE - Natural for DB2 Server Stub to Write Trace Rrecords

Determines whether the Natural for DB2 server stub generated writes trace records or not. The trace records are written to the dataset specified with `DDNAME SYSOUT`.

Value	Explanation
YES	Trace records are written.
NO	No trace records are written. This is the default value.

WLM - Natural for DB2 Start Server Stub Mode WLM/DB2 SPAS

`WLM` (Workload Manager) specifies where control is passed to after the Natural for DB2 start server stub has established the Natural server environments requested.

This parameter is only evaluated if the MODE parameter is set to MODE=STR. Specify WLM=YES if the Natural for DB2 start server stub runs in an address space that has been established by WLM.

Value	Explanation
YES	The start server stub generated links to DSNX9WLM, after setting up the Natural server environments.
NO	The start server stub generated links to DSNX9STP, after setting up the Natural server environments. This is default value.

5 Accessing a DB2 Table

To enable access to a DB2 table with a Natural program

1. Use the Natural Tools for DB2 to define a DB2 table; see ***Using Natural Tools for DB2***.
2. Use Predict or the **SQL Services** function of the Natural `SYSDDM` utility to create a Natural data definition module (DDM) of the defined DB2 table.
3. Once you have defined a DDM for a DB2 table, you can access the data stored in this table by using a Natural program.

Natural for DB2 translates the statements of a Natural program into SQL statements.

Natural automatically provides for the preparation and execution of each statement. In dynamic mode, a statement is only prepared once (if possible) and can then be executed several times. For this purpose, Natural internally maintains a table of all prepared statements (see ***Statement Table*** in *Internal Handling of Dynamic Statements*).

Almost the full range of possibilities offered by the Natural programming language can be used for the development of Natural applications which access DB2 tables. For a number of Natural DML statements, however, there are certain restrictions and differences as far as their use with DB2 is concerned; see ***Using Natural Native DML Statements*** as described in ***Using Natural Statements and System Variables***.

In the Natural *Statements* documentation, you can find notes on Natural usage with DB2 attached to the descriptions of the Natural DML statements concerned; see the Statements *Overview*.

As there is no DB2 equivalent to Adabas internal sequence numbers (ISNs), any Natural features which use ISNs are not available when accessing DB2 tables with Natural.

For SQL databases, in addition to the Natural native DML statements, Natural provides SQL statements as described in *Using Statements and System Variables*. In the Natural *Statements* documentation you can find a detailed description of these statements; see the section *SQL Statements*.

6 Using Natural Tools for DB2

This section describes how to invoke Natural Tools for DB2 and edit within the utilities available. In addition, it contains information on global PF-key settings and global maintenance commands.

Notes:

1. See also *Special Requirements for Natural Tools for DB2*.
2. If you have created a new `SYSDB2` library when installing Natural for DB2, ensure that it contains all Predict interface programs necessary to run the Natural Tools for DB2. These programs are loaded into `SYSDB2` at Predict installation time (see the relevant Predict documentation).

Invoking Natural Tools for DB2

To invoke Natural Tools for DB2

- Enter the Natural system command `SYSDB2`

The Natural Tools for DB2 **Main Menu** is displayed, which offers you the functions listed below.

```
15:04:05                ***** NATURAL TOOLS FOR DB2 *****             2009-11-27
                                   - Main Menu -


                        Code Function

                         A   Application Plan Maintenance
                         C   Catalog Maintenance
                         I   Interactive SQL
                         R   Retrieval of System Tables
                         S   Environment Setting
                         X   Explain PLAN_TABLE
                         F   File Server Statistics
                         D   DB2 Commands Execution
                         ?   Help
                         .   Exit

                  Code .. _


Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                                   Canc
```

Main Menu Functions

Function	Description
Application Plan Maintenance	Maintain DB2 application plans online.
Catalog Maintenance	Maintain the DB2 catalog.
Interactive SQL	Process SQL statements that are not embedded.
Retrieval of System Tables	Display/print DB2 objects and user authorizations.
Environment Setting	Execute SQL statements and display special register values.
Explain PLAN_TABLE	Interpret your PLAN_TABLE.
File Server Statistics	Display statistics on the generation and use of the file server.
DB2 Commands Execution	Issue DB2 commands from Natural.

Editing within the Natural Tools for DB2

The free-form editor available within the Natural Tools for DB2 requires that the Software AG Editor is installed. The main and line commands available for use within the Natural Tools for DB2 are a subset of those available within this editor.

Both main commands and line commands are described in detail as part of the Natural Tools for DB2 online help facility, which is invoked by pressing PF1 (Help). For further details, please refer to the Software AG Editor documentation.

Overview of Editor Main Commands

Main commands are entered in the command line of the editor screen. The most important main commands are:

Command	PF Key	Description
BOTTOM (++)		Positions to the bottom of the data.
CHANGE		Scans for a specified string and replaces each such string found with another specified string.
CLEAR		Clears the editor source area.
DELETE		Deletes the line(s) containing a given string according to the specified selection operands.
DOWN (+)	PF8	Scrolls the specified scroll amount downwards.
FIND		Finds a string specified by command operands at the location(s) specified by selection operands.
LEFT	PF10	Scrolls the specified scroll amount to the left.
LIMIT *n*		Sets a limit for the FIND command; *n* lines are processed.

Command	PF Key	Description
PRINT		Prints the data displayed.
RESET		Resets all pending line commands.
RFIND	PF5	Repeats the last FIND command.
RIGHT	PF11	Scrolls the specified scroll amount to the right.
TOP (--)		Positions to the top of the data.
UP (-)	PF7	Scrolls the specified scroll amount upwards.

The scroll amount for the UP, DOWN, LEFT, and RIGHT commands is specified in the SCROLL field at the top right corner of the list screen. Valid values for the scroll amount are:

Value	Explanation
CSR	Scroll amount is determined by cursor position
DATA	Scroll amount equals the page size less one line
HALF	Scroll amount is half the page size
MAX	Scroll amount equals the amount of data to the bottom/top
PAGE	Scroll amount is equal to the page size
n	Scroll amount is equal to *n* lines

Overview of Editor Line Commands

Line commands are entered in the editor prefix area of the corresponding statement line. The most important line commands are:

Command	Description
A	Inserts line(s) to be moved or copied after the current line.
B	Inserts line(s) to be moved or copied before the current line.
C	Copies the current line.
CC	Marks the beginning and end of a block of lines to be copied.
D	Deletes the current line.
DD	Marks the beginning and end of a block of lines to be deleted.
I*nn*	Inserts *nn* new lines after the current line.
M	Moves the current line.
MM	Marks the beginning and end of a block of lines to be moved.

Global PF-Key Settings

Within the Natural Tools for DB2, the following global PF-key settings apply:

Key	Setting	Description
PF1	Help	Pressing PF1 invokes the Natural Tools for DB2 online help system from any screen within the Natural Tools for DB2.
PF3	Exit	Pressing PF3 always takes you to the previous screen or function. When pressed on an editor screen where modifications have been made, the **Exit Function** window is displayed (as described in **Exit Function** in the sections Program Editor and Data Area Editor in the Natural *Editors* documentation). When you press PF3 on the Main Menu, you leave the Natural Tools for DB2.
PF12	Canc	Pressing PF12 always takes you back to the menu from where the current screen has been invoked. When you press PF12 on the **Main Menu**, you leave the Natural Tools for DB2.

Global Maintenance Commands

Within the Natural Tools for DB2, the following global maintenance commands apply:

Command	Description
COPY *name*	Copies the specified member from the current library into the editor, after (A) or before (B) the current line.
LIBRARY *name*	Specifies the Natural library *name* as current library.
LIST *name**	Lists all members from the current library whose names start with *name*. From the list, you can select a member by marking it with “S”.
PURGE *name*	Purges the specified member from the current library.
READ *name*	Reads the specified member from the current library into the editor. The current name is set to *name*.
SAVE [*name*]	Saves the generated code as the member *name* in the current library. If no name is specified, the current name is taken. Current library and member names are displayed above the Command line.

Member and library names must correspond to the Natural naming conventions: see *Object Naming Conventions* and *Library Naming Conventions* in *Using Natural*. Members can be JCL members, SQL members, or output members.

7 Application Plan Maintenance

Introduction

The application plan maintenance part of the Natural Tools for DB2 is used to generate JCL code to:

- create database request modules (DBRMs) from your Natural programs,
- maintain DB2 application plans and packages from within your Natural environment.

Two modes of operation are available: fixed mode and free mode.

Fixed Mode

In fixed mode, maintenance screens with syntax graphs help you to specify the correct commands. Complete JCL members can be generated using predefined job profiles. You simply enter the required data in input maps. The data are checked to ensure that they comply with the correct syntax. Then JCL members are generated from these data. The members can be submitted directly by pressing PF4 (Submi). But you can also switch to free mode by pressing PF5 (Free).

Free Mode

Pressing PF5 in fixed mode invokes the free-mode editor, which can be used to modify JCL code generated in fixed mode, without the syntactical restrictions imposed. In free mode you can submit the JCL member currently in the source area by pressing PF4 (as in fixed mode).

Invoking the Application Plan Maintenance Function

To invoke the Application Plan Maintenance function

- On the **Natural Tools for DB2 Main Menu**, enter function code A.

  The **Application Plan Maintenance** menu is displayed:

```
16:14:02              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                        - Application Plan Maintenance -


                   Code Function                Parameter


                    PP  Prepare Job Profile
```

```
                    CD  Create DBRMs           Lib

                    BI  Bind                   Lib, Obj

                    RB  Rebind                 Lib, Obj

                    FR  Free                   Lib, Obj

                    LJ  List   JCL             Lib, JCL

                    JO  Display Job Output     Node

                    ?   Help

                    .   Exit


           Code .. __  Object ...... ________

                       Library ..... SAG_____

                       JCL Member .. ________

                       Node ........ 148


 Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help        Exit                                       Logn        Canc
```

The following functions are available:

Code	Description
PP	Defines job profiles for DBRM creation and plan/package maintenance; see *Prepare Job Profile*.
CD	Generates JCL to create database request modules.
BI	Generates JCL to bind a plan or package.
RB	Generates JCL to rebind a plan or package.
FR	Generates JCL to free a plan or package.
LJ	Invokes the free-mode editor.
JO	Displays job output. **Note:** This function only applies if the Entire System Server is installed.

In addition, four parameters are available, which must be specified according to the selected function:

Parameter	Description
Object	Specifies whether to maintain a plan (PLAN or PL) or a package (PACKAGE or PK).
Library	Specifies the name of a Natural source library. All existing libraries except the ones beginning with SYS can be specified; a library must be specified for JCL maintenance. The library name is preset with your Natural user ID.
JCL Member	If a valid member name is specified, the corresponding JCL member is displayed. If a value is specified followed by an asterisk (*), all JCL members in the specified library whose names begin with this value are listed. If asterisk notation is specified only, a selection list of all JCL members in the specified library is displayed. If the JCL Member field is left blank, the empty free-mode editor screen is displayed.
Node	Specifies the number of the node to be used by the Entire System Server. The default number “148” can be overwritten.

Commands and PF-Key Settings

Within the maintenance screens in fixed mode, various windows can be invoked. These windows are accessed via 1-byte control fields.

To invoke a window

- Enter S in the corresponding control field.

If the control field displays an X, data have already been entered in the corresponding window.

In addition, the following PF-key settings apply in fixed mode:

Key	Function
PF4	Generates JCL code and submits it.
PF5	Generates JCL code and enters free mode.
PF6	Scrolls to the top of a window.
PF7	Scrolls backwards in windows.
PF8	Scrolls forwards in windows.
PF9	Scrolls to the bottom of a window.

Key	Function
PF10	Either shows the previous screen (<) or displays a **Natural Process Logon** window (Logn).
PF11	Shows the next screen.

In free mode, JCL code can be edited and submitted. Editing of JCL code is done via edit and line commands; see *Editing within the Natural Tools for DB2*.

Generated JCL code is submitted by pressing PF4.

Apart from being submitted, JCL code can also be copied, listed, purged, retrieved from, or saved in a Natural library. All this is done via maintenance commands; see *Global Maintenenance Commands*.

Prepare Job Profile

If you want to generate JCL to create a DBRM or to bind, free, or rebind a plan or package, you have to specify a job name, job cards, and the name of a job profile. Thus, you have to prepare the job profiles first. Once your job profiles are defined, you can always immediately select the corresponding function if you want to create a new DBRM or if you want to bind, free, or rebind an a plan or package using your predefined job profiles.

To define a job profile

1. On the **Natural Tools for DB2 Main Menu**, enter function code A.

   The **Application Plan Maintenance** menu is displayed.

2. On the **Application Plan Maintenance** menu, invoke the **Prepare Job Profile** function by entering function code PP.

   The **Prepare Job Profile** menu is displayed.

Prepare Job Profile Menu

```
16:14:33                ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                             - Prepare Job Profile -




                        Code Function

                         J   Default Job Cards
                         D   Profile for Create DBRM Job
                         P   Profile for DSN Jobs
```

```
                          ?   Help
                          .   Exit

                  Code .. _   Profile .. ________

 Command ===>
 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help        Exit                                                   Canc
```

Code	Description
J	Defines user-specific default job cards.
D	Defines job profiles for the DBRM creation function.
P	Defines job profiles for the plan or package maintenance functions.

In addition, the parameter `Profile` is available, which is relevant to function codes `D` and `P` only. With function code "J", `Profile` corresponds to `USER`.

Parameter	Description
`Profile`	Specifies the name of an already existing job profile. If a valid profile name is specified, the free-mode editor with the specified job profile is invoked, where the profile can be modified and saved. If a value is specified followed by an asterisk (*), all existing job profiles whose names begin with this value are listed. If asterisk notation is specified only, a selection list of all existing job profiles is displayed. If the field is left blank, the corresponding fixed-mode profile screen is invoked, where a new job profile can be created. To save the new profile, you have to switch to free mode.

Job profiles can be maintained (that is, copied, listed, purged, retrieved from, or saved in a Natural library) via maintenance commands; see *Global Maintenance Commands*.

Note: Job profiles are saved on the Natural system file `FNAT`.

Default Job Cards

All jobs generated by the **Application Plan Maintenance** function require job cards. With the **Default Job Cards** function, you can define a default job card for each user. The default job cards apply to all function screens on which you can generate JCL. Default job cards can be invoked and modified on all these screens. Asterisk notation (*) can be used to select the desired job card from a list.

To define a default job card

- On the **Prepare Job Profile** menu, enter function code `J` and press Enter.

The **Default Job Cards** screen is displayed.

```
16:14:33              ***** NATURAL TOOLS FOR DB2 *****           2009-10-30
                              - Default Job Cards -









 R ead,  S ave,  L ist or  P urge  Default Job Cards _     User ID .. ________


   Job Name ... ________

   Job Cards ..

    //        JOB ____________________________________________________________
    // ______________________________________________________________________
    // ______________________________________________________________________
    // ______________________________________________________________________
    // ______________________________________________________________________



Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                                   Canc
```

On this screen, you can create and save your user-specific job cards. To do so, you can also read (directly or from a list) and modify an already existing default job card. Existing job cards can be purged, too.

Note: All other function screens used to specify jobs contain the same two fields - **Job Name** and **Job Cards** - as the **Default Job Cards** screen. Thus, it is possible to override the default job cards in each of these screens, too.

To modify the job name

- Enter the new job name in the **Job Name** field and press Enter.

To modify the job cards

- In the **Job Cards** field, enter an `S` and press Enter.

  A window is displayed where you can modify all the job cards.

Profile for Create DBRM Job

The **Profile for Create DBRM Job** function enables you to define profiles for the **Create DBRMs** functions. Job profiles for DBRM creation consist of JCL which includes the following predefined set of substitution parameters:

Parameter	Description
`@JOBCARDS`	Is replaced by the job cards entered on the **Create DBRMs** screen (up to five lines). You can also code the job cards in the profile and omit the job cards modifier.
`@COMMAND`	Is replaced by the string `CREATE DBRM`.
`@DBRMNAME`	Is replaced by the name of the DBRM, which can be up to eight characters long.
`@CREATE-DBRM`	Is replaced by the command input for the static generation step. This parameter must be placed *after* the `//CMSYNIN` card and must comply with the Assembler naming conventions.
`@COMMAN2`	Is replaced by the string `MODIFY`.
`@MODIFY`	Is replaced by the command input for the static modification step.
`@XR-START` `@XR-END`	Both mark the JCL to contain the Natural Assembler `XREF` data; if no `XREF` option is specified, the JCL is deleted again.

To modify or rename a job profile for DBRM creation

1. On the **Prepare Job Profile** menu, invoke the **Profile for Create DBRM Job** function by entering function code `D`.
2. In the **Profile** field, specify a valid profile name and press Enter.

   The free-mode editor containing the specified profile is invoked, where you can modify, save, and rename the displayed profile.

To create a job profile for DBRM creation

1. On the **Prepare Job Profile** menu, enter function code `D`.
2. Leave the **Profile** field blank, and press Enter.

The **Profile for Create DBRM Job** screen is invoked, which helps you in creating a new profile.

```
16:15:18              ***** NATURAL TOOLS FOR DB2 *****           2009-10-30
                         - Profile for Create DBRM Job -



 +---------------------------- NATURAL Parameters ----------------------------+
  !  Name of Batch NATURAL      : ________
 !
  !  NATURAL Parameter         : ____________________________________________ !
  !  STEPLIB  DD                : _
 !
 +-------------------------- Precompile Parameters ---------------------------+
  !  DBRMLIB  DD               : ____________________________________________ !
  !  STEPLIB  DD                : _
 !
 +------------------------- Ass-Nat-Xref-Library ---------------------------+
  !  CMWKF02  DD               : ____________________________________________ !
  +-----------------------------------------------------------------------------+









 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Free                                       Canc
```

To save the newly created job profile

- Switch to free mode by pressing PF5.

Profile for DSN Jobs

The **Profile for DSN Jobs** function enables you to define profiles for the **Bind**, **Rebind**, and **Free** functions. The same profiles can be used for each of the three functions.

Profiles for DSN jobs consist of JCL which includes the following predefined set of substitution parameters:

Parameter	Description
@JOBCARDS	Is replaced by the current job cards; you can also code the job cards in the profile and omit the job cards modifier.
@DSNCMD	Is replaced by the command input for the bind, rebind or free function.
@PLANNAME	For the bind function, it is replaced by the name of the plan or package. For the rebind and free functions, it is set to blank.
@COMMAND	Is replaced by the string BIND, REBIND or FREE, respectively.

To modify or rename a profile for DSN jobs

1 On the **Prepare Job Profile** menu, enter function code P.

2 In the **Profile** field, specify a valid profile name, and press Enter.

The free-mode editor containing the specified profile is invoked, where you can modify, save, and rename the displayed profile

To create a new profile for DSN jobs

1 On the Prepare Job Profile menu, enter function code P.

2 Leave the **Profile** field blank, and press Enter.

The **Profile for DSN Jobs** screen is invoked, which helps you in creating a new profile for DSN jobs.

```
16:15:18              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                             - Profile for DSN Jobs -



  DB2 System .. ________                                   Retries .. ___



 +------------------------- Steplibs for DSN Jobs ----------------------------+
 !  STEPLIB     DD            : ____________________________________________ !
```

```
 !                            : ____________________________________________ !
 !                            : ____________________________________________ !
 !                            : ____________________________________________ !
 !                            : ____________________________________________ !
 +-----------------------------------------------------------------------------+


 +------------------------- DBRM Libraries for Bind --------------------------+
 !  DBRMLIB     DD            : ____________________________________________ !
 !                            : ____________________________________________ !
 !                            : ____________________________________________ !
 !                            : ____________________________________________ !
 !                            : ____________________________________________ !
 +-----------------------------------------------------------------------------+


Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Free                                       Canc
```

To save the newly created job profile

- Switch to free mode by pressing PF5.

Loading Job Profiles

Job profiles for DBRM creation and plan/package maintenance are loaded from the dataset CMWKF01 in batch mode.

To load a job profile

1. Logon to library SYSDB2.
2. In the command line, issue the command LOADPROF.

   The **Load Job Profiles** menu is displayed.

```
16:53:20              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                              - Load Job Profiles -
```

```
                        Code Function

                         ---- ----------------------------

                         D   Load Profile for Create DBRM

                         B   Load Profile for DSN Jobs

                         .   Exit

                         ---- ----------------------------

                  Code .. _   Profile .. ________

                              Replace .. N









 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
                   Exit                                                    Canc
```

The following functions are available:

Code	Description
D	Serves to load job profiles for DBRM creation.
B	Serves to load job profiles for plan or package maintenance.

The following parameters apply:

Parameter	Description	
Profile	Specifies the name of the profile to be loaded. This parameter must be specified.	
Replace	Specifies whether it is to be replaced or not if a profile with the specified name already exists.	
	Y	An already existing profile is replaced.
	N	An already existing profile is *not* replaced. This parameter is optional; the default setting is N.

Unloading Job Profiles

Job profiles for DBRM creation and plan/package maintenance are unloaded and written to the dataset CMWKF01 in batch mode.

To unload a job profile

1 Logon to library SYSDB2.

2 In the command line, issue the command UNLDPROF.

The **Load Job Profiles** menu is displayed.

```
16:53:20              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                Load Job Profiles









                         Code Function



                          D   Unload Profile for Create DBRM

                          B   Unload Profile for DSN Jobs

                          .   Exit
```

```
                    Code .. _   Profile .. ________




 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
                     Exit                                                  Canc
```

The following functions are available:

Code	Description
D	Unloads job profiles for DBRM creation.
B	Unloads job profiles for plan or package maintenance.

The following parameter applies:

Parameter	Description
Profile	Specifies the name of the profile to be unloaded. This parameter must be specified.

Create DBRMs

To create a DBRM, you have to generate JCL for DBRM creation.

To create a DBRM

1 On the **Application Plan Maintenance** menu, enter function code `CD`, and press Enter.

The **Create DBRM** screen is displayed where, in addition to a job name, your user-specific default job cards, and the desired job profile, you can specify all necessary information for the `CREATE DBRM` and `MODIFY` commands; see also *Generation Procedure: CMD CREATE*

Command and *Modification Procedure: CMD MODIFY Command* in the section *Preparing Programs for Static Execution*.

```
 16:15:44              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Create DBRM -



  Job Name ... DBRMJOB_          Job Cards .. X             Profile ..EXDBRM__



  >>-- CREate DBRM -- DBRM1___ -- USing --+-- _ -- PREDict DOCumentation --+-->
                                          +-- _ -- INput DAta -------------+



   >-+---------------------+------+----------------------+-----+------------+->
     +- With XRef - _____ -+      +- LIBrary - ________ -+     +- FS - ___ -+

              ( NO, YES, FORCE )                 !                 ( ON, OFF
)


 >---------+-------------------------------------------------------+---------><
           +---- _ --- NAT Library , NAT Member +---------------+-+

                                                  + , excl.Member-+



  >>---------------------------- MODify-+------------+------------------------><
                                        +- _ - XRef -+



 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---

      Help        Exit  Submi Free                                       Canc
```

2 In the **Job Name** field, a valid job name must be specified. If you only want to change the name of the job, you can do this using the **Job Name** field, too.

3 Via the **Job Cards** field, you can override your default job cards. To do so, enter an `S` in the **Job Cards** field.

A window containing your job cards is displayed.

An “X” in the **Job Cards** field indicates that job cards for DBRM creation are defined. A blank **Job Cards** field indicates that no job cards are defined.

4 In the **Profile** field, you can specify the name of a valid job profile for DBRM creation. If a value is specified followed by an asterisk (*), all existing job profiles whose names begin with this value are listed. If asterisk notation is specified only, a selection list of all available job profiles is displayed.

5 If you use the **INput DAta** option, a window is displayed, where you have to specify the Natural libraries and programs (members) to be contained in the DBRM.

```
16:15:44             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Create DBRM -



Job Name ... DBRMJOB_          Job Cards .. X             Profile .. EXDBRM__



 >>-- CREate DBRM -- DBRM1___ -- USing --+-- _ -- PREDict DOCumentation --+-->
                                         +-- _ -- INput DAta -------------+



 >-+---------------------+------+----------------------+-----+------------+->
   +- With XRef - _____ -+      +- LIBrary - ________ -+     +- FS - ___ -+

            ( NO, YES, FORCE )                 !                 ( ON, OFF )



 >---------+------- +-------------------------------------------+ ----------><
           +---- S  ! NAT Library,NAT Member,excl.Member  1 / 2  !

                    !      Test____ , PROG1___ , ________        !

                    !      Test____ , P*______ , PROG1___        !

>>----------------- !     ________ , ________ , ________       ! ----------><
                    !      ________ , ________ , ________        !

                    !      ________ , ________ , ________        !

Command ===>        !                                            !

Enter-PF1---PF2---P +-------------------------------------------+ F11--PF12---
      Help        Exit  Submi Free  --     -     +    ++                Canc
```

In the third column of the above window, you can specify a program that is to be excluded from the DBRM; this is possible only if you specify an asterisk (*) with the program name in the second column.

Within the window, you can scroll using PF6 (--), PF7 (-), PF8 (+), or PF9 (++).

The generated JCL code can be either edited and/or saved in free mode by pressing PF5 (Free), or submitted immediately by pressing PF4 (Submi).

Bind Plan

To generate JCL to bind a plan, you have to invoke the **Bind** function. All parameters necessary to bind a plan are entered on four screens, which show the syntax of the DB2 `BIND PLAN` command.

To generate JCL to bind a plan

1 On the **Application Plan Maintenance** menu, enter function code `BI`.

In the **Object** field, enter `PLAN` or `PL`, and press Enter.

The first **Bind Plan** screen is displayed, where all necessary information must be specified.

```
 23:16:38             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                  - Bind Plan -



  Job Name ... BINDJOB_          Job Cards .. X            Profile .. EXBIND1_




  >>- BIND +-----+------------+-+------------------+-------------------------+>
           !                  ! !                  ! !
 !
          + PLAN ( TESTPLAN )+ + OWNER ( ________ )+ + QUALIFIER ( ________ )+
                  plan-name             auth-id               qualifier-name


   >-+->-- MEMBER +- X ---(member name)---+-------------------------------+-+
     !                                    !                               !
!
     !                                    +- LIBRARY -- _ --(library name)-+
!
     !
```

```
!
     +->-- PKLIST -- X --(+------+---------+collection-id.package-id)--------+->
                          +-location-name.-+



       Read member name/package list from PREDICT?  N (Y/N)  DONE



  Command ===>

  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
        Help        Exit  Submi Free                              Next  Canc
```

2 Apart from the **specifications** to be made in the **Job Name**, **Job Cards**, and **Profile** fields, to bind a plan, you have to specify the name of the plan and all DBRMs and/or packages that are to be bound into the specified plan.

3 You invoke the window to specify the DBRM members and/or package lists by entering an `S` in the **MEMBER** and/or **PKLIST** field respectively. Either or both windows must be invoked; otherwise, you are prompted by the system to do so.

Within the windows for DBRM and package specification, you can scroll using PF6 (--), PF7 (-), PF8 (+), or PF9 (++).

4 If Predict is installed and a plan is documented in Predict, the DBRM members and/or package lists assigned to a plan in Predict can be read by entering `Y` for this option (default is `N`). A maximum of 50 DBRM members and/or 20 package lists can be read.

If you use this option and DBRM members and/or package lists have been successfully read, the **MEMBER** and **PKLIST** selection fields are marked with `X`, and `DONE` is displayed next to the **(Y/N)** input field; `FAILED` is displayed if:

- inconsistencies in the member/package list definition were detected,
- over 50 DBRM members or more than 20 package lists were defined for the specified plan,
- no members or package lists were defined for the specified plan,
- the plan was not documented in Predict at all.

Note: If Predict is not installed, the field **Read member name / package list from Predict?** does not appear on the above screen.

5 Pressing PF11 (Next) takes you to a second **Bind Plan** screen, where you can specify further options of the DB2 `BIND` command.

A keyword is generated by entering its first letter in the corresponding input field; the default values are highlighted.

```
16:17:05              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Bind Plan -



  >---+-----------------------+--+---------------+--+-------------------+--->
      !                       !  !               !  !                   !

      +- _______ --( PREPARE )-+  +- FLAG --( _ )-+  +- EXPLAIN --( ___ )-+

    ( NODEFER or DEFER)             ( I, W, E or C)           ( YES or NO )

  >---+-------------------+--+------------------+--+-------------------+--->
      !                   !  !                  !  !                   !

      +- VALIDATE ( ____ )-+  +- ISOLATION ( __ )-+  +- CACHESIZE ( ____ )+

            ( RUN or BIND )        ( RR, UR or CS )            ( 0 - 4096 )

  >---+-----------------------------+---+-----------------------------+--->
      !                               !   !                             !

      +--- ACQUIRE --( ________ )-----+   +--- RELEASE --( __________ )---+

                 ( USE or ALLOCATE )              ( COMMIT or DEALLOCATE )

  >---+-------------------+----------+---+-----------------------------+--->
      !                                     !   !                       !

      +- CURRENTSERVER ( ________________  )-+   +-- CURRENTDATA ( ___ )--+

                           location-name                    ( NO or YES )



 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit  Submi Free                          Prev  Next  Canc
```

Pressing PF10 (Prev) takes you back to the previous screen.

6 Pressing PF11 (Next) takes you to a third **Bind Plan** screen, where you can again specify further options of the DB2 BIND command.

```
 16:17:18            ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Bind Plan -

   >---------------+-------------------------------------------------------+--->
                   !                                                       !

                   +-- ACTION --+---- _ (REPLACE) --+--------------+----+--+

                                !                   +-- _ RETAIN --+    !

                                +---- _ (ADD) -------------------------+

   >---------------+-------------------------------------------------------+--->
                   !                                                       !

                   +-- DYNAMICRULES - _ ( RUN or BIND ) -------------------+



   >-+-------------------------------------------------------------------+-><
      !
!
     +-+- _ - ENABLE -------- (*) --------+-+-----------------------------+-+
       !                                  ! +->- DLIBATCH- _ -(con.-names)-+

       +- _ - ENABLE --+- _ -(con.-types)-+ +->- CICS ---- _ -(applids)----+

       +- _ - DISABLE -+                    +->- IMSBMP -- _ -(imsids)-----+

                                            +->- IMSMPP -- _ -(imsids)-----+

 Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help        Exit  Submi Free                          Prev  Next  Canc
```

7 Pressing PF11 (Next) takes you to a fourth **Bind Plan** screen, where you can again specify further options of the DB2 BIND command.

```
16:17:38             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Bind Plan -





 >----+----------------------+-------+-------------------------+------------->
      !                      !       !                         !

      +-- DEGREE --- ___ ----+       +-- SQLRULES ---  ___ ----+

                 ( 1 or ANY )                     ( DB2 or STD )





 >----+-------------------------------------------------------+------------->
      !                                                       !

      +-- DISCONNECT ----+--- _ - ( EXPLICIT ) -----+----------+

                         +--- _ - ( AUTOMATIC ) ----+

                         +--- _ - ( CONDITIONAL) ---+





 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit  Submi Free                          Prev        Canc
```

8 The generated JCL code can be either edited and/or saved in free mode by pressing PF5 (Free), or submitted immediately by pressing PF4 (Submi).

Rebind Plan

To generate JCL to rebind a plan, you have to invoke the **Rebind** function. All parameters necessary to rebind a plan are entered in three screens, which show the syntax of the DB2 `REBIND PLAN` command.

To generate JCL to rebind a plan

1 On the **Application Plan Maintenance** menu, enter function code `RB`.

In the **Object** field, enter `PLAN` or `PL`, and press Enter.

The first **Rebind Plan** screen is displayed, where all necessary information must be specified.

```
19:17:55              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Rebind Plan -



 Job Name ... FREEJOB_          Job Cards .. X            Profile .. EXBIND1_



 >>- REBIND PLAN -------------------------------------------------------------->


  >-+-(plan names)- X -+-+---------------------+-+-------------------------+-->
     !                 ! !                     ! !                         !

    +-- (*) -- _ ------+-+- OWNER ( ________ )-+ +- QUALIFIER ( ________ )-+

                                   auth-id                 qualifier-name



  >---+-------------------------------------------------------------------+----->
      !                                                                   !

      +-- PKLIST ---- _ --(+----------------+collection-id.package-id)--+

      !                   +-location-name.-+                            !

      +-- NOPKLIST -- _ ------------------------------------------------+
```

```
Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit  Submi Free                                Next  Canc
```

2 Apart from the **specifications** to be made in the **Job Name**, **Job Cards**, and **Profile** fields, you have to specify the names of the plans to be rebound in a window. If you specify asterisk notation (*), all existing plans are rebound.

3 Pressing PF11 (Next) takes you to a second **Rebind Plan** screen, where you can specify further options of the DB2 `REBIND` command.

A keyword is generated by entering its first letter in the corresponding input field; the default values are highlighted.

```
16:18:15             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Rebind Plan -



  >---+-----------------------+--+--------------+--+-------------------+--->
      !                       !  !              !  !                   !

      +- _______ --( PREPARE )-+  +- FLAG --( _ )-+  +- EXPLAIN --( ___ )-+

    ( NODEFER or DEFER)            ( I, W, E or C)          ( YES or NO )

  >---+-------------------+--+-----------------+--+-------------------+--->
      !                   !  !                 !  !                   !

      +- VALIDATE ( ____ )-+  +- ISOLATION ( __ )-+  +- CACHESIZE ( ____ )+

            ( RUN or BIND )        ( RR, CS or UR )           ( 0 - 4096 )

  >---+-----------------------------+---+-----------------------------+--->
      !                               !   !                             !

      +--- ACQUIRE --( ________ )-----+   +--- RELEASE --( __________ )---+

                 ( USE or ALLOCATE )             ( COMMIT or DEALLOCATE )

  >---+-------------------+----------+---+-----------------------------+--->
      !                                   !   !                         !

      +- CURRENTSERVER ( ________________  )-+   +-- CURRENTDATA ( ___ )--+

                            location-name                     ( NO or YES )
```

```
Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit  Submi Free                          Prev  Next  Canc
```

Pressing PF10 (Prev) takes you back to the previous screen.

4 Pressing PF11 (Next) takes you to a third **Rebind Plan** screen, where you can again specify further options of the DB2 `REBIND` command.

```
16:18:38             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Rebind Plan -



 >-+------------------+---+------------------+---+------------------------+->
   !                  !   !                  !   !                        !

   +- DEGREE - ___ ---+   +- SQLRULES - ___ --+   +- DYNAMICRULES - ____ --+

           ( 1 or ANY )          ( DB2 or STD )            ( RUN or BIND )



 >-+----------------------------------------+---------------------------+->
   +- DISCONNECT --+-- _ --( EXPLICIT ) ------+

                   +-- _ --( AUTOMATIC ) -----+

                   +-- _ --( CONDITIONAL ) ---+



 >-+-------------------------------------------------------------------+-><
   !                                                                   !

  +-+- _ - ENABLE -------- (*) --------+-+-----------------------------+-+

     !                                 ! +->- DLIBATCH- _ -(con.-names)-+

     +- _ - ENABLE --+- _ -(con.-types)-+ +->- CICS ---- _ -(applids)----+

     +- _ - DISABLE -+                    +->- IMSBMP -- _ -(imsids)-----+

                                          +->- IMSMPP -- _ -(imsids)-----+

Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
```

```
      Help        Exit  Submi Free                          Prev        Canc
```

5 The generated JCL code can be either edited and/or saved in free mode by pressing PF5 (Free), or submitted immediately by pressing PF4 (Submi).

Free Plan

A free plan can be generated with the **Free** function of the **Application Plan Maintenance** menu.

To generate JCL to free a plan

1 On the **Application Plan Maintenance** menu, enter function code FR.

In the Object field, enter PLAN or PL, and press Enter.

The **Free Plan** screen is displayed, where all necessary information must be specified.

```
16:19:35            ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                                - Free Plan -



 Job Name ... FREEJOB_          Job Cards .. X            Profile .. EXBIND1_



 >>------- FREE PLAN -----+---(plan name)---- X ------+----------------------->
                          !                           !

                          +--------- (*) ---- _ ------+



 >----------------------+--------------------------+----------------------->
                          !                           !

                          +--- FLAG -----( _ )--------+
```

```
                                        (I, W, E or C)





 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit  Submi Free                                        Canc
```

2 Apart from the **specifications** to be made in the **Job Name**, **Job Cards**, and **Profile** fields, all parameters necessary to free a plan are entered in a screen showing the syntax of the DB2 `FREE PLAN` command. The names of the plans to be freed are entered in a window. If you specify asterisk notation (*), all plans are freed.

3 The generated JCL code can be either edited and/or saved in free mode by pressing PF5 (Free), or submitted immediately by pressing PF4 (Submi).

Bind Package

Packages can be bound with the Bind function of the **Application Plan Maintenance** menu. All parameters necessary to bind a package are entered on three screens, which show the syntax of the DB2 `BIND PACKAGE` command.

To generate JCL to bind a package

1 On the **Application Plan Maintenance** menu, enter function code “BI”.

In the Object field, enter `PACKAGE` or `PK`, and press Enter.

The first **Bind Package** screen is displayed, where all necessary information must be specified.

```
16:19:58             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Bind Package -



 Job Name ... BINDJOB_          Job Cards .. X            Profile .. EXBIND2_
```

```
  >>- BIND PACKAGE -(-+-----------------------+- ___________________ ----------->
                      +- _________________  . -+    collection-id

                          location-name



   >--------------+------------------+-+----------------------+-------------->
                  + OWNER ( ________ )+ + QUALIFIER ( ________ )+

                            auth-id                qualifier-name



   >-+- MEMBER ( ________ )+-----------------------------------------------+-+
     !        member-name  +- LIBRARY --- _ (library-name)----------------+
!
     !
!
     +- COPY ( ___________________ . ________ )-+---------------------------+-+->
                 collection-id     package-id  +- COPYVER - _ (version-id)-+



  Command ===>

  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
        Help        Exit  Submi Free                                Next  Canc
```

2 Apart from the **specifications** to be made in the **Job Name**, **Job Cards**, and **Profile** fields, to bind a package, you have to specify the collection ID of the package and a DBRM or a further package to be bound into the specified package.

You specify the DBRM or the second package in the **MEMBER** or **COPY** field respectively. Either of the fields must be selected and the package ID will be either the DBRM name or the package ID of the copied package.

3 Pressing PF11 (Next) takes you to a second **Bind Package** screen, where you can specify further options of the DB2 `BIND` command.

A keyword is generated by entering its first letter in the corresponding input field; the default values are highlighted.

```
16:20:05            ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                                - Bind Package -



  >----------+------------------------+-----------+---------------+---------->
             !                        !           !               !

             +- SQLERROR ( _________ )-+          +- FLAG --( _ )-+

              ( NOPACKAGE or CONTINUE )            ( I, W, E or C)

  >----------+-------------+--+---------------+--------------------+---------->
             !             !  !               !                    !

             +- EXPLAIN --( ___ )-+           +- VALIDATE ( ____ )-+

                  ( NO or YES )                   ( RUN or BIND )

  >----------+------------------+------+-------------------------+---------->
             !                  !      !                         !

             +- ISOLATION ( __ )-+      +- RELEASE -( __________ )-+

              ( RR, RS, CS, UR or NC)       ( COMMIT or DEALLOCATE )

  >----------+---------------------+---+-------------------------+---------->
             !                     !   !                         !

             +- CURRENTDATA ( ___ )-+   +- DYNAMICRULES --( ____ )-+

                        ( NO or YES )                ( RUN or BIND )



 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit  Submi Free                          Prev  Next  Canc
```

Pressing PF10 (Prev) takes you back to the previous screen.

4 Pressing PF11 (Next) takes you to a third **Bind Package** screen, where you can again specify further options of the DB2 BIND command.

```
16:20:18             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Bind Package -



 >-+-----------------------------------------------+---+------------------+->
   !                                               !   !                  !

   +- ACTION -+- _ (REPLACE) -+--------------+--+--+   +- DEGREE - ___ ----+

              !               + REPLVER - _ -+  !           ( 1 or ANY )

              !                   (version-id)  !

              +- _ (ADD) -----------------------+




 >-+-------------------------------------------------------------------+-><
   !                                                                   !

   +-+- _ - ENABLE -------- (*) --------+-+-----------------------------+-+

     !                                  ! +->- DLIBATCH- _ -(con.-names)-+

     +- _ - ENABLE --+- _ -(con.-types)-+ +->- CICS ---- _ -(applids)----+

     +- _ - DISABLE -+                    +->- IMSBMP -- _ -(imsids)-----+

                                          +->- IMSMPP -- _ -(imsids)-----+

                                          +->- REMOTE -- _ -(loc/lu-name)+


Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit  Submi Free                          Prev        Canc
```

5 The generated JCL code can be either edited and/or saved in free mode by pressing PF5 (Free), or submitted immediately by pressing PF4 (Submi).

Rebind Package

A package can be rebound with the **Rebind** function of the **Application Plan Maintenance** menu. All parameters necessary to rebind a package are entered in two screens, which show the syntax of the DB2 `REBIND PACKAGE` command

To generate JCL to rebind a package

1 On the **Application Plan Maintenance** menu, enter function code `RB`.

In the **Object** field, enter `PACKAGE` or `PK`, and press Enter.

The first Rebind Package screen is displayed, where all necessary information must be specified.

```
 16:20:55             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Rebind Package -



  Job Name ... FREEJOB_          Job Cards .. X            Profile .. EXBIND2_



  >>- REBIND PACKAGE -------------------------------------------------------->



   >-+--- _ ------------------------- (*) ----------------------------------+->
      !
!
     +--- _ -(+----------------+-collection-id.package-id-+---------------+)-+
              +-location-name.-+                          +-.(version-id)-+



   >------------+--------------------+-+-------------------------+----------->
                !                    ! !                         !

                +- OWNER ( ________ )-+ +- QUALIFIER ( ________ )-+

                             auth-id                 qualifier-name
```

```
 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit  Submi Free                                Next  Canc
```

2 Apart from the **specifications** to be made in the **Job Name**, **Job Cards**, and **Profile** fields, you have to specify the names of the packages to be rebound in a window. If you specify asterisk notation (*), all locally existing packages are rebound.

3 Pressing PF11 (Next) takes you to a second **Rebind Package** screen, where you can specify further options of the DB2 REBIND command.

A keyword is generated by entering its first letter in the corresponding input field; the default values are highlighted.

```
16:21:21              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Rebind Package -



 >----------+--------------------+-----------+--------------------+--------->
            !                    !           !                    !

            +- FLAG -----( _ )---+           +- DEGREE --( ___ )--+

                 ( I, W, E or C)                     ( 1 or ANY )

 >----------+--------------------+-----------+--------------------+--------->
            !                    !           !                    !

            +- EXPLAIN --( ___ )-+           +- VALIDATE ( ____ )-+

                 ( NO or YES )                   ( RUN or BIND )

 >----------+--------------------+-----+-----------------------+----------->
            !                    !     !                       !

            +- ISOLATION ( __ )--+     +- RELEASE -( __________ )-+

            ( RR, RS, CS, UR or NC )      ( COMMIT or DEALLOCATE )

 >----------+---------------------+---+-------------------------+---------->
            !                     !   !                         !

            +- CURRENTDATA ( ___ )-+   +- DYNAMICRULES -( ____ )--+

                       ( NO or YES )                ( RUN OR BIND )
```

```
Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit  Submi Free                          Prev  Next  Canc
```

Pressing PF10 (Prev) takes you back to the previous screen.

4 Pressing PF11 (Next) takes you to a third **Rebind Package** screen, where you can again specify further options of the DB2 `REBIND` command.

```
16:21:38             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                               - Rebind Package -









 >-+-----------------------------------------------------------------------+-><
   !                                                                       !

  +-+- _ - ENABLE -------- (*) --------+-+-----------------------------+-+

     !                                 ! +->- DLIBATCH- _ -(con.-names)-+

     +- _ - ENABLE --+- _ -(con.-types)-+ +->- CICS ---- _ -(applids)----+

     +- _ - DISABLE -+                   +->- IMSBMP -- _ -(imsids)-----+

                                         +->- IMSMPP -- _ -(imsids)-----+

                                         +->- REMOTE -- _ -(loc/lu-name)+









Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit  Submi Free                          Prev        Canc
```

5 The generated JCL code can be either edited and/or saved in free mode by pressing PF5 (Free), or submitted immediately by pressing PF4 (Submi).

Free Package

A package can be freed with the **Free Package** function of the **Application Plan Maintenance** menu.

To generate JCL to free a package

1 On the **Application Plan Maintenance** menu, enter function code FR.

In the **Object** field, enter PACKAGE or PK, and press Enter.

The Free Package screen is displayed, where all necessary information must be specified.

```
16:22:05            ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                                - Free Package -


 Job Name ... FREEJOB_          Job Cards .. X            Profile .. EXBIND2_



 >>-- FREE PACKAGE -------------------------------------------------------->


  >--+- _ -------------------------- (*) ---------------------------------+-->
     !                                                                     !

    +- _ --(-+--------------+collection-id.+----------- (*) ---------+-)--+

             +location-name.+             +package-id+-------------++

                                                     +.---- (*) ---+

                                                     +.(version-id)+



 >-----------------------+--------------------------+----------------------><
                         !                          !

                         +--- FLAG -----( _ )--------+
```

```
                                        ( I, W, E or C )



 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit  Submi Free                                        Canc
```

2 Apart from the **specifications** to be made in the **Job Name**, **Job Cards**, and **Profile** fields, all parameters necessary to free a package are entered in a screen showing the syntax of the DB2 `FREE PACKAGE` command. The names of the packages to be freed are entered in a window. If you specify asterisk notation (*), all local packages are freed.

3 The generated JCL code can be either edited and/or saved in free mode by pressing PF5 (Free), or submitted immediately by pressing PF4 (Submi).

List JCL Function

The **List JCL** function serves to invoke the free-mode editor via the **Application Plan Maintenance** menu.

To invoke the List JCL function

1 On the **Application Plan Maintenance** menu, enter function code `LJ`.

- If you leave the **JCL Member** field blank and press Enter, the empty free-mode editor is invoked.
- If you specify a value followed by an asterisk, or specify asterisk notation only and press Enter, a list of JCL members is displayed for selection.
- If you specify a valid member name and press Enter, the invoked free-mode editor contains the corresponding JCL.

```
16:18:18             ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
 APM - free mode    TESTLIB(TESTPLAN)    S 01- ---------------Columns 001 072
=====>                                                   Scroll ===>  PAGE
 ***** ****************************** top of data ******************************
  00001 //BINDJOB  JOB TESTPLAN,CLASS=K,MSGCLASS=X
  00002 //*********************************************************
  00003 //* EXAMPLE JOB PROFILE FOR BIND, FREE AND REBIND          *
  00004 //*                                                        *
  00005 //* BIND PLAN                                              *
  00006 //*********************************************************
```

```
 00007 //BINDJOB  EXEC PGM=IKJEFT01,DYNAMNBR=20,REGION=4096K
 00008 //STEPLIB  DD DSN=DB2.Vnnn.DSNLOAD,DISP=SHR
 00009 //DBRMLIB  DD DSN=DB2.Vnnn.DBRMLIB.DATA,DISP=SHR
 00010 //SYSTSPRT DD SYSOUT=*
 00011 //SYSPRINT DD SYSOUT=*
 00012 //SYSUDUMP DD SYSOUT=*
 00013 //SYSTSIN  DD *
 00014 DSN SYSTEM (DB2)
 00015     BIND PLAN (PLAN1)
 00016     MEMBER (  DBRM1)
 00017 END

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit  Submi Rfind Rchan -     +            <      >   Canc
```

Within the free-mode editor, JCL members can be copied, listed, purged, retrieved from, or saved in a Natural library. All this is done via maintenance commands; see *Global Maintenance Commands*.

2 Press PF4 (Submi) to submit JCL code listed in the editor, press PF5 (Fix) to switch to fixed mode.

Display Job Output

The **Display Job Output** function can be used to display the output of a JCL member.

Note: The Display Job Output function is available only if the Entire System Server is installed.

To display the output of a JCL member

1 On the **Application Plan Maintenance** menu, enter function code `JO`.

In the Node field, the default node number (148) for Entire System Server can be modified.

A screen is displayed, where you can specify the desired job name and job number, as well as the numbers of the `SYSOUT` types.

```
16:20:05             ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                         - Application Plan Maintenance -
```

```
                Job Name ........ ________

                Job Number ...... _____

                Sysout Type ..... __          ( CC,JL,SI,SM,SO     )

                Sysout Number ... __          ( Sysout file number )

                Node ............ 148



 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12--
      Help        Exit                                      Logn        Canc
```

2 In the **Job Name** field, a valid job name can be specified.

- If you specify a value followed by an asterisk (*), or specify asterisk (*) notation only, a list of job output members is displayed for selection. In a job output member selection list, you can mark an output member with either `B` to display the member only, or `L` to display a list of all the job output's `SYSOUT` datasets, which in turn can be marked with `B` for display.
- If you leave the **Job Name** field blank, you must specify a job number.

3 In the **Job Number** field, you can specify a unique job number. Only if a unique job number has been specified, specifications can be made in the **Sysout Type** and **Sysout Number** fields, too.

4 In the **Sysout Type** field, you can specify the type of `SYSOUT` dataset of the job with the specified job number to be displayed. The following codes apply:

Code	SYSOUT Type
`CC`	Condition Code
`JL`	Job Listing
`SI`	System Input
`SM`	System Message
`SO`	System Output

5 In the **Sysout Number** field, you can specify a file number to display a specific `SYSOUT` dataset of the type specified in the Sysout type field.

If you leave the **Sysout Number** field blank, all `SYSOUT` datasets of the specified type are displayed.

8 Catalog Maintenance

The **Catalog Maintenance** part of the **Natural Tools for DB2** enables you to generate SQL statements to maintain the DB2 catalog (that is, DB2 tables and other DB2 objects) without leaving your development environment.

The **Catalog Maintenance** function incorporates an SQL generator that automatically generates from your input the SQL code required to maintain the desired DB2 object. You can display, modify, save, and retrieve the generated SQL code.

The DDL/TML definitions are stored in the current Natural library.

Fixed Mode and Free Mode

The catalog maintenance function offers two modes of operation: fixed mode and free mode.

To switch from fixed mode to free mode

- Press PF5 (Free).

To return from free mode to fixed mode

- Press PF3 (Exit) in free mode.

Fixed Mode

In fixed mode, input screens with syntax graphs help you to specify correct SQL code. You simply enter the required data in the input screens, and the data are automatically checked to ensure that they comply with the DB2 SQL syntax. If the input is incomplete, you are prompted for the missing data. Then, SQL members are generated from the entered data. The members can be executed directly by pressing PF4 (Submi). But you can also press PF5 (Free) to switch to free mode, where the generated SQL code can be modified.

After the execution of an SQL statement, a message is returned, which indicates that the statement has been successfully executed. If an error occurred, the resulting DB2 error message can be displayed by pressing PF2 (Error), which executes the `SQLERR` command.

Input screens consist of various kinds of input fields. There are:

- fields to enter DB2 object names,
- fields to invoke windows,
- fields to be marked for selection,
- fields to enter keywords,
- fields to specify numeric values,

- fields to enter string constants.

For each field where a window can be invoked, you can specify an S. When you press Enter, the window appears and you can select or enter the necessary information. If such a selection is required, an S is already preset when the corresponding screen is invoked.

When you press Enter again, the window closes and if data have been entered, the field is marked with X instead of S. If not, the field is left blank or marked with S again.

This will continue each time you press Enter until no S remains. To redisplay a window where data have been entered, you change its X mark back to S.

If another letter or character is used, an error message appears on the screen.

Mark field with S to show window.

The wrong character is automatically replaced by an S and if you press Enter again, the corresponding window appears.

In fields where keywords are to be entered, you must enter one of the keywords displayed beneath the field. Default keywords are highlighted.

Free Mode

When free mode is invoked from fixed mode (by pressing PF5 (Free)), the data that were entered in fixed mode are shown as generated SQL code which can be saved for later use or modification.

If you modify an SQL member in free mode, this has no effect on the fixed-mode version of the member. You can save your modified code in free mode, but when you return to fixed mode, the original data appear again. Thus, both original and modified data are available.

In free mode you can execute the member currently in the source area by pressing PF4 (Submi), as in fixed mode.

Execution of SQL statements automatically switches to the output screen, which shows the SQL return code of the executed commands.

See the list of the SQL code maintenance commands available in free mode in the section ***Global Maintenenance Commands***.

Invoking the Catalog Maintenance Function

To invoke the Catalog Maintenance function

- On the **Natural Tools for DB2 Main Menu**, enter function code `C`, and press Enter.

  The **Catalog Maintenance** menu is displayed:

```
16:03:13            ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                            - Catalog Maintenance -


      Code   Maintenance  Parameter        Code   Authorization  Parameter


       CR    CREATE       Object            GR    GRANT          Object

       AL    ALTER        Object            RE    REVOKE         Object

       DR    DROP                           LO    LOCK TABLE

       SC    SET SQLID


      Code   Description  Parameter        Code   Function       Parameter


       EN    EXPLAIN                        F     Free Mode      Member

       CO    COMMENT ON                     ?     Help

       LB    LABEL ON                       .     Exit


   Code .. __  Object .... ________

               Library ... ________

               Member .... ________
```

```
Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                                   Canc
```

In the **Code** field, the function code assigned to the desired function can be specified, together with the desired **Object**, **Library**, and/or **Member** name.

If you switch to **free mode** and enter a valid member name, you can read this member from the Natural library specified with the **Library** parameter. The **Library** parameter is preset with your Natural user ID.

With the `CREATE VIEW` and `EXPLAIN` functions, a subselect or an explainable SQL statement must be entered, respectively. Both can be done in a separate editor session, where previously saved members can be used. The editor is invoked by entering an `S` in the appropriate field.

With the functions `CREATE`, `ALTER`, `GRANT`, and `REVOKE`, an object code must be specified, for example, `TB` for `TABLE`. If you leave the object field blank, a window is displayed which shows you a list of all available objects together with their object codes.

If you enter for example the `CREATE` function without specifying an object, a window is invoked which prompts you for the type of object to be created:

```
16:03:13            ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                            - Catalog Maintenance -



      Code  +----------------------+       Code   Authorization  Parameter

            ! CREATE               !

       CR   !                      !        GR    GRANT          Object

       AL   ! AL    ALIAS          !        RE    REVOKE         Object

       DR   ! DB    DATABASE       !        LO    LOCK TABLE

       SC   ! IX    INDEX          !

            ! ST    STOGROUP       !

      Code  ! SY    SYNONYM        !       Code   Function       Parameter

            ! TB    TABLE          !

       EN   ! TS    TABLESPACE     !        F     Free Mode      Member
```

```
        CO   ! VI    VIEW           !        ?     Help

        LB   ! .     Exit           !        .     Exit

             !                      !

    Code ..  ! __ .. Enter Object   !

             !                      !

             +----------------------+




 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                                     Canc
```

In the following section some examples illustrate how to use the **Catalog Maintenance** function in fixed mode.

Create Table Function

To invoke the Create Table function

1 In the `CREATE` function, enter the object code `TB`, and press Enter.

The first **Create Table** syntax input screen is displayed.

You can enter the creator and table names on this screen, as well as the individual column names, formats, and lengths, as shown below:

```
  09:47:19             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Create Table -                        1  /
9


 >>- CREATE TABLE - SAG_____ . DEMOTABLE_________ ----------------------------->
                      <creator.>table-name

 >+--- LIKE ------- ________ . ___________________ +-------------------------+-+>
```

```
  !                <creator.>table/view-name    +- _ - INCLUDING IDENTITY + +
  !
!
  +( COL1_______________  CHAR___________ ( 20________ ) _ - __ - _ - __ - _ , +
  +- COL2_______________  INTEGER________ ( __________ ) _ - NN - _ - 2_ - _ , +
  +- COL3_______________  SMALLINT_______ ( __________ ) _ - NN - _ - 1_ - _ , +
  +- COL4_______________  CHAR___________ ( 2_________ ) S - __ - _ - __ - _ , +
  +- COL5_______________  VARCHAR________ ( 30________ ) _ - NN - _ - 3_ - _ , +
  +- COL6_______________  DECIMAL________ ( 2,5_______ ) _ - __ - X - __ - _ , +
  +- COL7_______________  FLOAT__________ ( __________ ) _ - NN - _ - __ - _ , +
  +- COL8_______________  DATE___________ ( __________ ) _ - __ - _ - __ - _ , +
  +- COL9_______________  TIME___________ ( __________ ) _ - __ - _ - __ - _ , +
  +- ___________________  _______________ ( __________ ) _ - __ - _ - __ - _ , +
        column-name          format          length    S/M  NN  fld  PK/ R/C

                                                        B       proc UK  D/G

Command ===>
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec  Free  --     -     +    ++          Next  Canc
```

Note: Since the specification of any special characters as part of a Natural field or DDM name does not comply with Natural naming conventions, any special characters allowed within DB2 should be avoided. The same applies to DB2 delimited identifiers, which are not supported by Natural.

In the top right-hand corner of the screen, the index of the top most column (1), and the total number of columns specified (9) is displayed. If you want to specify more columns than fit on one terminal screen, press PF8 (+) to scroll one page forward.

An `S` in the **S/M/B** field of column 4 means that the `FOR SBCS DATA` option is selected for this column. Other possible values for this field are `M` (`FOR MIXED DATA`) and `B` (`FOR BIT DATA`).

Columns 3, 2, and 5 form the primary key, in the specified order. Primary key columns must be selected with an `S` or ordered by specifying appropriate numbers between 1 and 16. In the present example, all primary key columns are defined as `NOT NULL`. In addition, column 7 is specified as `NOT NULL`.

For column 6, a field procedure has been entered in a window invoked by `S`. The window has been closed again, and the **fld proc** field is now marked with `X`.

2 If you enter an `R` in the **R/C/D/G** field for a given column and press Enter, a window is displayed, in which you can specify a references clause, which identifies this column as a foreign key of a referential constraint.

```
+-------------------------------------------------------+
!  References-Clause for Column:  COL1                  !
!                                                       !
! >--- REFERENCES ---- ________ . ________________ -->  !
!                       <creator.>table-name            !
! >-+--------------------------------+---------------->  !
!   +- ON DELETE --+-- _ - RESTRICT --+                 !
!                  +-- _ - CASCADE ---+                 !
!                  +-- _ - SET NULL --+                 !
!                  +-- _ - NO ACTION -+                 !
!                                                       !
+-------------------------------------------------------+
```

You must specify the name (with an optional creator name) of the parent table to be referenced. In addition, you must specify the action to be taken when a row in the referenced table is deleted. The following options are provided:

- `RESTRICT` or `NO ACTION` prevents the deletion of the parent row until all dependent rows are deleted.
- `CASCADE` deletes all dependent rows, too.
- `SET NULL` sets to null all columns of the foreign key in each dependent row that can contain null values.
- A key that consists of more than one column must be defined by a `FOREIGN KEY` clause.

3 If you enter a `C` in the **R/C/D/G** field for a given column and press Enter, a window is displayed, in which you can specify a check constraint for this column.

```
 16:08:09            ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                               - Create Table -                        1  /
9


  >>--- CREATE TABLE --------- SAG_____ . DEMOTABLE_________ ---------------->
                                <creator.>table-name

  >+------- LIKE ------------- ________ . ________________ ----------------+->
   !                            <creator.>table/view-name
!
   +( COL1_______________ - CHAR___________ ( 20___ ) - _ - _ -- _ - __ - C ,-+
 +-------------------------------------------------------------------------+
 !  --- check-constraint  for   Column:    COL1                  -----------
!
 !
 !
 ! >-+-------------------------+- CHECK  ( ____________________________________ !
 !   !                         !           ____________________________________ !
```

```
!   +- CONSTRAINT - ________ -+          ______________________________________ !
!                 constraint-name        ______________________________________ !
!                                        ______________________________________ !
!                                        ______________________________________ !
!
!
!
!
+-------------------------------------------------------------------------------+


Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12--
                   Exit                                                   Canc
```

You must specify a column check condition. A check condition is a search condition with various restrictions which are described in detail in the relevant DB2 literature by IBM. In addition, you may specify a name for the check constraint.

4 If you enter a `D` in the **R/C/D/G** field for a given column and press Enter, a window is displayed, in which you can specify a default value other than the system default value for this column.

```
10:14:04             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                             - Create Table -                       1  / 9

+-------------------------------------------------------------------------------+
!      Default-Clause for Column:  COL1                                         !
!                                                                               !
! >--- _ - WITH DEFAULT ----------------------------------------------------->  !
! >-+-------------------------+-+-----------------------------------+-+---+->  !
!   +- ___________________  ( -+ +-- _ - USER ----------------------+ + ) +    !
!      cast-function-name       +-- _ - CURRENT SQLID -------------+          !
!                               +-- _ - NULL ----------------------+          !
!                                _____________________________________          !
!                                _____________________________________          !
!                                _____________________________________          !
!                                _____________________________________          !
!                                _____________________________________          !
!                                             constant                          !
!                                                                               !
+-------------------------------------------------------------------------------+
                                                        B       proc UK  D/G
 Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12--
                   Exit                                                   Canc
```

One of the following types of default values can be specified:

- USER: an execution-time value of the special register USER.
- CURRENT SQLID: the SQL authorization ID.
- NULL: the null value.
- constant: a constant which names the default value for the column.

For further information on default values, refer to the relevant DB2 literature by IBM.

5 If you enter a G in the **R/C/D/G** field for a given column and press Enter, a window is displayed, in which you can define the **GENERATED-Clause** for this column.

```
 10:18:29              ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                                - Create Table -                       1  / 9

>>- CREATE TABLE - SAG_____ . DEMOTABLE_________ ----------------------------->
+-------------------------------------------------------------------------------+
!      GENERATED-Clause for Column:  COL1                                       !
!                                                                               !
! >------ GENERATED ---------+-- _  ALWAYS -------+------------------------>  !
!                            +-- _  BY DEFAULT ---+                            !
! >-+-------------------------------------------------------------------+->  !
!   +- _  AS IDENTITY -+-----------------------------------------------+-+    !
!                      +- ( -+-- _  START WITH --- 1__________ --+- ) -+      !
!                            +-- _  INCREMENT BY - 1__________ --+            !
!                            ++- _  NO CACHE --------------------++            !
!                             +- _  CACHE -------- 20_________ -+             !
!                                                                               !
+-------------------------------------------------------------------------------+
 +- ___________________  ________________ ( __________ ) _ - __ - _ - __ - _ , +
       column-name          format          length    S/M  NN  fld  PK/ R/C
                                                       B       proc UK  D/G
  Command ===>

  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12--
                     Exit                                                   Canc
```

GENERATED can only be defined if the column has a ROWID data type (or a distinct type that is based on a ROWID data type), or if the column is to be an identity column.

For further information on the *GENERATED-Clause*, refer to the relevant DB2 literature by IBM.

6 Windows like the one below may help you in making a valid selection. They are invoked by entering the help character (?) in the appropriate field on the screen:

```
 10:23:44              +-----------------------------------+         2009-10-30
                       !  I      INTEGER                   !           1  / 9
                       !  S      SMALLINT                  !
>>- CREATE TABLE - SAG_ !  F      FLOAT(integer)            ! ----------------->
                    <cr !  RE     REAL                      !
>+--- LIKE ------- ____ !  DO     DOUBLE                    ! --------------+-+>
 !                  <cr !  DE     DECIMAL(integer,integer) ! DING IDENTITY + +
 !                      !  N      NUMERIC(integer,integer) !                 !
 +( COL1_______________ !  CH     CHAR(integer)            !  - _ - __ - _ , +
 +- COL2_______________ !  VARC   VARCHAR(integer)         !  - _ - 2_ - _ , +
 +- COL3_______________ !  CL     CLOB(integer)            !  - _ - 1_ - _ , +
 +- COL4_______________ !  B      BLOB(integer)            !  - _ - __ - _ , +
 +- COL5_______________ !  G      GRAPHIC(integer)         !  - _ - 3_ - _ , +
 +- COL6_______________ !  VARG   VARGRAPHIC(integer)      !  - _ - __ - _ , +
 +- COL7_______________ !  DB     DBCLOB(integer)          !  - _ - __ - _ , +
 +- COL8_______________ !  DA     DATE                     !  - _ - __ - _ , +
 +- COL9_______________ !  TIME   TIME                     !  - _ - __ - _ , +
 +- ___________________ !  TIMES  TIMESTAMP               !  - _ - __ - _ , +
       column-name      !                                  !   fld  PK/ R/C
                        !  RO     ROWID                    !   proc UK  D/G
                        !                                  !
Command ===>            !  ______ .. Enter Value           !
Enter-PF1---PF2---PF3-- +-----------------------------------+ F10--PF11--PF12---
        Help  Error Exit  Exec  Free  --    -     +     ++          Next  Canc
```

In the case of complex SQL statements, more than one input screen may be required. If so, you can switch to the following screen by pressing PF11 (Next), or return to the previous screen by pressing PF10 (Prev).

As you can see on the above screen, the beginning of the syntax specification for an SQL statement is always indicated by >>.

7 Since the syntax of the `CREATE TABLE` statement is a rather complex one, three more screens are required. Once all necessary information has been entered on the first screen, you press PF11 (Next) to display the next **Create Table** input screen, where you can specify additional optional parameters.

```
 10:31:51             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                              - Create Table -                       1  / 0

  +-----------------------------------<-----------------------------------+
>-+-+-------------------------------------------------------------------+-+->
    !                                                                     !
    +- , - FOREIGN KEY ----- ________ ------- _ --- (column-name) ->      !
                          <constraint-name>                               !
                                                                          !
     >---- REFERENCES ------ ________ . ___________________ -------->     !
                               <creator.>table-name                       !
                                                                          !
```

```
    >-+---------------------------+----- ON DELETE -+- S - RESTRICT -+-+
      +-- _ --- (column-name) ----+                 +- _ - CASCADE --+
                                                    +- _ - SET NULL -+
                                                    +- _ - NO ACTION +




Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec  Free  --    -     +     ++    Prev  Next  Canc
```

On this screen, you can specify a referential constraint to another table. To do so, enter an `S` in the **column-name** field. A list of all columns available in the current table (dependent table) is displayed, where you can select the column(s) to comprise the foreign key related to another table (parent table). You can also specify a name for the constraint. If not, the constraint name is derived from the first column of the foreign key.

A foreign key consists of one or more columns in a dependent table that together must take on a value that exists in the primary key of the related parent table.

In the **REFERENCES** part, you must specify the table name (with an optional creator name) of the parent table which is to be affected by the specified constraint. In addition, you must specify the action to be taken when a row in the referenced parent table is deleted.

The following options are provided:

- `RESTRICT` or `NO ACTION` prevents the deletion of the parent row until all dependent rows are deleted.
- `CASCADE` causes all dependent rows to be deleted, too.
- `SET NULL` sets to null all columns of the foreign key in each dependent row that can contain null values.

In the top right-hand corner of the screen, the index of the currently displayed referential constraint block (1) and the total number of referential constraint blocks defined (0) is displayed.

When all information has been entered, you can press either PF10 (Prev) to return to the previous screen, or PF11 (Next) to go to the next screen.

8 On the next screen you have again the possibility to specify columns as unique. This time, however, up to six groups of unique columns can be defined, with up to 16 columns per group. The individual columns are specified in a window, which can be invoked for each group.

```
 10:43:52              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Create Table -


>---+------------------------------------------ +-------------------------+ -->
    !                                            ! ------ column-name ---- !
    +- , - UNIQUE ----------------------------- !  __  COL1               !
    !                                            !  __  COL2               !
    +- , - UNIQUE ----------------------------- !  __  COL3               !
    !                                            !  __  COL4               !
    +- , - UNIQUE ----------------------------- !  __  COL5               !
    !                                            !                         !
    +- , - UNIQUE ----------------------------- !  __  COL6               !
    !                                            !  __  COL7               !
    +- , - UNIQUE ----------------------------- !  __  COL8               !
    !                                           +-------------------------+
    +- , - UNIQUE ------------------------------  _ -- (column-name) ---+




Command ===>
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
                  Exit              --    -     +     ++                Canc
```

Since unique columns must not contain null values, a further window is invoked automatically, on which you can define the columns specified as unique also as `NOT NULL` (unless you already defined them as such on the first Create Table input screen).

When all information has been entered, you can press either PF10 (Prev) to return to the previous screen or PF11 (Next) to go to the last syntax input screen.

9 On the last syntax input screen, you can now:

- Restrict dropping of the current table (and also of the database and tablespace that contain this table).
- Define a check constraint for the current table. To define a check constraint, you must specify a table check condition. A check condition is a search condition with various restrictions which are described in the relevant DB2 literature by IBM. In addition, you may specify a name for the check constraint.

```
10:47:02              ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                              - Create Table -

  >-----+- IN -----------  ________ . ________ ----------------------+------>
        !             <database-name.>tablespace-name                !
        +- IN DATABASE -------------- ________ ----------------------+
                                    database-name

  >------- EDITPROC ------ ________ --------- VALIDPROC -- ________ -------->

  >------- AUDIT --------- _______ ---------- OBJID ------ _____ ----------->
                   ( NONE, CHANGES, ALL )                 integer

  >------- DATA CAPTURE -- _______ ---------- CCSID ------ _______ --------->
                     ( NONE, CHANGES )              ( ASCII, EBCDIC )

  >------- WITH RESTRICT ON DROP -- _ ------------------------------------->

  >------- CHECK --------- _ ---------------------------------------------><
                   check-condition

 Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12--
       Help  Error Exit  Exec  Free                          Prev        Canc
```

If you press PF10 (Prev) on this screen, you return to the previous screen.

As you can see on the above screen, the end of the syntax specification for an SQL statement is always indicated by `><`.

An active help facility that consists of selection lists in windows is available for all fields referencing existing database objects. Selection lists are invoked by entering either an asterisk (*) or part of an object name followed by an asterisk in the corresponding input field.

If, for example, you enter `D*` in the "database-name" field of the above screen, a window appears where you can check your selection criteria. When you press Enter, a list of all databases whose names begin with `D` appears.

```
10:47:02              ***** NATURAL TO +-----------------------+    2009-10-30
                              - Create !  Database   Tablespa  !
                                       !  D*______ . ________  !
  >-----+- IN -----------  d*______ .  !                      ! ----+------>
        !             <database-name.> +-----------------------+     !
        +- IN DATABASE --------------  ! Select ==> __         ! ----+
                                    dat !                       !
                                        !   1 DSNDB04  ALLDATA0 !
  >------- EDITPROC ------ ________ -- !   2 DSNDB04  CANTABRD ! __ -------->
```

```
                                        !   3 DSNDB04  CDBPR06  !
   >------- AUDIT --------- _______ --- !   4 DSNDB04  DATEGRP  ! ----------->
                   ( NONE, CHANGES, AL !   5 DSNDB04  DECIMALR !
                                        !   6 DSNDB04  DEMO     !
   >------- DATA CAPTURE -- _______ --- !   7 DSNRGFDB DSNRGFTS ! _ --------->
                      ( NONE, CHANGES  !   8 DSNRLST  DSNRLS01 ! CDIC )
                                        !   9 DB27WRK  DSN32K01 !
   >------- WITH RESTRICT ON DROP -- _  !                       ! ----------->
                                        !  10 DB27WRK  DSN4K01  !
   >------- CHECK --------- _ --------- !  11 DSN8D71L DSN8S71B ! ---------->
                    check-condition     !  12 DSN8D71P DSN8S71C !
                                        +----------------------+
Command ===>
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec  Free                          Prev        Canc
```

Within the selection list, you can scroll up (PF6 / “--” or PF7 / “-”) or down (PF8 / “+” or PF9 / “++”), and select the desired database. The name of the selected database is copied to the corresponding field in your input screen.

10 When all information has been entered, you can either switch to free mode (PF5) or submit the created member directly to DB2 for execution (PF4). If execution is successful, you receive the message:

```
Statement(s) successful, SQLCODE = 0
```

If not, an error code is returned.

In free mode, the following editor screen displays the generated SQL code:

```
 10:53:50             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
 FREE - Input        SAG                  S 01- ---------------Columns 001 072
=====>                                                          Scroll ===>  PAGE
 ***** ****************************** top of data ******************************
 00001 CREATE TABLE SAG.DEMOTABLE
 00002   (COL1                 CHAR(20),
 00003    COL2                 INTEGER                NOT NULL,
 00004    COL3                 SMALLINT               NOT NULL,
 00005    COL4                 CHAR(2)                FOR SBCS DATA,
 00006    COL5                 VARCHAR(30)            NOT NULL,
 00007    COL6                 DECIMAL(2,5)
 00008      FIELDPROC PROGNAME
 00009        ('STRING1','STRING2'),
 00010    COL7                 FLOAT                  NOT NULL,
 00011    COL8                 DATE,
 00012    COL9                 TIME,
 00013   PRIMARY KEY (COL3,                    COL2,
 00014                COL5)
 00015   )
```

```
00016   IN DSNDB04.DEMO;
***** *************************** bottom of data ***************************


 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Setup Exit  Exec  Rfind Rchan -     +     Outpu             Canc
```

The free-mode editor is an adapted version of the Software AG Editor. It is almost identical to the interactive **ISQL - Input** screen. However, no `SELECT` statements can be issued from free mode.

For further details, please refer to the relevant *Software AG Editor* documentation.

Create Tablespace Function

To invoke theCreate Tablespace function

1 On the **Catalog Maintenance** screen, enter the code `CR`.

In the **Object** field, enter `TS` and press ENTER.

The first **Create Tablespace** syntax input screen is displayed:

```
 16:08:09             ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                                - Create Tablespace -



  >>-- CREATE TABLESPACE ----- TS1_____ -------- IN ----- ________ ----------->
                            tablespace-name             database-name



           +- VCAT ---- ________ ------------------------------------------+
  >- USING -+          catalog-name                                        +->
            +- STOGROUP- ________ - PRIQTY  ____ - SECQTY  ___ - ERASE  ___
-+
                       stogroup-name      integer       integer   ( YES or NO )




  >--- FREEPAGE -------- ___ ----- PCTFREE -- __ ------------ COMPRESS  ___ --->
                       integer            integer                ( YES or NO )
```

```
 >--- NUMPARTS -------- __ ----- _ ------------------------------------------>
                       integer    PART



 >--- SEGSIZE --------- __ ------------------------------------------------->
                       integer



Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12--
      Help  Error Exit  Exec  Free                                Next  Canc
```

2 Once you have entered all necessary information, press PF11 (Next) to go to the next screen:

```
16:08:09             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                             - Create Tablespace -





>---+-------------------------------------------------------------------+--><
    !                                                                   !

    +--- BUFFERPOOL ------ ______ ----------------------------------------+

    !                  bufferpool-name                                  !

    +--- LOCKSIZE -+------ _________ ------------------------+------------+

    !              !( ANY, TABLE, TABLESPACE )               !            !

    !              +------ ____ ---+----------------------+--+            !

    !               ( ROW or PAGE )!                      !               !

    !                              +- LOCKMAX -- ______ --+               !

    !                                     ( SYSTEM or integer )           !

    +--- CLOSE ----------- ___ ------------------------------------------+

    !                ( YES or NO )                                      !

    +--- DSETPASS -------- ________ --------------------------------------+

                           password
```

```
 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12--
      Help  Error Exit  Exec  Free                          Prev        Canc
```

On the second **Create Tablespace** syntax input screen, you can now specify additional buffer pool names as well as the `LOCKSIZE` option with the `LOCKMAX` clause.

If you enter an `S` in the **bufferpool-name** field and press Enter, a window is displayed, in which you can specify additional buffer pool names.

Refer to the relevant DB2 literature by IBM for further details on the `COMPRESS`, `LOCKSIZE` and `LOCKMAX` clauses.

Alter Table Function

The following example illustrates the use of the **Alter Table** syntax input screen.

To invoke the Alter Table function

1 On the **Catalog Maintenance** screen, enter the code `AL`.

In the **Object** field, enter `TB` and press Enter.

The **Alter Table** screen is displayed, where you can specify the following:

```
11:01:47              ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                                - Alter Table -

>>-- ALTER TABLE ------------- ________ . __________________ ----------------->
                               <creator.>table-name
>-+- ALTER  __________________ -- SET DATA TYPE - VARCHAR - ( __________ ) --+>
  !             column-name                                     length       !
>-+- ADD  __________________ _________________  ( __________ ) - _ -- __ - __ -->
  !          column-name         format           length     S/M/B  NN  UK/PK
  !    +--<
  !    +>- _ ------ _ ---------- _ -------------- _ --------------- _ -------+>
  !   field-proc default   check-constr   reference-constr   GENERATED-Clause!
  !                                                                          !
```

```
>-+- VALIDPROC --------------- ________ ------------------------------------+>
  !                        program-name or NULL                               !
  +- AUDIT ------------------ _______ -------------------------------------+
  !                        ( NONE, CHANGES, ALL )                             !
  +- DATA CAPTURE ------------ _______ -------------------------------------+
                            ( NONE, CHANGES )


  Command ===>

  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
        Help  Error Exit  Exec  Free                                Next  Canc
```

2 If you enter an S in the **field-proc** input field and press Enter, a window is displayed, in which you can specify a field procedure to be executed for this column:

```
 11:05:47             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Alter Table -

>>-- ALTER TABLE ------------- ________ . __________________ ----------------->
                                <creator.>table-name
>-+- ALTER  __________________ -- SET DATA TYPE - VARCHAR - ( __________ ) --+>
  !             column-name                                        length      !
>-+- ADD  __________________ ________________  ( __________ ) - _ -- __ - __ -->
  !          column-name         format           length     S/M/B  NN  UK/PK
  !    +--<              +-----------------------+
  !    +>- S ------ _ -- !            1 / 0      !  --------------- _ -------+>
  !   field-proc default ! --- FIELDPROC ----     ! -constr   GENERATED-Clause!
  !                       !      ________         !                           !
>-+- VALIDPROC --------- !    program-name       ! --------------------------+>
  !                       !  ( ____________ ,     !                           !
  +- AUDIT ------------- !    ____________ ,     ! --------------------------+
  !                       !    ____________ )     !                           !
  +- DATA CAPTURE ------ !    (constants,)       ! --------------------------+
                          !                       !
                          !                       !
                          +-----------------------+
Command ===>
  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
                     Exit                                                    Canc
```

3 If you enter an S in the **default** field and press Enter, a window is displayed, in which you can specify a default value other than the system default value for this column:

```
 11:07:31              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Alter Table -

+-----------------------------------------------------------------------------+
! >--- _ - WITH DEFAULT ----------------------------------------------------> !
! >-+-------------------------+-+-----------------------------------+-+---+-><!
!   +- ___________________  ( -+ +-- _ - USER ----------------------+ + ) +   !
!      cast-function-name       +-- _ - CURRENT SQLID -------------+         !
!                               +-- _ - NULL ----------------------+         !
!                                _______________________________             !
!                                _______________________________             !
!                                _______________________________             !
!                                _______________________________             !
!                                _______________________________             !
!                                             constant                        !
!                                                                             !
!                                                                             !
!                                                                             !
+-----------------------------------------------------------------------------+


Command ===>
  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
                    Exit                                                    Canc
```

One of the following types of default values can be specified:

- `USER`: an execution-time value of the special register `USER`.
- `CURRENT SQLID`: the SQL authorization ID.
- `NULL`: the null value.
- `constant`: a constant which names the default value for the column.

For further information on default values, refer to the relevant DB2 literature by IBM.

4 If you enter an `S` in the **check-constraint** field and press Enter, a window is displayed, in which you can specify a check constraint for this column:

```
 11:09:02              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Alter Table -

>>-- ALTER TABLE ------------- ________ . ___________________ ----------------->
                                <creator.>table-name
>-+- ALTER  ___________________ -- SET DATA TYPE - VARCHAR - ( __________ ) --+>
  !             column-name                                        length       !
>-+- ADD  ___________________ ________________  ( __________ ) - _ -- __ - __ -->
  !          column-name         format           length     S/M/B  NN  UK/PK
  !    +--<
  !    +>- _ ------ _ ---------- S -------------- _ --------------- _ -------+>
```

```
  !   field-proc default   check-constr   reference-constr   GENERATED-Clause!
+-----------------------------------------------------------------------------+
! >-+-------------------------+- CHECK  ( ___________________________________ !
!   !                         !           ___________________________________ !
!   +- CONSTRAINT - ________ -+           ___________________________________ !
!                 constraint-name         ___________________________________ !
!                                                                             !
!                                         ___________________________________ !
!                                         ___________________________________ !
!                                                                             !
+-----------------------------------------------------------------------------+
  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
                     Exit                                                   Canc
```

You must specify a column check condition. A check condition is a search condition with various restrictions which are described in detail in the relevant DB2 literature by IBM. In addition, you may specify a name for the check constraint.

5 If you enter an S in the **reference-constraint** field and press Enter, a window is displayed, in which you can specify a references clause, which identifies this column as a foreign key of a referential constraint:

```
 11:10:36             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                               - Alter Table -

>>-- ALTER TABLE ------------- ________ . __________________ ----------------->
                               <creator.>table-name
>-+- ALTER  ___________________ -- SET DATA TYPE - VARCHAR - ( __________ ) --+>
  !             column-name                                      length       !
>-+- ADD  ___________________ _________________  ( __________ ) - _ -- __ - __ -->
  !          column-name         format           length     S/M/B  NN  UK/PK
  !    +--<
  !    +>- _ ------ _ ---------- _ -------------- S --------------- _ -------+>
  !   field-proc default   check-constr   reference-constr   GENERATED-Clause!
  !        +-------------------------------------------------------------+       !
>-+- VALID ! >--- REFERENCES ---- ________ . __________________ -->  ! ------+>
  !        !                       <creator.>table-name              !       !
  +- AUDIT ! >-+--------------------------------+---------------->  ! ------+
  !        !   +- ON DELETE --+-- _ - RESTRICT --+                   !       !
  +- DATA  !                  +-- _ - CASCADE ---+                   ! ------+
           !                  +-- _ - SET NULL --+                   !
           !                  +-- _ - NO ACTION -+                   !
           !                                                         !
Command == !                                                         !
Enter-PF1- !                                                         ! -PF12---
           +-------------------------------------------------------------+  Canc
```

You must specify the name (with an optional creator name) of the parent table to be referenced. In addition, you must specify the action to be taken when a row in the referenced table is deleted. The following options are provided:

- RESTRICT or NO ACTION prevents the deletion of the parent row until all dependent rows are deleted.
- CASCADE deletes all dependent rows, too.
- SET NULL sets to null all columns of the foreign key in each dependent row that can contain null values.

6 Once you have entered your column definitions, press PF11 (Next).

A screen is invoked in which you can add or drop primary and/or foreign keys:

```
 11:14:42              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Alter Table -

>--+--- ADD ------ PRIMARY KEY ------------------- _ -- (column-name) ---+
   !                                                                      !
   +--- DROP ----- PRIMARY KEY ------------------- _ --------------------+-->


>--+->- ADD ------ FOREIGN KEY --- ________ ------ _ -- (column-name) -->
   !                              constraint-name
   ! >- REFERENCES ----> ________ . ___________________ ----------------->
   !                      <creator.>table-name
   ! >-+---------------------------+------ ON DELETE -+- S - RESTRICT -+-+-->
   !   +--- _ --- (column-name) ---+                  +- _ - CASCADE --+ !
   !                                                  +- _ - SET NULL -+ !
   !                                                  +- _ - NO ACTION + !
   +->- DROP ----- FOREIGN KEY --- ________ ------------------------------+
                                  constraint-name



  Command ===>

  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
        Help  Error Exit  Exec  Free                          Prev  Next  Canc
```

7 Once you have entered the required information for adding and/or dropping primary and/or foreign keys, press PF11 (Next). A screen is invoked, in which you can specify a RESTRICT ON DROP clause, add or drop a CHECK constraint, and/or drop any constraint:

```
12:20:24              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - Alter Table -




>---+-- ADD --- _ --+----- RESTRICT ON DROP ---------------------------------->
    !               !

    +-- DROP -- _ --+




>------ ADD CHECK ----------- _ ---------------------------------------------->
                             check-condition



>------ DROP CHECK  --------- ________ -------------------------------------->
                             constraint-name




>------ DROP CONSTRAINT ----- ________ -------------------------------------->
                             constraint-name









Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec  Free                          Prev        Canc
```

Alter Tablespace Function

The following example illustrates the use of the **Alter Tablespace** syntax input screen.

To invoke the Alter Tablespace function

1 On the **Catalog Maintenance** screen, enter the code `AL`.

In the **Object** field, enter `TS` and press Enter.

The **Alter Tablespace** screen is displayed, where you can specify the following:

```
12:20:24            ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                            - Alter Tablespace -



 >>------------- ALTER TABLESPACE -- ________ . ________ -------------------->
                                  <database-name.>tablespace-name



            +-->- BUFFERPOOL ------- ______ -----------------+

            !                    bufferpool-name             !

  >---------+-->- CLOSE ------------ ___ --------------------+--------------->
            !                    ( YES or NO )               !

            +-->- DSETPASS --------- ________ ---------------+

            !                        password                !

            +-->- PART ------------- __ ---------------------+

            !                      integer                   !

            +-->- FREEPAGE --------- ___ --------------------+

            !                      integer                   !

            +-->- PCTFREE ---------- __ ---------------------+

            !                      integer                   !

            +-->- COMPRESS --------- ___ --------------------+
```

```
                                ( YES or NO )



 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec  Free                                Next  Canc
```

2 If you enter an S in the **bufferpool-name** field and press Enter, a window is displayed, in which you can specify additional buffer pool names:

```
12:20:24            ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                            - Alter Tablespace -

                                          +--------------------------------+
 >>------------- ALTER TABLESPACE -- _______ !
!
                                <database-na !     Valid values for
!
                                             !     bufferpool-name:
!
           +-->- BUFFERPOOL ------- S_____  ! ----------------------------
!
           !                    bufferpool-n !
!
  >---------+-->- CLOSE ------------ ___ --- !  -  4KB buffer pools -
!
           !                    ( YES or NO  !  BP0, BP1, BP2, ..., BP49
!
           +-->- DSETPASS --------- _______ !
!
           !                        passwor !  - 32KB buffer pools -
!
           +-->- PART ------------- __ ---- !  BP32K, BP32K1, ..., BP32K9
!
           !                       integer   !
!
           +-->- FREEPAGE --------- ___ --- !  ______  Selection
!
           !                       integer   !
!
          +-->- PCTFREE ---------- __ -----+--------------------------------+
           !                       integer                   !

           +-->- COMPRESS --------- ___ --------------------+

                                ( YES or NO )
```

```
Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
                  Exit                                                     Canc
```

3 Once you are back in the first **Alter Tablespace** syntax input screen, press PF11 (Next) to go to the next screen:

```
12:20:24            ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                             - Alter Tablespace -




                        +- VCAT ----- ________ --+

            +-->- USING -+          catalog-name  +---------------+

            !            +- STOGROUP - ________ --+               !

            !                      stogroup-name                  !

  >---------+-->- PRIQTY ------------- ____ ----------------------+------><

            !                        integer                      !

            +-->- SECQTY ------------- ___ -----------------------+

            !                        integer                      !

            +-->- ERASE -------------- ___ -----------------------+

            !                      (YES or NO)                    !

            +-->- LOCKMAX ------------ ______ --------------------+

            !                      (SYSTEM or integer)            !

            +-->- LOCKSIZE ---+------- ____ --- LOCKMAX - ______ -+

                              ! (PAGE or ROW)  (SYSTEM or integer)!

                              +------- __________ ----------------+

                                   (ANY, TABLE or TABLESPACE)
```

```
 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec  Free                          Prev        Canc
```

4 On the second **Alter Tablespace** syntax input screen, you can now specify the `LOCKMAX` and `LOCKSIZE` options.

Refer to the relevant DB2 literature by IBM for further details on the `COMPRESS`, `LOCKSIZE` and `LOCKMAX` clauses.

SQL Skeleton Members

SQL skeleton members are provided for processing the following SQL statements that are not supported by the **Catalog Maintenance** function:

- `CREATE AUXILIARY TABLE`
- `CREATE DISTINCT TYPE`
- `CREATE TRIGGER`
- `GRANT ALTERIN`
- `REVOKE ALTERIN`

An SQL skeleton member is a Natural text member that contains an SQL skeleton that complies with the DB2 SQL syntax rules as described in the relevant IBM literature. The replacable items in the SQL skeleton shown in lower-case characters must be filled with user input so that the skeleton becomes a valid SQL statement that can be executed in free mode (see ***Free Mode***) or ISQL (see **Interactive SQL**). The skeleton members are delivered in the Natural system library `SYSDB2`, along with example SQL members.

9 Interactive SQL

The **Interactive SQL** function of the **Natural Tools for DB2** enables you to execute SQL statements dynamically.

Invoking the Interactive SQL Function

To invoke the Interactive SQL function

- On the **Natural Tools for DB2 Main Menu**, enter function code `I`.

  The **Interactive SQL** screen is displayed:

```
16:21:04             ***** NATURAL TOOLS FOR DB2 *****           2009-10-30
                              - Interactive SQL -









                        Code   Function

                        ----   -------------------------

                          I    SQL Input Member

                          O    Data Output Member

                          ?    Help

                          .    Exit

                        ----   -------------------------

                   Code.. _    Library .. SAG_____

                               Member ... ________
```

```
 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                                    Canc
```

The following functions are available:

Code	Description
I	Displays SQL members in the interactive SQL input screen.
O	Displays output members in the interactive SQL output screen.

The following parameters can be specified:

Parameter	Description
Library	Specifies the name of the current Natural library which contains the specified input/output members. Specification of libraries whose names begin with SYS is not allowed. The library name is preset with your Natural user ID.
Member	If a valid member name is specified, the corresponding member is displayed. If a value is specified followed by an asterisk (*), all input/output members in the current library whose names begin with this value are listed. If asterisk notation is specified only, a selection list of all input/output members in the current library is displayed. If the **Member** field is left blank, the empty SQL input/output screen is displayed.

SQL Input Members

To invoke the SQL Input Member function

- On the **Interactive SQL** screen, enter function code I and press Enter.

  Depending on what member name you have specified, different screens are displayed.

  These screens are explained in the following sections.

ISQL Input Screen

If you leave the **Member** field blank, the empty **ISQL - Input** screen is invoked:

```
16:21:56              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
 ISQL - Input        SAG                   S 01- ---------------Columns 001 072
 ====>                                                          Scroll ===>  PAGE
 ***** ****************************** top of data ******************************
 '''''
 '''''
 '''''
 '''''
 '''''
 '''''
 '''''
 '''''
 '''''
 '''''
 '''''
 '''''
 '''''
 '''''
 '''''
 '''''
 ***** **************************** bottom of data ****************************

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Setup Exit  Exec  Rfind Rchan -     +     Outpu            Canc
```

The **ISQL - Input** screen is a free-mode editor (see *Editing within the Natural Tools for DB2*) which provides a functionality similar to the one of the Software AG Editor. Using the editor you can enter or edit SQL statements via editor main and line commands. You can execute the SQL statements immediately from within the editor by pressing PF4 (Exec), or you can save them as an SQL member in a Natural library for later execution.

For information on the PF keys available, see *PF Key Settings*.

Note: The `PRINT` command is not available in the SQL input screen.

Apart from the editor main and line commands, SQL code maintenance commands are also available to maintain SQL members in a Natural library; see *Global Maintenenance Commands*. With these maintenance commands, input members can be listed, retrieved, saved in a Natural library, copied, and purged. They are entered in the command line of the input screen.

You can also obtain a list of the available maintenance commands by entering the help character, that is, a question mark (?), in the command line of the input screen. A window is displayed from which the desired command can be selected. The window can be scrolled forwards by pressing PF8, or backwards by pressing PF7.

```
12:22:12              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
 ISQL - Input        SAG                  S 01- ---------------Columns 001 072
 ====> ?                                                       Scroll ===>  PAGE
 ***** ********************** +----------------------------------+*************
                               !                                  !
                               !   _  List <*,member>             !
                               !   _  READ <member>               !
                               !   _  SAVE <member>               !
                               !   _  COPY <member>               !
                               !   _  Purge <member>              !
                               !   _  LIBrary <library>           !
                               !   _  SELect <TB,CO> name1 name2  !
                               !                                  !
                               +----------------------------------+





 ***** **************************** bottom of data ****************************

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Setup Exit  Exec  Rfind Rchan -     +     Outpu             Canc
```

To assist you in coding your SQL member, existing DB2 tables and columns can be listed using the `SELECT` command. From the list, you can include table and column names into the editor.

The `SELECT` command is available for table and column selection:

Command	Description
SELECT TABLE [*creator*.]*name*	Selects all tables with the specified creator (optional) and name. For both *creator* and *name*, you can specify a value followed by an asterisk (*), and all tables whose names begin with this value are selected. . If you specify asterisk notation only, all existing tables are selected. If you specify a table name without a creator, all tables with the specified name are selected, regardless of their creator.
SELECT COLUMN *creator*.*name*	Selects all columns of the table *creator*.*name*. Since the table must be uniquely identified, asterisk notation cannot be used.

Sample Input Screen with Table Listing Window

```
12: +-------------------------------------------------------------------+
 ISQ ! Tab:                                                            !
==== ! SYSIBM.*                                                        !
 *** !   Table Name                      Creator                       !
 ''' ! _ SYSDATABASE                     SYSIBM                        !
 ''' ! _ SYSDATATYPES                    SYSIBM                        !
 ''' ! _ SYSDBAUTH                       SYSIBM                        !
 ''' ! _ SYSDBRM                         SYSIBM                        !
 ''' ! _ SYSDUMMY1                       SYSIBM                        !
 ''' ! _ SYSDUMMYA                       SYSIBM                        !
 ''' ! _ SYSDUMMYE                       SYSIBM                        !
 ''' ! _ SYSDUMMYU                       SYSIBM                        !
 ''' ! _ SYSFIELDS                       SYSIBM                        !
 ''' ! _ SYSFOREIGNKEYS                  SYSIBM                        !
 ''' ! _ SYSINDEXES                      SYSIBM                        !
 ''' ! _ SYSINDEXES_HIST                 SYSIBM                        !
 ''' ! _ SYSINDEXPART                    SYSIBM                        !
 ''' ! _ SYSINDEXPART_HIST               SYSIBM                        !
 ''' ! _ SYSINDEXSTATS                   SYSIBM                        !
 ''' ! _ SYSINDEXSTATS_HIST              SYSIBM                        !
 *** ! _ SYSJARCLASS_SOURCE              SYSIBM                        !
     ! _ SYSJARCONTENTS                  SYSIBM                        !
Ente !                                                                 !
     +-------------------------------------------------------------------+
```

From the table list, you can select a table for display of its columns by marking it with `C` in front of the table name. The columns of a table are listed together with their type and length. A creator or table name longer than 32 characters will be truncated. This will be indicated by a > symbol at the end of the creator or table name.

Sample Input Screen with Column Listing Window

```
 12:27:08              ** +-----------------------------------------------+
 ISQL - Input         GGS ! Tab: SYSIBM.SYSTABLES                         !
=====>                    !                                               !
 ***** ****************** !   Column Name                   Type     Len  !
 A     SELECT             ! M NAME                          VARCHAR  128  !
 00002 SYSIBM.SYSTABLES   ! M CREATOR                       VARCHAR  128  !
 ***** ****************** ! M TYPE                          CHAR     1    !
                          ! M DBNAME                        VARCHAR  24   !
                          ! M TSNAME                        VARCHAR  24   !
                          ! _ DBID                          SMALLINT 2    !
                          ! _ OBID                          SMALLINT 2    !
                          ! _ COLCOUNT                      SMALLINT 2    !
                          ! _ EDPROC                        VARCHAR  24   !
                          ! _ VALPROC                       VARCHAR  24   !
                          ! _ CLUSTERTYPE                   CHAR     1    !
                          ! _ CLUSTERRID                    INTEGER  4    !
```

```
                          ! _ CARD                                INTEGER  4    !
                          ! _ NPAGES                              INTEGER  4    !
                          ! _ PCTPAGES                            SMALLINT 2    !
                          ! _ IBMREQD                             CHAR     1    !
                          ! _ REMARKS                             VARCHAR  762  !
                          ! _ PARENTS                             SMALLINT 2    !
Enter-PF1---PF2---PF3---P !                                                    !
      Help  Setup Exit  E +----------------------------------------------------+
```

If you want to copy table or column names from a selection list into the editor, mark the corresponding table or column with `M` as shown on the previous screen. The table or column names are copied either after or before the line marked with an `A` or a `B` respectively, or to the top of the displayed data.

Sample Input Screen with Copied Column Names

```
 12:29:44              ** +----------------------------------------------------+
 ISQL - Input         GGS ! Tab: SYSIBM.SYSTABLES                                !
=====>                    !                                                      !
 ***** ****************** !   Column Name                         Type     Len  !
 A     SELECT             ! _ NAME                                VARCHAR  128  !
 00002 NAME               ! _ CREATOR                             VARCHAR  128  !
 00003 , CREATOR          ! _ TYPE                                CHAR     1    !
 00004 , TYPE             ! _ DBNAME                              VARCHAR  24   !
 00005 , DBNAME           ! _ TSNAME                              VARCHAR  24   !
 00006 , TSNAME           ! _ DBID                                SMALLINT 2    !
 00007 SYSIBM.SYSTABLES   ! _ OBID                                SMALLINT 2    !
 ***** ****************** ! _ COLCOUNT                            SMALLINT 2    !
                          ! _ EDPROC                               VARCHAR  24   !
                          ! _ VALPROC                              VARCHAR  24   !
                          ! _ CLUSTERTYPE                          CHAR     1    !
                          ! _ CLUSTERRID                           INTEGER  4    !
                          ! _ CARD                                 INTEGER  4    !
                          ! _ NPAGES                              INTEGER  4    !
                          ! _ PCTPAGES                            SMALLINT 2    !
                          ! _ IBMREQD                             CHAR     1    !
                          ! _ REMARKS                             VARCHAR  762  !
                          ! _ PARENTS                             SMALLINT 2    !
Enter-PF1---PF2---PF3---P !                                                    !
      Help  Setup Exit  E +----------------------------------------------------+
```

Fixed Mode with Interactive SQL

All fixed-mode input screens from the *Catalog Maintenance* part of the **Natural Tools for DB2** are available as help maps within the *Interactive SQL* part.

To invoke this help facility, enter the name of the SQL statement you want to create in the command line of your **ISQL - Input** screen, for example, `CREATE TABLE` or `CR TB` for the `CREATE TABLE` command.

The same command abbreviations apply as with the **Catalog Maintenance** function.

If you enter `CREATE TABLE` or `CR TB`, the **Create Table** screen is invoked:

```
 01:22:12              ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                                - Create Table -                       1  / 9

>>- CREATE TABLE - SAG_____ . DEMOTABLE_________ ----------------------------->
                    <creator.>table-name
>+--- LIKE ------- ________ . __________________ +-------------------------+-+>
 !                  <creator.>table/view-name    +- _ - INCLUDING IDENTITY + +
 !                                                                           !
 +( COL1_______________  CHAR___________ ( 20________ ) _ - __ - _ - __ - _ , +
 +- COL2_______________  INTEGER________ ( __________ ) _ - NN - _ - 2_ - _ , +
 +- COL3_______________  SMALLINT_______ ( __________ ) _ - NN - _ - 1_ - _ , +
 +- COL4_______________  CHAR___________ ( 2_________ ) S - __ - _ - __ - _ , +
 +- COL5_______________  VARCHAR________ ( 30________ ) _ - NN - _ - 3_ - _ , +
 +- COL6_______________  DECIMAL________ ( 2,5_______ ) _ - __ - X - __ - _ , +
 +- COL7_______________  FLOAT__________ ( __________ ) _ - NN - _ - __ - _ , +
 +- COL8_______________  DATE___________ ( __________ ) _ - __ - _ - __ - _ , +
 +- COL9_______________  TIME___________ ( __________ ) _ - __ - _ - __ - _ , +
 +- ___________________  _______________ ( __________ ) _ - __ - _ - __ - _ , +
       column-name          format          length     S/M  NN  fld  PK/ R/C
                                                        B       proc UK  D/G
Command ===>
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec  Free  --     -     +    ++          Next  Canc
```

If you have entered data for a complete SQL statement, you can generate an SQL statement from the entered data and include it into the **ISQL - Input** screen.

Using PF4 (Incl), you include the generated SQL code and remain on the **Create Table** screen.

Using PF5 (IBack), you include the generated SQL code and return to the **ISQL - Input** screen.

Retrieve an SQL Member

If you specify a unique member name in the **Member** field of the **Interactive SQL** screen, the corresponding SQL member is listed on the input screen. If no member exists with the specified name, a corresponding message is returned.

Sample SQL Member Listed in Input Screen

```
01:03:23              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
 ISQL - Input        SAG(TESTSEQ)          S 01- ---------------Columns 001 072
 ====>                                                          Scroll ===>  PAGE
 ***** ****************************** top of data ******************************
 00001 CREATE TABLE DEMOTABLE
 00002   (COL1                 CHAR(8),
 00003    COL2                 INTEGER
 00004   ) IN DATABASE DEMO;
 00005 INSERT INTO DEMOTABLE
 00006   VALUES ('AAAAA',1);
 00007 * INSERT INTO DEMOTABLE
 00008 *   VALUES ('BBBBB',2);
 00009 SELECT FROM DEMOTABLE;
 00010 DROP TABLE DEMOTABLE;
 ***** **************************** bottom of data ****************************





Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Setup Exit  Exec  Rfind Rchan -     +     Outpu            Canc
```

Listed SQL members can be purged, modified, executed, or saved.

An asterisk (*) in front of a statement line turns this line into a comment line, which means that the corresponding SQL code is not considered for execution.

List of SQL Members

If you specify a value followed by an asterisk (*) in the **Member** field of the **Interactive SQL** screen, a list of all SQL input members in the current library whose names begin with this value is displayed.

If you specify an asterisk (*), a list of all SQL input members in the current library is displayed.

Sample SQL Input Member Selection List

```
15:06:14              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                Select Member

      C      Member      Type         User        Date        Time
      -      --------    -----------  --------    ----------  --------
      _      CRAXTB      SQL          SAG         2009-10-30  13:48:53
      _      CRDITY      SQL          SAG         2009-10-30  13:39:14
      _      CRPRQE      SQL          SAG         2009-10-30  13:54:21
      _      CRTB        SQL          SAG         2009-10-30  13:48:14
      _      CRTRIG      SQL          SAG         2009-10-30  13:53:01
      _      CRTRIG2     SQL          SAG         2009-10-30  13:14:10
      _      DRPRQE      SQL          SAG         2009-10-30  13:55:04
      _      DRPRQE2     SQL          SAG         2009-10-30  13:50:30
      _      GGSDTYPE    SQL          SAG         2009-10-30  13:52:10
      _      GRSHPR      SQL          SAG         2009-10-30  13:28:01
      _      RESHPR      SQL          SAG         2009-10-30  13:31:05
      _      SELPROCS    SQL          SAG         2009-10-30  13:09:05
      _      SELTABS     SQL          SAG         2009-10-30  13:56:22




Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
Cont              Exit                                          >     Canc
```

From the input screen selection list, SQL members can be selected for display by marking them with an `S`.

If the list has been invoked by a `PURGE` command, members can be purged by marking them with a `P`.

By pressing PF11 (>), you can switch from the default view of the **Select Member** screen as shown above to the extended view with the first line of each member displayed in the **Description** column:

```
15:09:17              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                Select Member

      C      Member      Description (first line of member)

      -      --------    ---------------------------------------------------
      _      CRAXTB      CREATE AUXILIARY TABLE aux-table-name
      _      CRDITY      CREATE DISTINCT TYPE distinct-type-name
      _      CRPRQE      * ALL PROCEDURES FROM QARNDB31(10,110), WHICH HAVE 'C
      _      CRTB        CREATE TABLE NEWTYPE
      _      CRTRIG      CREATE TRIGGER trigger-name NO CASCADE BEFORE|
      _      CRTRIG2     CREATE TRIGGER trigger-name (NO CASCADE BEFORE|
```

```
      _      DRPRQE      * ALL PROCEDURES FROM QARNDB31(10,110), WHICH HAVE 'C
      _      DRPRQE2     DROP PROCEDURE CALLN2 RESTRICT;
      _      GGSDTYPE    SELECT COLTYPE,LENGTH,LENGTH2,DATATYPEID,SOURCETYPEID
      _      GRSHPR      GRANT ALTERIN [, CREATEIN] [, DROPIN]
      _      RESHPR      REVOKE ALTERIN [, CREATEIN] [, DROPIN]
      _      SELPROCS    SELECT * FROM SYSIBM.SYSPROCEDURES
      _      SELTABS     SELECT * FROM SYSIBM.SYSTABLES



Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
Cont              Exit                                      <           Canc
```

The first line of a member can be the first line of an SQL statement or a comment line which provides more information on the member.

Data Output Members

To invoke the Data Output Member function

- On the **Interactive SQL** screen, enter function code 0 and press Enter.

  Depending on what member name you have specified, different screens are displayed.

  These screens are explained in the following sections.

Data Output Screen

If you leave **Member** field of the **Interactive SQL** screen blank, the empty **ISQL - Output** screen is invoked.

```
 15:19:15              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
  ISQL - Output       SAG                  S 02- ---------------Columns 001 072
  ====>                                                     Scroll ===>  PAGE
  ***** ****************************** top of data ******************************
  ***** ***************************** bottom of data *****************************
```

```
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind Rchan -     +            <     >    Canc
```

From the data output screen you have access to output data members only. Output members consist of data retrieved from the database as a result of executed SQL statements. These data can be browsed and saved for later use as output members on the Natural system file `FUSER`. In addition to the data retrieved from the database, output members also contain DB2 status information, and the executed SQL member.

If you execute an SQL statement, the results are automatically shown on the output screen. Thus, you can enter the interactive SQL output screen also by executing an SQL statement from the input screen. From the output screen you can return to the input screen by pressing PF3 (Exit).

For information on the other PF keys available, see ***PF Key Settings***.

The maintenance commands available for output members can be displayed and selected in a window, too; see ***Global Maintenenance Commands***. The window is invoked by entering the help character, that is, a question mark (?), in the command line of the output screen.

```
15:57:59              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
 ISQL - Output       SAG                  S 02- ---------------Columns 001 072
 ====> ?                                                     Scroll ===>  PAGE
 ***** ********************** +----------------------------------+*************
 ***** ********************** !                                  !*************
                                !   _  List <*,member>             !
                                !   _  READ <member>               !
                                !   _  SAve <member>               !
                                !   _  Purge <member>              !
                                !   _  LIBrary <library>           !
                                !                                  !
                                +----------------------------------+
```

```
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind Rchan -     +            <     >    Canc
```

Apart from the maintenance commands, only browse commands are available (see *Editing within the Natural Tools for DB2*), since output members cannot be modified. Both browse and maintenance commands are entered in the command line of the output screen.

If an output member is too large to fit on your terminal screen, you can use the `FIX ON` *n* command to keep the first *n* characters on the screen when scrolling to the left or to the right.

Retrieve an Output Member

If you specify a unique member name in the **Member** field of the **Interactive SQL** screen, the corresponding output member is listed on the output screen. If no member exists with the specified name, a corresponding message is returned.

Sample Output Member Listed in Output Screen

```
16:27:12              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
 ISQL - Output       SAG(TESTSEQO)         S 02- ---------------Columns 001 072
 ====>                                                         Scroll ===>  PAGE
 ***** ****************************** top of data ******************************
 00001 CREATE TABLE DEMOTABLE
 00002   (COL1                CHAR(8),
 00003    COL2                INTEGER
 00004   ) IN DATABASE DEMO
 00005 ------------------------------------------------------------------------
 00006 STATEMENT WAS SUCCESSFUL, SQLCODE = 0
 00007 ------------------------------------------------------------------------
 00008 INSERT INTO DEMOTABLE
 00009   VALUES ('AAAAA',1)
 00010 ------------------------------------------------------------------------
 00011 STATEMENT WAS SUCCESSFUL, SQLCODE = 0
 00012 ------------------------------------------------------------------------
 00013 SELECT FROM DEMOTABLE
 00014 ------------------------------------------------------------------------
 00015 COL1          COL2
 00016 ------------------------------------------------------------------------
 00017 AAAAA            1

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind Rchan -     +            <     >    Canc
```

List of Output Members

If you specify a value followed by an asterisk (*) in the **Member** field of the **Interactive SQL** screen, a list of all data output members in the current library whose names begin with this value is displayed.

If you specify asterisk notation only, a list of all data output members in the current library is displayed.

Sample Data Output Member Selection List

```
16:24:02              ***** NATURAL TOOLS FOR DB2 *****          2009-10-30
                                Select Member


      C     Member      Type         User        Date        Time
      -     --------    -----------  --------    --------    -----------
      _     AAAA        SQL-RESULT   SAG         2009-10-30  13:54:54
      _     ADEMVIEW    SQL-RESULT   SAG         2009-10-30  14:01:09
      _     AIRCRAFT    SQL-RESULT   SAG         2009-10-30  10:01:32
      _     BBBB        SQL-RESULT   SAG         2009-10-30  15:25:14
      _     BSP1        SQL-RESULT   SAG         2009-10-30  14:57:11
```

From the output member selection list, output members can be selected for display by marking them with an `S`.

If the list has been invoked by a `PURGE` command, members can be purged by marking them with a `P`.

Processing SQL Statements

SQL input members can only be accessed from the **ISQL - Input** screen. They are executed from the input screen against DB2 by pressing PF4 (Exec).

After execution, the data output screen appears which contains the results of the executed SQL member.

If an SQL member consists of more than one SQL statements, the individual statements must be separated by a semicolon. They can be executed one by one or all together at the same time.

To choose the form of execution, a window is provided which can be invoked by pressing PF2 (Setup).

```
16:29:12              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
 ISQL - Input        SAG(TESTSEQ)          S 01- ---------------Columns 001 072
 ====>                                 +---------------------------------------+
 ***** ****************************** !                                       !
 00001 CREATE TABLE DEMOTABLE         !  _  Execute statements one by one     !
 00002   (COL1                 CHAR(8 !  X  Execute all statements together   !
 00003    COL2                 INTEGE !                                       !
 00004   ) IN DATABASE DEMO;          !  _  Optional Commit/Rollback          !
 00005 INSERT INTO DEMOTABLE          !  X  Automatic Commit/Rollback         !
 00006   VALUES ('AAAAA',1);          !                                       !
 00007 * INSERT INTO DEMOTABLE        !  _  Ignore positive SQL codes         !
 00008 *   VALUES ('BBBBB',2);        !                                       !
 00009 SELECT FROM DEMOTABLE;         ! Text for NULL values      : <NULL>__  !
 00010 DROP TABLE DEMOTABLE;          ! Sql termination character : ;         !
 ***** **************************** b ! Maximum length of columns :    _____  !
                                      ! Maximum number of rows    :  _______  !
                                      ! DB2 cost limit            :  _______  !
                                      !                                       !
                                      ! Header Line every 15___ Data Lines    !
                                      ! Record Length Data Session: _250      !
                                      !                                       !
Enter-PF1---PF2---PF3---PF4---PF5---PF+---------------------------------------+
      Help  Setup Exit  Exec  Rfind Rchan -     +     Outpu             Canc
```

Below is information on the options provided:

- Execute Statements One By One
- Execute All Statements Together
- Automatic Commit/Rollback
- Optional Commit/Rollback
- Text For NULL Values
- SQL Termination Character
- Maximum Length of Columns
- Maximum Number of Rows
- DB2 Cost Limit
- Header Line Every n Data Lines

- Record Length Data Session

Execute Statements One By One

After each SQL statement the output screen is shown. From the output screen, you can either execute the next SQL statement from the input screen by pressing PF4 (Next), or skip the remaining SQL statements and return to the input screen immediately by pressing PF3 (Exit).

Execute All Statements Together

All statements are executed immediately one after the other. The output screen shows the results of all statements together.

Statements containing cursor names, host variables, or parameter markers cannot be executed with interactive SQL. Also not executed are statements available as embedded SQL only; that is, statements whose functions are automatically performed by Natural.

These statements are:

CLOSE
CONNECT
DECLARE
DELETE WHERE CURRENT OF CURSOR
DESCRIBE
EXECUTE
FETCH
INCLUDE
OPEN
PREPARE
SELECT INTO
SET *host-variable*
SET CURRENT PACKAGESET
UPDATE WHERE CURRENT OF CURSOR
WHENEVER

Automatic Commit/Rollback

If you select **Automatic Commit/Rollback**, each modification of the database is automatically either committed or rolled back, depending on whether all the SQL statements involved execute successfully. If so, an `SQL COMMIT WORK` command is executed; if not, an `SQL ROLLBACK` command backs out all database modifications since the last commit point.

Optional Commit/Rollback

If you select **Optional Commit/Rollback**, a window is invoked after each SQL statement, offering you the option to either commit or roll back the resulting database modifications shown on the screen.

Note: Since under CICS and IMS TM each terminal I/O results in a `SYNCPOINT`, the optional commit/rollback feature only applies in a TSO environment.

In all environments, you can include `SQL COMMIT` and `ROLLBACK` commands in your input member, too. Under CICS and IMS TM, however, these commands are translated into the corresponding TP-monitor calls.

Text For NULL Values

The text that is to be shown for `NULL` values can be specified here; the default string is `---`.

SQL Termination Character

If you enter multiple SQL statement, they need to be separated. The default statement termination character is the semi-colon (;).

Maximum Length of Columns

Limits the length for a single column to *n* characters. This limit only applies to character data. `DATE`, `TIME`, or `NUMERIC` columns are not truncated. The value `0` indicates that no limit exists.

Maximum Number of Rows

Limits the number of rows returned by one `SELECT` statement. The value `0` indicates that no limit exists.

DB2 Cost Limit

Sets a limit for the DB2 cost estimate. `SELECT` statements which exceed this limit are not executed. The value `0` indicates that no limit exists.

Header Line Every n Data Lines

For `SELECT` statements, you can specify that every *n* data lines a header line is inserted with the names of the selected columns. If *n* is set to `0`, only one header line is displayed at the top of the data.

Record Length Data Session

The record length (*n*) for the output session can be specified. If the specified record length is smaller than the record length of the output data, the output records are truncated accordingly. The truncation of records is indicated by a greater than character (>) as the leftmost character in the first line beneath each header line. The default value for *n* is 250 bytes.

PF-Key Settings

The following PF-key settings apply to the **ISQL - Input** screen:

Key	Setting	Function
PF2	Setup	Invokes a window with further processing options.
PF4	Exec	Executes the SQL member currently in the input screen.
PF5	Rfind	Repeats the last executed `FIND` command.
PF6	Rchan	Repeats the last executed `CHANGE` command.
PF7	-	Scrolls the display one page backward.
PF8	+	Scrolls the display one page forward.
PF9	Outpu	Invokes the output member selection list directly from within the input screen.

Apart from PF2 (Setup), PF4 (Exec), and PF9 (Outpu), the same PF-key settings apply to the **ISQL - Output** screen, too. In addition, the following PF-key settings are available:

Key	Setting	Function
PF4	Next	Executes the next SQL statement if an SQL member consists of more than one statement, and if you have chosen to execute them one after the other. If not, the setting for PF4 is left blank.
PF10	<	Scrolls the display of the output screen to the left.
PF11	>	Scrolls the display of the output screen to the right.

Unloading Interactive SQL Results

Results from interactive SQL are unloaded and written to a dataset referred to by DD name `CMWKF01` in batch mode using the `UNLDDATA` command.

`CMWKF01` should be of variable record format; the record length depends on the size of the SQL output member and can range from 250 to 4000 bytes.

To unload results from interactive SQL

1 Logon to the Natural system library `SYSDB2`.

2 In the command line, enter the command `UNLDDATA` and press ENTER.

The **Unload SQL Results** menu is displayed:

```
16:53:20              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                             - Unload SQL Results -









                          Code Function

                          ---- -------------------

                           U   Unload SQL Results

                           .   Exit

                          ---- -------------------
```

```
                    Code .. _   Library .. ________

                                Member ... ________









 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
                   Exit                                                    Canc
```

The following function is available:

Code	Description
U	Unloads results from interactive SQL execution.

The following parameters apply:

Parameter	Description
Library	Specifies the name of the Natural library from which the specified output members are to be unloaded. You cannot specify libraries whose names begin with SYS. This parameter must be specified.
Member	Specifies the name(s) of the output member(s) to be unloaded. This parameter must be specified.

10 Retrieval of System Tables

Important: Before you use the **Retrieval of System Tables** function, refer to *LISTSQL and Explain Functions* in the section *Special Requirements for Natural Tools for DB2*.

The DB2 system tables provide information on the contents of your DB2 system. The **Retrieval of System Tables** function enables you to:

- display information on DB2 objects without coding SQL queries;
- easily access related objects, such as indexes of a table.

The DB2 objects supported by the **Retrieval of System Tables** function are database, tablespace, table, index, column, plan, check constraints, statistic tables, package, and DBRM (database request module), as well as access rights to and relationships between these objects.

DB2 objects are presented in one of the following two ways:

- As selection lists, where all objects are of the same type, and where commands can be issued to display related objects.
- You can list databases, tables, plans, and packages by name. From the database listings, you can invoke listings of the tablespaces or tables of a database. From the table listing, you can invoke listings of the columns and indexes of a table. From the plan listing, you can invoke listings of the DBRMs of a plan, of the package list of a plan, of the tables and indexes used by a plan, and of the systems which are enabled or disabled for a plan. From the package listing, you can invoke listings of the tables and indexes used in a package and of the systems which are enabled or disabled for a package. From the database, table, plan, or package listings, you can also investigate who is authorized to access a DB2 object. In addition, the **User Authorization** menu enables you to list all existing access rights by user ID.
- As reports, which merely contain information on different types of DB2 objects, and where only browse commands can be issued.

The most important browse commands can also be issued via PF keys; see *Editing within the Natural Tools for DB2*.

This section covers the following topics:

Invoking the Retrieval of System Tables Function

To invoke the Retrieval of System Tables function

- On the **Natural Tools for DB2 Main Menu**, enter function code `R`.

The **Retrieval of System Tables** screen is displayed:

```
16:31:56             ***** NATURAL TOOLS FOR DB2 *****            2006-05-25
                         - Retrieval of System Tables -


                    Code  Function            Parameter


                     D    List Databases      Database

                     K    List Packages       Collection, Name

                     P    List Plans          Plan

                     T    List Tables         Tbreator, Tbname

                     U    User Authorizations

                     S    Statistic Tables

                     ?    Help

                     .    Exit


              Code .. _    Database Name ....... ________________________

                          Package Collection .. ______________________________
                         Package Name ........ ______________________________
                            Plan Name ........... ________________________

                         Table Creator ....... ______________________________
                         Table Name .......... ______________________________


 Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Setup Exit                                                     Canc
```

With PF2 (Setup) the maximum length of one column and the number of fixed characters when scrolling left may be specified. The default values for both parameters may be changed in the `CONFIG` subprogram in library `SYSDB2`.

When a column value is longer than the maximum length, it will be truncated and marked with a greater than sign (>) in the case of strings truncated at the right end or a less than sign (<) in the case of numbers truncated at the left end.

Note, that for further commands on a line, for example, the line command `I`, only the visible value can be taken as input. This means that commands on lines will fail, when values for further processing are truncated.

```
16:31:56             ***** NATURAL TOOLS FOR DB2 *****            2007-10-05
                          - Retrieval of System Tables -



                     Code  Function            Parameter

                                  +------Retrieval of System Tables------+

                      D    List Dat !                                    !

                     K    List Pac ! Maximum length of columns ... ____8  !

                     P    List Pla ! Number of fixed characters .. ____0  !

                      T    List Tab !                                    !

                      U    User Aut !                                    !

                     S    Statisti +-------------------------------------+

                      ?    Help

                      .    Exit



               Code .. _    Database Name ....... ________________________

                           Package Collection .. ______________________________
                          Package Name ........ ______________________________
                             Plan Name ........... ________________________

                          Table Creator ....... ______________________________
                          Table Name .......... ______________________________


 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Setup Exit                                                    Canc
```

The following functions are available:

Code	Description
D	Lists databases defined in the DB2 catalog.
K	Lists packages defined in the DB2 catalog.
P	Lists plans defined in the DB2 catalog.
S	Statistic tables.
T	Lists tables defined in the DB2 catalog.
U	Provides information on which user(s) can access which DB2 objects.

The following parameters must be specified as selection criteria:

Parameter	Description
Database Name	The name of the database to be listed. Asterisk notation (*) for range specification is possible. The Database Name parameter is relevant to the **List Databases** function only.
Package Collection	The collection of the package to be listed. Asterisk notation (*) for range specification is possible. The Package Collection parameter is relevant to the **List Packages** function only.
Package Name	The name of the package to be listed. Asterisk notation (*) for range specification is possible. The Package Name parameter is relevant to the **List Packages** function only.
Plan Name	The name of the plan to be listed. Asterisk notation (*) for range specification is possible. The Plan Name parameter is relevant to the **List Plans** function only.
Table Creator	The name of the creator of the table(s) to be listed. Asterisk notation (*) for range specification is possible. The Table Creator parameter is relevant to the **List Tables** function only.
Table Name	The name of the table to be listed. Asterisk notation (*) for range specification is possible. The Table Name parameter is relevant to the **List Tables** function only.

List Databases

To invoke the List Databases function

1 On the **Retrieval of System Tables** screen, enter function code D.

2 Specify the name of the database(s) to be listed.

- If a value followed by an asterisk is specified, all databases defined in the DB2 catalog whose names begin with this value are listed.
- If asterisk notation is specified only, all databases defined in the DB2 catalog are listed.

```
 16:32:24             ***** NATURAL TOOLS FOR DB2 *****            2007-10-05
  DATABASES *                              S 01     Row 0 of 25 Columns 001 059
  ====>                                                   Scroll ===>  PAGE
     DATABASE CREATOR     STOGROUP BPOOL     DBID CREATEDBY ROSHARE TIMESTAMP
GR
  ** ******************************** top of data ********************************
  __ DEMO     DEFAULT     SYSDEFLT BP0        269 DEFAULT           0001-01-0>
  __ DEMODB   SAG2        SYSDEFLT BP0        273 SAG2             0001-01-0>D8
  __ DEVELOP  SAG         DEVELOP  BP0        260 SAG              0001-01-0>DB
  __ ECHDB01  SAG2        SYSDEFLT BP0        272 SAG2              0001-01-0>
  __ EFGDB    SAG         SYSDEFLT BP0        263 SAG               0001-01-0>
  __ HBUTST   SAG2        SYSDEFLT BP0        275 SAG2              0001-01-0>
  __ PLANTAB  SAG2        SYSDEFLT BP0        270 SAG2              0001-01-0>
  __ Predict  SAG2        SYSDEFLT BP0        262 SAG2              0001-01-0>
  __ QA       SAG2        SYSDEFLT BP0        265 SAG2              0001-01-0>
  __ SAGDB04  SYSIBM      SYSDEFLT BP0          4 SYSIBM            0001-01-0>
  __ SAGDB06  SYSIBM                            6 SYSIBM            0001-01-0>
  __ SAGDB07  SAG1        SYSDEFLT BP0          7 SAG1              0001-01-0>
  __ SAGDDF   SAG1        SYSDEFLT BP0        257 SAG1              0001-01-0>
  __ SAGRLST  SAG1        SYSDEFLT BP0        256 SAG1              0001-01-0>
  __ SAG8D22A SAG1        SAG8G220 BP0        258 SAG1              0001-01-0>
  __ SAG8D22P SAG1        SAG8G220 BP0        259 SAG1              0001-01-0>


 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help        Exit        Rfind        -     +           <      >   Canc
```

The following line commands are available on the database listing screen. Line commands are entered in front of the desired database(s):

Command	Description
I	Displays information on a database.
S	Selects a database to be used with main commands (see below).
U	Unselects a database.
AU	Displays information on access rights to a database.
TB	Displays all tables defined in a database.
TS	Displays all tablespaces defined in a database.

The listings of tables or tablespaces displayed as a result of the TB or TS command can be used for further processing, whereas the contents of the screens displayed as a result of the AU or I command are for information purposes only.

A list of all line commands available with the **List Database** function can be invoked as a window by entering the help character, that is, a question mark (?), in front of any of the listed databases.

The commands `AU`, `TB`, and `TS` can also be used as main commands. Main commands are entered in the command line of the database list screen and apply to all databases previously selected with the line command `S`.

A further main command is the `INFO` command, which is the equivalent of the `I` line command, but displays information on all previously selected databases. Instead of being displayed, all information resulting from the `I` or `INFO` commands can also be marked for printing. Even if already displayed, information can be printed by issuing the `PRINT` command.

```
16:32:24             ***** NATURAL TOOLS FOR DB2 *****            2007-10-05
 DATABASES *                              S 01     Row 0 of 25 Columns 001 059
 ====>                                                   Scroll ===>  PAGE
   DATABASE CREATOR    STOGROUP BPOOL    DBID CREATEDBY ROSHARE TIMESTAMP GR
 ** **** +-------------------------------------------------------+ **********
  I_ DEMO !                                                      ! 01-01-0>
  __ DEMO !                Select what to display               ! 01-01-0>D8
  __ DEVE !                                                     ! 01-01-0>DB
  __ ECHD !                                                      ! 01-01-0>
  __ EFGD !                  _ authorizations for database      ! 01-01-0>
  __ HBUT !                  _ tablespaces in database          ! 01-01-0>
  __ PLAN !                  _ tables      in database          ! 01-01-0>
  __ PRED !                                                      ! 01-01-0>
  __ QA   !                                                      ! 01-01-0>
  __ SAGD !                                                      ! 01-01-0>
  __ SAGD !                 Mark  _ to print output              ! 01-01-0>
  __ SAGD !                                                      ! 01-01-0>
 __ SAGD +-------------------------------------------------------+ 01-01-0>
  __ SAGRLST  SAG1        SYSDEFLT BP0        256  SAG1            0001-01-0>
  __ SAG8D22A SAG1        SAG8G220 BP0        258  SAG1            0001-01-0>
  __ SAG8D22P SAG1        SAG8G220 BP0        259  SAG1            0001-01-0>


Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind        -     +            <     >   Canc
```

A list of all main commands available with the **List Database** function can be invoked as a window by entering the help character, that is, a question mark (?), in the command line of the database list screen.

List Tablespaces

The function to list tablespaces is not part of the **Retrieval of System Tables** main menu.

To list tablespaces

- Issue the "TS" command on the database listing screen only.

  A tablespace listing screen is displayed, for example:

```
16:35:07              ***** NATURAL TOOLS FOR DB2 *****            2006-05-25
 TABLESPACES IN DATABASE DB2DEMO          S 02      Row 0 of 2 Columns 032 075
 ====>                                                   Scroll ===>  PAGE
    DATABASE NAME       CREATOR  BPOOL    PGSIZE PARTITIONS NTABLES SEGSIZE LO
 ** ****************************** top of data ******************************
 __ DB2DEMO  AUTOMOBI    SAG      BP0           4          0       1       0 A
 __ DB2DEMO  EMPLOYEE    SAG      BP0           4          0       1       0 A
 ** ***************************** bottom of data ****************************
```

  The following line commands are available on the tablespace listing screen. Line commands are entered in front of the desired tablespace(s):

Command	Description
I	Displays information on a tablespace.
S	Selects a tablespace to be used with main commands.
U	Unselects a tablespace.
PT	Displays all partitions of a tablespace.
TB	Displays all tables defined in a tablespace.

  The **listings of tables** displayed as a result of the TB command can be used for further processing, whereas the listings resulting from the I and PT commands are for information purposes only.

  A list of all line commands available on the tablespace listing screen can be invoked as a window by entering the help character, that is, a question mark (?), in front of any of the listed tablespaces.

  The commands PT and TB can also be used as a main commands entered on the command line of the tablespace listing screen. Main commands apply to all tablespaces previously selected with the line command S.

A further main command is the `INFO` command, which is the equivalent of the `I` line command, but displays information on all previously selected tablespaces. Instead of being displayed, all information resulting from the `I` or `INFO` commands can also be marked for printing. Even if already displayed, information can be printed by issuing the `PRINT` command.

```
16:35:07             ***** NATURAL TOOLS FOR DB2 *****            2006-05-25
 TABLESPACES IN DATABASE DB2DEMO          S 02     Row 0 of 2 Columns 032 075
 ====>                                                     Scroll ===>  PAGE
    DATABASE NAME       CREATOR  BPOOL    PGSIZE PARTITIONS NTABLES SEGSIZE LO
 ** **** +-------------------------------------------------------+ **********
 __ DB2D !                                                       !       0 A
 __ DB2D !                Select what to display                 !       0 A
 ** **** !                                                       ! **********
         !                                                         !

         !                                                         !

         !                  _ partitions of tablespace             !

         !                  _ tables     in tablespace             !

         !                                                         !

         !                                                         !

         !                                                         !

         !                 Mark  _ to print output                 !

         !                                                         !

        +-------------------------------------------------------+



Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind        -     +           <     >    Canc
```

A list of all main commands available on the tablespace listing screen can be invoked as a window by entering the help character, that is, a question mark (?), in the command line of the screen.

List Plans

To invoke the List Plans function

- On the **Retrieval of System Tables** screen, enter function code `P`.

  The name of the plan(s) to be listed must be specified.

  - If a value followed by an asterisk is specified, all plans defined in the DB2 catalog whose names begin with this value are listed.
  - If asterisk notation is specified only, all plans defined in the DB2 catalog are listed.

  Press Enter.

```
16:37:59              ***** NATURAL TOOLS FOR DB2 *****            2007-10-05
 PLAN *                                   S 01     Row 0 of 80 Columns 023 075
 ====>                                                        Scroll ===>  PAGE
    PLAN     CREATOR     VALIDATE ISO ACQUIRE REL VALID OPER EXPLAIN   PLSIZE
 ** ******************************** top of data ********************************
 __ CAFPLAN  SAG3        R        S   U       C   Y     Y    N           2472
 __ SAGEDCL  SAG1        R        S   U       C   Y     Y    N           1992
 __ SAGESPCS SAG1        R        S   U       C   Y     Y    N           1992
 __ SAGESPRR SAG1        R        R   U       C   Y     Y    N           1992
 __ SAGTIA22 SAG1        R        S   U       C   Y     Y    N           1992
 __ SAG8BH22 SAG1        R        S   U       C   Y     Y    N           2296
 __ SAG8CC22 SAG1        R        S   U       C   Y     Y    N           4376
 __ SAG8IC22 SAG1        R        S   U       C   Y     Y    N           4264
 __ SAG8SC22 SAG1        R        S   U       C   Y     Y    N           2296
 __ SAGPLA   SAG         R        S   U       C   Y     Y    N           2648
 __ TREPH01  SAG4        B        S   U       C   A     Y    N           2168
 __ TREPLANC SAG2        R        S   U       C   N     Y    N           4560
 __ TREPLANG SAG2        R        S   U       C   N     Y    N           8976
 __ TREPLANO SAG2        R        S   U       C   N     Y    N           8976
 __ TREPLANT SAG2        R        S   U       C   Y     Y    N           2472
 __ TREPLAN1 SAG2        R        S   U       C   N     Y    N           3248


Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind        -     +           <     >    Canc
```

Commands Allowed on Plans

The following line commands are available on the plan listing screen. Line commands are entered in front of the desired plan(s):

Command	Description
I	Displays information on a plan.
S	Selects a plan to be used with main commands.
U	Unselects a plan.
AU	Displays information on access rights to a plan.
DR	Displays all DBRMs contained in a plan.
IX	Displays all indexes used by a plan.
PK	Displays the package list of a plan.
SY	Displays the systems enabled or disabled for a plan.
TB	Displays tables used in a plan.

The listing displayed as a result of the DR, IX, PK, or TB command can be used for further processing, whereas the contents of the screens displayed as a result of the I, AU, or SY command are for information purposes only.

A list of all line commands available with the **List Plans** function can be invoked as a window by entering the help character "?" in front of any of the listed plans.

The commands AU, DR, IX, PK, SY, and TB can also be used as main commands, which are entered on the command line of the plan listing screen and apply to all plans previously selected with the line command S.

The INFO main command, which is the equivalent of the I line command, displays information on the DBRMs and their SQL statements contained in the plans previously selected. As with the **List Database** function, information resulting from the I or INFO commands can be printed, too.

```
16:37:59              ***** NATURAL TOOLS FOR DB2 *****             2007-10-05
 PLAN *                                  S 01     Row 0 of 80 Columns 023 075
 ====>                                                         Scroll ===>  PAGE
    PLAN     CREATOR     VALIDATE ISO ACQUIRE REL VALID OPER EXPLAIN   PLSIZE
 ** **** +-------------------------------------------------------+ **********
 I_ CAFP !                                                       !     2472
 __ SAGE !                Select what to display                 !     1992
 __ SAGE !                                                       !     1992
 __ SAGE !              _ DBRMs of plan                          !     1992
 __ SAGT !              _ package list of plan                   !     1992
 __ SAG8 !              _ systems enabled or disabled for plan   !     2296
```

```
 __ SAG8 !              _ tables  referenced in plan              !     4376
 __ SAG8 !              _ indexes used in plan                    !     4264
 __ SAG8 !              _ authorizations for plan                 !     2296
 __ SAGP !                                                        !     2648
 __ TREP !                 Mark  _ to print output                !     2168
 __ TREP !                                                        !     4560
 __ TREP +------------------------------------------------------+     8976
 __ TREPLANO SAG2        R        S   U       C   N     Y    N           8976
 __ TREPLANT SAG2        R        S   U       C   Y     Y    N           2472
 __ TREPLAN1 SAG2        R        S   U       C   N     Y    N           3248

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind        -     +           <     >    Canc
```

A list of all main commands available with the **List Plans** function can be invoked as a window by entering the help character, that is, a question mark (?), in the command line of the plan list screen.

DBRMs of Plan

If you issue the `DR` command on the plan listing screen, a list of all DBRMs bound into the selected plan(s) is displayed.

```
16:40:56              ***** NATURAL TOOLS FOR DB2 *****             2007-10-05
 DBRMS OF PLAN SAGTEST                     S 02      Row 0 of 3 Columns 033 075
 ====>                                                        Scroll ===>  PAGE
    PLAN     DBRM     TIMESTAMP    CREATOR  TIME     DATE     PDS NAME QUOTE CO
 ** ******************************** top of data ********************************
 __ SAGTEST  TEST1    148C251A1>   SAG      16:24:10 07-10-05 DB2.V42.>N     N
 __ SAGTEST  TEST2    148C251A1>   SAG      16:24:42 07-10-05 DB2.V42.>N     N
 __ SAGTEST  TEST3    148C251A1>   SAG      16:25:15 07-10-05 DB2.V42.>N     N
 ** ****************************** bottom of data ******************************
```

Commands Allowed on DBRMs

The following line commands are available on the DBRM listing screen. Line commands are entered in front of the desired DBRM(s):

Command	Description
`I`	Displays information on a DBRM.
`S`	Selects a DBRM to be used with main commands.
`U`	Unselects a DBRM.

A list of all line commands available on the DBRM listing screen can be invoked as a window by entering the help character, that is, a question mark (?), in front of any of the listed DBRMs.

The only main command that applies to DBRMs is the `INFO` command, which is the equivalent of the `I` line command, but displays information on all previously selected DBRMs. Instead of being displayed, all information resulting from the `I` or `INFO` commands can also be marked for printing. Even if already displayed, information can be printed by issuing the `PRINT` command.

```
16:40:56              ***** NATURAL TOOLS FOR DB2 *****             2007-10-05
 DBRMS OF PLAN SAGTEST                     S 02      Row 0 of 3 Columns 033 075
 ====>                                                Scroll ===>  PAGE
    PLAN     DBRM     TIMESTAMP    CREATOR  TIME     DATE     PDS NAME QUOTE CO
 ** **** +-------------------------------------------------------+***********
 I_ SAGT !                                                      ! .>N     N
 __ SAGT !                 Select what to display               ! .>N     N
 __ SAGT !                                                      ! .>N     N
 ** **** !                                                      !***********
         !                                                      !
         !                  _ Plans referencing DBRM            !
         !                  _ SQL statements of DBRM            !
         !                                                      !
         !                                                      !
         !                                                      !
         !                 Mark  _ to print output              !
         !                                                      !
         +-------------------------------------------------------+



Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind        -     +           <     >    Canc
```

Indexes Used in Plan

If you issue the `IX` command on either the **plan listing screen** or the **table listing screen**, a list of all indexes used in the selected plan(s) or table(s) is displayed.

```
16:40:56              ***** NATURAL TOOLS FOR DB2 *****             2007-10-05
 INDEXES OF PLAN SAGTEST                   S 02      Row 0 of 3 Columns 033 075
 ====>                                                Scroll ===>  PAGE
    CREATOR  INDEX NAME    CREATOR  TABLE NAME COLCNT UNIQ CLSTRNG CLSTRD -RATI
 ** ****************************** top of data ******************************
 __ SAGCRE   XDEPT1        SAGCRE   DEPT            1 P    N       Y         10
 __ SAGCRE   XEMP1         SAGCRE   EMP             1 P    Y       Y         10
 __ SAGCRE   XEMP2         SAGCRE   EMP             1 D    N       N          4
 ** ***************************** bottom of data ******************************
```

Commands Allowed on Indexes

The following line commands are available on the index listing screen. Line commands are entered in front of the desired index(es):

Command	Description
I	Displays information on an index.
S	Selects an index to be used with main commands.
U	Unselects an index.
CO	Displays all columns of an index.
PT	Displays the partitions of an index.

The listings of columns displayed as a result of the CO or PT command cannot be used for further processing. Like the display resulting from the I command, they are for information purposes only.

A list of all line commands available on the index listing screen can be invoked as a window by entering the help character "?" in front of any of the listed indexes.

The commands CO and PT can be used as main commands, too, and entered in the command line of the index listing screen. If so, all columns of all indexes previously selected with the line command S are displayed.

A further main command is the INFO command, which is the equivalent of the line command I, but displays information on all previously selected indexes. Instead of being displayed, all information resulting from the I or INFO commands can also be marked for printing. Even if already displayed, information can be printed by issuing the PRINT command.

```
16:40:56              ***** NATURAL TOOLS FOR DB2 *****             2007-10-05
 INDEXES OF PLAN SAGTEST                   S 02      Row 0 of 3 Columns 033 075
 ====>                                                   Scroll ===>  PAGE
    CREATOR  INDEX NAME    CREATOR  TABLE NAME COLCNT UNIQ CLSTRNG CLSTRD -RATI
 ** **** +-------------------------------------------------------+ **********
 I_ SAGC !                                                        !         10
 __ SAGC !                 Select what to display                !         10
 __ SAGC !                                                        !          4
 ** **** !                                                        ! **********
         !                  _ columns  of index                   !
         !                  _ portions of index                   !
         !                  _ plans using index                   !
         !                  _ packages using index                !
         !                                                        !
         !                                                        !
         !                 Mark  _ to print output                !
         !                                                        !
         +-------------------------------------------------------+
```

```
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind        -     +           <     >    Canc
```

A list of all main commands available on the index listing screen can be invoked as a window by entering the help character "?" in the command line of the screen.

Package List of Plan

If you issue the `PK` command on the plan listing screen, a list of all entries in the package list of the selected plan(s) is displayed.

```
16:40:56              ***** NATURAL TOOLS FOR DB2 *****             2007-10-05
 PACKAGE LIST FOR PLAN SAGTEST             S 02      Row 0 of 3 Columns 033 075
 ====>                                                          Scroll ===>  PAGE
    PLANNAME LOCATION COLLID      NAME     SEQNO  TIMESTAMP IBM
 ** ********************** top of data ************************
 __ SAGTEST           SAGCOLLE>   *            1  2007-10-0>N
 __ SAGTEST           SAG_STAT>   *            2  2007-10-0>N
 ** ***************************** bottom of data ***************
```

Commands Allowed on Package List Entries

The following line commands are available on the package list screen. Line commands are entered in front of the desired package list entry:

Command	Description
`I`	Displays information on a package list entry.
`S`	Selects a package list entry to be used with main commands.
`U`	Unselects a package list entry.
`PK`	Displays all packages of a package list entry.

The **listing of packages** as a result of the `PK` command can be used for further processing, whereas the display resulting from the `I` command is for information purposes only.

A list of all line commands available with a package list can be invoked as a window by entering the help character, that is, a question mark (?), in front of any of the listed entries.

The command `PK` can also be used as main command, which is entered in the command line of the above screen and applies to all package list entries previously selected with the line command `S`.

List Packages

To invoke the List Packages function

- On the **Retrieval of System Tables** screen, enter function code `K`.

  The collection and name of the package(s) to be listed can be specified.

  If a value followed by an asterisk is specified, all packages defined in the DB2 catalog whose collections/names begin with this value are listed.

  If asterisk notation is specified only, all packages defined in the DB2 catalog are listed.

  Press Enter.

```
11:06:11              ***** NATURAL TOOLS FOR DB2 *****            2007-10-05
 PACKAGE *.*                              S 01    Row 34 of 65 Columns 041 075
 ====>                                                   Scroll ===>  PAGE
    COLLID   NAME        CONTOKEN CONTOKEN (HEX) OWNER    CREATOR  QUALIFIER
 __ SAGQCATV SAGQVPLN    ?  l?F   148C409316C673>SAG      SAG      SAG
 __ SAGQCATV SAGQVPPA    ?k  ? ?? 149270680F77E0>SAG      SAG      SAG
 __ SAGQCATV SAGQVRAS    ?   ??=? 148C409B09097E>SAG      SAG      SAG
 __ SAGQCATV SAGQVREL    ?   ??y0 148C409C06DFA8>SAG      SAG      SAG
 __ SAGQCATV SAGQVREV    ? ? ?v?  148CDFAD16A51F>SAG      SAG      SAG
 __ SAGQCATV SAGQVRIL    ?  s ?B  148C40A20329C2>SAG      SAG      SAG
 __ SAGQCATV SAGQVROO    ? ?  A y 148CDFAF03C18E>SAG      SAG      SAG
 __ SAGQCATV SAGQVSCA    ?  u??S  148C40A409DEE2>SAG      SAG      SAG
 __ SAGQCATV SAGQVSQL    ?    ??? 148C40AB001D3F>SAG      SAG      SAG
 __ SAGQCATV SAGQVSTM    ?   ? 7q 148C40AD078CF7>SAG      SAG      SAG
 __ SAGQCATV SAGQVSTO    ?   ? ?  148C40B409681E>SAG      SAG      SAG
 __ SAGQCATV SAGQVTAB    ?   ? +U 148C40B61F024E>SAG      SAG      SAG
 __ SAGQCATV SAGQVTAS    ?   ?  d 148C40B80874FF>SAG      SAG      SAG
 __ SAGQCATV SAGQVTBA    ?   ?  ? 148C40BB1854EC>SAG      SAG      SAG
 __ SAGQCATV SAGQVTBC    ?   ?d ? 148C40BD1684EC>SAG      SAG      SAG
 __ SAGQCATV SAGQVTBP    ?   ?    148C40BF07AE9D>SAG      SAG      SAG
 __ SAGQCATV SAGQVTBS    ?     ?? 148C40CA034928>SAG      SAG      SAG


Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind        -     +           <     >    Canc
```

Commands Allowed on Packages

The following line commands are available on the package listing screen. Line commands are entered in front of the desired package(s):

Command	Description
I	Displays information on a package.
S	Selects a package to be used with main commands.
U	Unselects a package.
AU	Displays information on access rights to a package.
IX	Displays all indexes used by a package.
SY	Displays all systems enabled or disabled for a package.
TB	Displays all tables used by a package.

The listings of **indexes** or **tables** displayed as a result of the IX or TB command can be used for further processing, whereas the displays resulting from the AU, SY, or I command are for information purposes only.

A list of all line commands available with the **List Packages** function can be invoked as a window by entering the help character, that is, a question mark (?), in front of any of the listed packages.

The commands AU, IX, SY, and TB can also be used as main commands, which are entered in the command line of the table listing screen and apply to all tables previously selected with the line command S.

The INFO main command, which is the equivalent of the I line command, displays information on all tables previously selected. All information resulting from the I or INFO commands can also be printed.

```
11:06:11              ***** NATURAL TOOLS FOR DB2 *****             2007-10-05
 PACKAGE *.*                                S 01    Row 34 of 65 Columns 041 075
 ====>                                                         Scroll ===>  PAGE
    COLLID   NAME        CONTOKEN CONTOKEN (HEX) OWNER    CREATOR  QUALIFIER
 i_ SAGQ +-------------------------------------------------------+ G
 __ SAGQ !                                                       ! G
 __ SAGQ !                 Select what to display                ! G
 __ SAGQ !                                                       ! G
 __ SAGQ !           _ systems enabled or disabled for package   ! G
 __ SAGQ !           _ tables  referenced in package             ! G
 __ SAGQ !           _ indexes used in package                   ! G
 __ SAGQ !           _ statements of package                     ! G
 __ SAGQ !           _ authorizations on package                 ! G
 __ SAGQ !                                                       ! G
 __ SAGQ !                                                       ! G
 __ SAGQ !                 Mark  _ to print output               ! G
```

```
  __ SAGQ !                                                          ! G
  __ SAGQ +----------------------------------------------------------+ G
  __ SAGQCATV SAGQVTBC    ?   ?d ? 148C40BD1684EC>SAG      SAG      SAG
  __ SAGQCATV SAGQVTBP    ?   ?    148C40BF07AE9D>SAG      SAG      SAG
  __ SAGQCATV SAGQVTBS    ?     ?? 148C40CA034928>SAG      SAG      SAG

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help        Exit        Rfind        -     +           <     >    Canc
```

A list of all main commands available with the **List Packages** function can be invoked as a window by entering the help character, that is, a question mark (?), in the command line of the packages list screen.

List Tables

To invoke the List Tables function

- On the **Retrieval of System Tables** screen, enter function code `T`.

  The creator and name of the table(s) to be listed can be specified.

  - If a value followed by an asterisk is specified, all tables defined in the DB2 catalog whose creator/name begins with this value are listed.
  - If asterisk notation is specified only, all tables defined in the DB2 catalog are listed.

  Press Enter.

```
16:42:58              ***** NATURAL TOOLS FOR DB2 *****            2007-10-05
 TABLE SAG*.*                              S 01   Row 34 of 361 Columns 036 075
 ====>                                                     Scroll ===>  PAGE
    CREATOR  TABLE NAME    TYPE COLCOUNT KEYCOLS RECLEN DATABASE TSNAME
C
 ** ******************************** top of data ********************************
  __ SAGCRE   ACT           T           3       1     38 SAG8D22A ACT
  __ SAGCRE   DEPT          T           4       1     59 SAG8D22A SAG8S2
  __ SAGCRE   EACT          T           5       0     54 SAG8D22A SAG8S2
  __ SAGCRE   EDEPT         T           6       0     75 SAG8D22A SAG8S2
  __ SAGCRE   EEMP          T          16       0    123 SAG8D22A SAG8S2
  __ SAGCRE   EEPA          T           8       0     52 SAG8D22A SAG8S2
  __ SAGCRE   EMP           T          14       1    107 SAG8D22A SAG8S2
  __ SAGCRE   EMPPROJACT    T           6       0     36 SAG8D22A EMPPRO
  __ SAGCRE   EPROJ         T          10       0     86 SAG8D22A SAG8S2
  __ SAGCRE   EPROJACT      T           7       0     45 SAG8D22A SAG8S2
  __ SAGCRE   PROJ          T           8       1     70 SAG8D22A PROJ
  __ SAGCRE   PROJACT       T           5       3     29 SAG8D22A PROJAC
  __ SAGCRE   TCONA         T           5       0   4056 SAG8D22P SAG8S2
```

```
  __ SAGCRE   TDSPTXT       T           3       0     91 SAG8D22P SAG8S2
  __ SAGCRE   TOPTVAL       T          11       0    354 SAG8D22P SAG8S2
  __ SAGCRE   VACT          V           3       0      0 SAG8D22A ACT


Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind        -     +           <     >    Canc
```

Commands Allowed on Tables

The following line commands are available on the table listing screen. Line commands are entered in front of the desired table(s):

Command	Description
I	Displays information on a table.
S	Selects a table to be used with main commands.
U	Unselects a table.
AU	Displays information on access rights to a table.
CO	Displays all columns of a table.
IX	Displays all indexes on a table.
CC	Checks constraints.

The **listings of indexes** displayed as a result of the IX command can be used for further processing, whereas the listings of columns resulting from the CO command, as well as the displays resulting from the AU or I command, are for information purposes only.

A list of all line commands available with the **List Tables** function can be invoked as a window by entering the help character, that is, a question mark (?), in front of any of the listed tables.

The commands AU, CO, and IX can also be used as main commands, which are entered in the command line of the table listing screen and apply to all tables previously selected with the line command S.

The INFO main command, which is the equivalent of the I line command, displays information on all tables previously selected. All information resulting from the I or INFO commands can also be printed.

```
16:42:58              ***** NATURAL TOOLS FOR DB2 *****             2007-10-05
 TABLE SAG*.*                              S 01   Row 34 of 361 Columns 036 075
 ====>                                                     Scroll ===>  PAGE
    CREA +-------------------------------------------------------+          C
 ** **** !                                                       ! **********
 I_ SAGC !                                                       !
 __ SAGC !                 Select what to display                ! S2
 __ SAGC !                                                       ! S2
 __ SAGC !  _ columns  of table/view    _ referential constraints  ! S2
 __ SAGC !  _ synonyms of table/view    _ authorized  users        ! S2
 __ SAGC !  _ plans    using table/view                          ! S2
 __ SAGC !  _ packages using table/view _ indexes  of table        ! S2
 __ SAGC !  _ views    using table/view _ columns  of indexes      ! RO
 __ SAGC !  _ base tables of view       _ plans using indexes      ! S2
 __ SAGC !  _ definition  of view       _ packages using indexes   ! S2
 __ SAGC !  _ check conditions of table                            !
 __ SAGC !                                                       ! AC
 __ SAGCR!                 Mark  _ to print output               ! S2
 __ SAGCR+-------------------------------------------------------+ S2
 __ SAGCRE   TOPTVAL       T          11       0    354 SAG8D22P SAG8S2
 __ SAGCRE   VACT          V           3       0      0 SAG8D22A ACT

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind        -     +           <     >    Canc
```

A list of all main commands available with the **List Tables** function can be invoked as a window by entering the help character, that is, a question mark (?), in the command line of the table listing screen.

User Authorizations

To invoke the User Authorization function

- On the **Retrieval of System Tables** screen, enter function code `U` and press Enter.

  The **Retrieval of User Authorizations** menu is displayed:

```
16:44:51              ***** NATURAL TOOLS FOR DB2 *****             2007-10-05
                       - Retrieval of User Authorizations -
```

```
                    Code Function                Parameter


                     C   Column   Authorizations Grantee

                     D   Database Authorizations Grantee

                     K   Package  Authorizations Grantee

                     P   Plan     Authorizations Grantee

                     R   Resource Authorizations Grantee

                     T   Table    Authorizations Grantee

                     U   User     Authorizations Grantee

                     ?   Help

                     .   Exit


              Code .. _   Grantee .. ________________________________




 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                                    Canc
```

The following functions are available:

Code	Description
C	Displays the columns which can be accessed by the specified grantee.
D	Displays the databases which can be accessed by the specified grantee.
K	Displays the packages which can be accessed by the specified grantee.
P	Displays the plans which can be accessed by the specified grantee.
R	Displays the resources which can be accessed by the specified grantee.
T	Displays the tables which can be accessed by the specified grantee.
U	Displays the system privileges of the specified grantee.

The following parameter must be specified:

Parameter	Description
Grantee	A list of all existing DB2 objects of the specified object type to which the specified grantee has access is displayed.

List Statistic Tables

To invoke the List Statistic Tables function

- On the **Retrieval of System Tables** screen, enter function code S and press Enter.

  The **Retrieval of Statistic Tables** menu is displayed:

```
16:38:47              ***** NATURAL TOOLS FOR DB2 *****            2007-10-05
                         - Retrieval of Statistic Tables -




                      Code Function              Parameter


                       C   List SYSCOLSTATS      Creator, Name

                       D   List SYSCOLDISTSTATS  Creator, Name

                       I   List SYSINDEXSTATS    Index Owner, Name

                       T   List SYSTABSTATS      Creator, Name

                       ?   Help

                       .   Exit


              Code .. _   Index Owner ......... ______________________________
                          Index Name .......... ______________________________
                          Table Creator ....... ______________________________
                          Table Name .......... ______________________________
```

```
 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12--
      Help        Exit                                                    Canc
```

The following functions are available:

Code	Description
C	Displays the partitioned statistics for columns in a partitioned table space.
D	Displays the distribution of the values of the first column of a partitioned index.
I	Displays the statistics for a partitioned index.
T	Displays the statistics for a partitioned table space.

The following parameters must be specified:

Parameter	Description
Table Creator	The name of the creator of the table for which the statistics are to be displayed.
Table Name	The name of the table for which the statistics are to be displayed.
Index Owner	The name of the owner of the index for which the index statistics are to be displayed.
Index Name	The name of the index for which the index statistics are to be displayed.

11 Environment Setting

The **Environment Setting** facility of the **Natural Tools for DB2** allows you to issue special SQL statements interactively.

For details on the SQL statements described in this section, see the relevant DB2 literature by IBM.

Invoking the Environment Setting Facility

To invoke the Environment Setting facility

- On the **Natural Tools for DB2 Main Menu**, enter function code `S` and press Enter.

  The **Environment Setting** screen is displayed.

```
 15:01:49              ***** NATURAL TOOLS FOR DB2 *****            2009-10-07
                            - Environment Setting -


        Code Function                    Code Function SET CURRENT

         CO  CONNECT                      SS  SQLID
         RE  RELEASE (connection)         SP  PACKAGESET
         SC  SET CONNECTION               SD  DEGREE
         SY  SET ENCRYPTION PASSWORD      SU  RULES
         SR  Display SPECIAL REGISTER     SO  OPTIMIZATION HINT
         ?   Help                         SL  LOCALE LC_CTYPE
         .   Exit                         SA  PATH
                                          SE  PRECISION
                                          SM  MAINTAINED TABLE TYPES FOR OPT
                                          SB  PACKAGE PATH
  Code .. __                              SF  REFRESH AGE
                                          SH  SCHEMA
                                          SN  APPLICATION ENCODING SCHEME

Command ===>
```

  This screen offers you the following functions:

CO	Specifies and executes the SQL statement `CONNECT`.
RE	Specifies and executes the SQL statement `RELEASE`.
SC	Specifies and executes the SQL statement `SET CONNECTION`.
SS	Specifies and executes the SQL statement `SET CURRENT SQLID`.
SP	Specifies and executes the SQL statement `SET CURRENT PACKAGESET`.
SD	Specifies and executes the SQL statement `SET CURRENT DEGREE`.

SU	Specifies and executes the SQL statement SET CURRENT RULES.
SO	Specifies and executes the SQL statement SET CURRENT OPTIMIZATION HINT.
SL	Specifies and executes the SQL statement SET CURRENT LOCALE LC_CTYPE.
SA	Specifies and executes the SQL statement SET CURRENT PATH.
SE	Specifies and executes the SQL statement SET CURRENT PRECISION.
SM	Specifies and executes the SQL statement SET CURRENT MAINTAINED TABLE TYPE FOR OPTIMIZATION.
SB	Specifies and executes the SQL statement SET CURRENT PACKAGE PATH.
SF	Specifies and executes the SQL statement SET CURRENT REFRESH AGE.
SH	Specifies and executes the SQL statement SET CURRENT SCHEMA.
SN	Specifies and executes the SQL statement SET CURRENT APPLICATION ENCODING SCHEME.
SY	Specifies and executes the SQL statement SET ENCRYPTION PASSWORD.
SR	Displays the current values of the supported special registers.

Connect

To invoke the Connect function

- On the **Environment Setting** screen, enter function code CO and press Enter.

  The **Connect** screen is displayed:

```
14:23:29              ***** NATURAL TOOLS FOR DB2 *****            2006-04-13
                                   - Connect -









 >>---- CONNECT ---+-- _ --------------------------------+-------------------><
                   !                                     !

                   !                                     !
```

```
                    +-- _ --- TO ---- _______________  --+

                    !                  (location name)    !

                    !                                     !

                    +-- _ --- RESET ----------------------+



  Current Server Version ________



 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec                                                Canc
```

The **Connect** function connects the current application to a designated server. This server is the current server, which is displayed in the **Current Server Version** field.

On the **Connect** screen, you identify the current server by specifying a location name. The identified server must be known to the local DB2 subsystem.

Release

To invoke the Release function

- On the **Environment Setting** screen, enter function code `RE` and press Enter.

  The **Release** screen is displayed:

```
14:24:29             ***** NATURAL TOOLS FOR DB2 *****           2006-04-13
                                  - Release -
```

```
>>--- RELEASE ------+-------- ________________ ------+--------------------><
                     !         location-name          !
                     !                                !
                     +-- _ --- CURRENT ---------------+
                     !                                !
                     !-- _ --- ALL SQL ---------------!
                     !                                !
                     +-- _ --- ALL PRIVATE -----------+


Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec                                                Canc
```

The **Release** function places one or more connections in the release pending state.

Set Connection

To invoke the Set Connection function

- On the **Environment Setting** screen, enter function code `SC` and press Enter.

The **Set Connection** screen is displayed:

```
14:23:47             ***** NATURAL TOOLS FOR DB2 *****           2006-04-13
                                - Set Connection -



>>--- SET CONNECTION -------- _________________ ---------------------------><
                                location-name



Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec                                                Canc
```

On the **Set Connection** screen, you identify a server by specifying a location name. The identified server must be known to the local DB2 subsystem.

Set Current SQLID

To invoke the Set Current SQLID function

- On the **Environment Setting** screen, enter function code `SS` and press Enter.

  The **Set Current SQLID** screen is displayed:

```
14:23:47              ***** NATURAL TOOLS FOR DB2 *****            2006-04-13
                               - Set Current SQLID -



>>--- SET CURRENT SQLID = ----- __________ -------------------->&lt;

                            ( USER,

                              string-constant)
```

```
 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec  Free                                        Canc
```

The **Set Current SQLID** function changes the value of the SQL authorization identifier. With SQL statements that use unqualified table names, DB2 uses the SQLID as an implicit table qualifier. This enables you to access identical tables with the same table name but with different creator names.

On the **Set Current SQLID** screen, you can replace the value of `CURRENT SQLID` by the value of the special register `USER` or by a string constant. The string constant can be up to 8 characters long.

In all supported TP-monitor environments, the SQLID can then be kept across terminal I/Os until its resetting or the end of the session.

Set Current Packageset

To invoke the Set Current Packageset function

- On the **Environment Setting** screen, enter function code `SP` and press Enter.

  The **Set Current Packageset** screen is displayed:

```
09:39:07              ***** NATURAL TOOLS FOR DB2 *****            2006-04-18

                           - Set Current Packageset -



>>--- SET CURRENT PACKAGESET = ---------------------------------------------->


 >-+-- _ - USER -------------------------------------------------------+-><

   !                                                                    !

   +-- ____________________________________________________________  !

                                (string-constant)                       !

       ___________________________________________________________ -+
```

```
                            (string-constant cont.)


Command ===>
  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
        Help  Error Exit  Exec                                                Canc
```

The `SET CURRENT PACKAGESET` statement assigns a value to the special register `CURRENT PACKAGESET`.

On the **Set Current Packageset** screen, you can replace the value of `CURRENT PACKAGESET` by the value of the special register `USER` or by a string constant of up to 18 characters.

Set Current Degree

To invoke the Set Current Degree function

- On the **Environment Setting** screen, enter function code `SD` and press Enter.

  The **Set Current Degree** screen is displayed:

```
 14:23:58             ***** NATURAL TOOLS FOR DB2 *****            2006-04-13
                            - Set Current Degree -









  >>--- SET CURRENT DEGREE ---------- ___ ----------------------------------><
                                    ( 1 or ANY )
```

```
 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec                                                Canc
```

CURRENT DEGREE specifies the degree of parallelism for the execution of queries that are dynamically prepared by the application process.

Set Current Rules

To invoke the Set Current Rules function

- On the **Environment Setting** screen, enter function code SU and press Enter.

  The **Set Current Rules** screen is displayed:

```
14:23:58             ***** NATURAL TOOLS FOR DB2 *****            2006-04-13
                            - Set Current Rules -
```

```
>>--- SET CURRENT RULES ----------- ___ ----------------------------------><
                                ( DB2 or STD )



Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Error Exit  Exec                                              Canc
```

`CURRENT RULES` specifies whether certain SQL statements are executed in accordance with DB2 rules or the rules of the SQL standard.

Set Current Optimization Hint

To invoke the Set Current Optimization Hint function

- On the **Environment Setting** screen, enter function code `SO` and press Enter.

  The **Set Current Optimization Hint** screen is displayed:

```
09:41:43            ***** NATURAL TOOLS FOR DB2 *****            2006-04-18

                    - Set Current Optimization Hint -
```

```
>>--- SET CURRENT OPTIMIZATION HINT ---------------------------------------->



 >--- ____________________________________________________________________

                                (string-constant)

     ____________________________________________________________________ --->&lt;

                            (string-constant cont.)

Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Error Exit  Exec                                                Canc
```

CURRENT OPTIMIZATION HINT specifies the user-defined optimization hint that DB2 should use to generate the access path for dynamic statements.

Set Current Locale LC_CType

To invoke the Set Current Locale LC_CType function

- On the **Environment Setting** screen, enter function code SL and press Enter.

  The **Set Current Locale LC_CType** screen is displayed:

```
14:58:12              ***** NATURAL TOOLS FOR DB2 *****            2006-04-13
                        - Set Current Locale LC_CType -





>>--- SET CURRENT LOCALE LC_CTYPE ------------------------------------------>

 >--------- ____________________________________________________ ---------->&lt;
```

```
                              (string-constant)





 Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Error Exit  Exec                                                Canc
```

`CURRENT LOCALE LC_CTYPE` specifies the `LC_CTYPE` locale that will be used to execute SQL statements that use a built-in function that references a locale.

Set Current Path

To invoke the et Current Path function

- On the **Environment Setting** screen, enter function code `SA` and press Enter.

  The **Set Current Path** screen is displayed:

```
09:42:09              ***** NATURAL TOOLS FOR DB2 *****             2006-04-18

                              - Set Current Path -




>>- SET CURRENT PATH -------------------------------------------------------->


   +-----------------------------<--( , )--------------------------------+

   !                                                                      !

>-++------------------------------- _ ----------------------------------++-><

    !                   (schema-name<,schema-name,...>)                  !

    !                                                                    !
```

```
   +- _ ----------------------- SYSTEM PATH ----------------------------+

   !                                                                    !

   +- _ -------------------------- USER -------------------------------+

   !                                                                    !

   +- _ ---------------------- CURRENT PATH ----------------------------+

   !                                                                    !

   +- _ ------------------ CURRENT PACKAGE PATH ------------------------+

Command===>
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
     Help  Error Exit  Exec                                            Canc
```

`CURRENT PATH` specifies the SQL path used to resolve unqualified data type names and function names in dynamically prepared SQL statements.

Set Current Precision

To invoke the Set Current Precision function

- On the **Environment Setting** screen, enter function code `SE` and press Enter.

  The **Set Current Precision** screen is displayed:

```
 15:01:17              ***** NATURAL TOOLS FOR DB2 *****            2006-04-13
                           - Set Current Precision -





>>--- SET CURRENT PRECISION ------- DEC15 ---------------------------------><
                                (DEC15,DEC31,15,31,
                           D15.1 - D15.9,D31.1 - D31.9)
```

```
 Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Error Exit  Exec                                                Canc
```

CURRENT PRECISION specifies the rules to be used when both operands in a decimal operation have precisions of 15 or less.

Set Current Maintained Types for Optimization

To invoke the Set Current Maintained Types function

- On the **Environment Setting** screen, enter function code SM and press Enter.

  The **Set Current Maintained Types** for Optimization screen is displayed:

```
09:36:51              ***** NATURAL TOOLS FOR DB2 *****             2006-04-18

                        - Set Current Maintained Types -


>>--- SEET CURRENT MAINTAINED TYPES --- SYSTEM ----------------------------><

                              ( ALL, NONE, SYSTEM or USER )









 Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Error Exit  Exec                                                Canc
```

CURRENT MAINTAINED TABLE TYPES FOR OPTIMIZATION specifies a value that identifies the types of objects that can be considered to optimize the processing of dynamic SQL queries. This register contains a keyword representing table types.

Set Current Package Path

To invoke the Set Current Package Path function

- On the **Environment Setting** screen, enter function code `SB` and press Enter.

  The **Set Current Package Path** screen is displayed:

```
 09:37:22              ***** NATURAL TOOLS FOR DB2 *****            2006-04-18

                           - Set Current Package Path -





>> - SET CURRENT PACKAGE PATH ------------------------------------------------>





   +-----------------------------< --( , )--------------------------------+

    !                                                                      !

 > -++-------------------------------- _ ---------------------------------++-><

    !                 (collection-id< ,collection-id,...> )                !

    !                                                                      !

    +- _ -------------------------- USER ---------------------------------+

    !                                                                     !
```

```
    +- _ ---------------------- CURRENT PATH ----------------------------+

    !                                                                    !

    +- _ ------------------ CURRENT PACKAGE PATH ------------------------+



Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Error Exit  Exec                                              Canc
```

`CURRENT PACKAGE PATH` specifies a value that identifies the path used to resolve references to packages that are used to execute SQL statements.

Set Current Refresh Age

To invoke the Set Current Refresh Age function

- On the **Environment Setting** screen, enter function code `SF` and press Enter.

  The **Set Current Refresh Age** screen is displayed:

```
09:37:40              ***** NATURAL TOOLS FOR DB2 *****            2006-04-18

                          - Set Current Refresh Age -





>> --- SET CURRENT REFRESH AGE ----- ____________________ ----------------><

                        ( 0 or ANY/99999999999999.000000 )
```

```
Command ===>

  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
        Help  Error Exit  Exec                                                Canc
```

`CURRENT REFRESH AGE` specifies a timestamp duration value with a data type of `DECIMAL`.

Set Current Schema

To invoke the Set Current Schema function

- On the **Environment Setting** screen, enter function code `SH` and press Enter.

  The **Set Current Schema** screen is displayed:

```
09:38:01              ***** NATURAL TOOLS FOR DB2 *****            2006-04-18

                             - Set Current Schema -



>>- SET CURRENT SCHEMA ------------------------------------------------------>


 >--+- ____________________________________________________________ -+-->&lt;

    !                           (schema-name)                         !

    !                                                                 !

    +- _ --------------------------- USER -------------------------------+

    !                                                                 !

    +- _ -------------------------- DEFAULT ----------------------------+

    !                                                                 !

    +- ____________________________________________________________ -+

                               (string-constant)
```

```
Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Error Exit  Exec                                                Canc
```

The `CURRENT SCHEMA`, or equivalently `CURRENT_SCHEMA`, special register specifies the schema name used to qualify unqualified database object references in dynamically prepared SQL statements.

Set Current Application Encoding Scheme

To invoke the Set Current Application Encoding Scheme function

- On the **Environment Setting** screen, enter function code `SN` and press Enter.

  The **Set Current Application Encoding Scheme** screen is displayed:

```
09:38:21              ***** NATURAL TOOLS FOR DB2 *****            2006-04-18

                  - Set Current Application Encoding Scheme -









 >>--- SET CURRENT APPLICATION ENCODING SCHEME ----------------------------->



 >--------------------------------- _______ ------------------------------><

                            ( ASCII, EBCDIC, UNICODE
```

```
                                  or 1 - 65533)









 Command ===>

  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
        Help  Error Exit  Exec                                                Canc
```

`CURRENT APPLICATION ENCODING SCHEME` specifies which encoding scheme is to be used for dynamic statements. It allows an application to indicate the encoding scheme that is used to process data.

Set Encryption Password

To invoke the Set Encryption Password function

- On the **Environment Setting** screen, enter function code `SY` and press Enter.

  The Set Encryption Password screen is displayed:

```
09:36:13              ***** NATURAL TOOLS FOR DB2 *****            2006-04-18

                          - Set Encryption Password -









>>--- SET ENCRYPTION PASSWORD ---------------------------------------------->
```

```
>---- ____________________________________________________________________

                        (password-string-constant)

     ____________________________________________________________ ---->

                     (password-string-constant cont.)



>-+-------------------------------------------------------------------+-><

  !                                                                   !

  +--- WITH HINT --- ___________________________________ ----------------+

                          (hint-string-constant)




Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Error Exit  Exec                                              Canc
```

The **Set Encryption Password** function sets the value of the encryption password and, optionally, the password hint.

Display Special Registers

To invoke the Display Special Registers function

- On the **Environment Setting** screen, enter function code `SR` and press Enter.

  The **Display Special Registers** screen is displayed:

```
15:18:07              ***** NATURAL TOOLS FOR DB2 *****            2006-04-13
                         - Display Special Registers -
 Current
  +Client_Acctng .........
  +Client_ApplName .......
  +Client_UserID .........
  +Client_WrkStnName .....
   Appl.Encoding Scheme .. EBCDIC
```

```
   Date .................. 13.04.2006
   Degree ................ 1
   LC_CType .............
  +Maintained Types ...... SYSTEM

   Member ................ DB28
  +Optimization Hint .....

  +Package Path ..........



Command ===>
 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
        Help  Error Exit  Updat                                     Next  Canc
```

When you press PF11, the next screen of Special Register values is displayed.

```
15:31:20              ***** NATURAL TOOLS FOR DB2 *****           2006-04-13
                         - Display Special Registers -
 Current
  +PackageSet ............

  +Path .................. "SYSIBM","SYSFUN","SYSPROC","GGS"


   Precision ............ DEC15
   Refresh Age ..........
   Rules ................ DB2
  +Schema ............... GGS

   Server ............... DAEFDB28
   SQLID ................ GGS
   Time .................. 15.31.20
   TimeStamp ............ 2006-04-13-15.31.20.948481
   TimeZone ............. 10000
   User .................. GGS

Command ===>
 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Error Exit  Updat                                Prev        Canc
```

When you press PF10, the previous screen of Special Register values is displayed.

The **Display Special Registers** screens show you the current values of the Special Registers of DB2 supported by Natural for DB2.

Fields, which are prefixed with a plus sign (+), may contain more data than displayed on the screen. You can display the full contents either when you position the cursor on the field (description or data) and press Enter, or when you enter the abreviation of the field (which are

the capital letters of the description) prefoxed by the plus sign (+) in the command line. For example, `+PS` shows a window with the full value of the **Current Package Set**.

12 Explain PLAN_TABLE

Important: Before you use the **Explain PLAN_TABLE** function, refer to *LISTSQL and Explain Functions* in the section *Special Requirements for Natural Tools for DB2*.

The **Explain PLAN_TABLE** facility of the **Natural Tools for DB2** interprets the results of SQL `EXPLAIN` commands from your `PLAN_TABLE`. The information contained in your `PLAN_TABLE` is represented in so-called explanations.

Explanations of a `PLAN_TABLE` describe the access paths chosen by DB2 to execute SQL statements.

An SQL statement is executed by DB2 in one or more steps. For each execution step, one row is inserted into the `PLAN_TABLE`. All rows together describing the access path for one SQL statement are called an explanation.

The explanations are identified in the `PLAN_TABLE` by a combination of either plan name, DBRM (database request module) name, and query number or collection name, package name, and query number.

EXPLAIN Modes

DB2 provides three ways to explain SQL statements:

- Dynamic EXPLAIN
- Bind Plan EXPLAIN
- Bind Package EXPLAIN

Depending on the way the identifications of the explanations differ.

Dynamic EXPLAIN

Executes an SQL `EXPLAIN` command dynamically, where the explanation is inserted into the `PLAN_TABLE` of your current SQLID.

The `EXPLAIN` command can be issued within the **Catalog Maintenance** and **Interactive SQL** facilities of the **Natural Tools for DB2**. In addition, the Natural `LISTSQL` command can be used to extract SQL statements from cataloged Natural programs, and to issue the SQL `EXPLAIN` command for the extracted SQL statements.

If you issue the SQL `EXPLAIN` command dynamically, you should specify a query number to help identify the explanation in the `PLAN_TABLE`. The same query number should be used for related statements.

Depending on the method with which the DBRM used by the dynamic SQL processor is bound into the plan, DB2 uses two different ways to identify rows in the `PLAN_TABLE`:

- Dynamic Mode

- Package Mode

Dynamic Mode

The DBRM is bound directly into the plan.

When an explanation is inserted, the plan name, the DBRM name, and the query number are determined by DB2 as follows:

Parameter	Description
`plan name`	is left blank;
`DBRM name`	is the name of the DBRM used by the dynamic SQL processor;
`query number`	is equal to the query number you specified with the `EXPLAIN` command (the default query number is `1`).

This explanation mode is called dynamic mode.

Package Mode

The DBRM is bound as package into the plan.

When an explanation is inserted, the collection name, the package name, and the query number are determined by DB2 as follows:

Parameter	Description
`collection name`	is the name of the collection that contains the package;
`package name`	is the name of the package used by the dynamic SQL processor;
`query number`	is equal to the query number you specified with the `EXPLAIN` command (the default query number is `1`).

This explanation mode is called package mode.

Bind Plan EXPLAIN

Binds an application plan with the option **EXPLAIN YES**, where the explanation is inserted into the `PLAN_TABLE` of the owner of the plan. When an explanation is inserted, the plan name, the DBRM name, and the query number are determined by DB2 as follows:

Parameter	Description
`plan name`	is the name of the plan;
`DBRM name`	is the name of the DBRM that contains the SQL statement;
`query number`	is equal to the statement number (*`stmtno`*), which is generated by the DB2 precompiler.

Bind Package EXPLAIN

Binds a package with the option **EXPLAIN YES**, where the explanation is inserted into the `PLAN_TABLE` of the owner of the package. When an explanation is inserted, the collection name, the package name, and the query number are determined by DB2 as follows:

Parameter	Description
`collection name`	is the name of the collection that contains the package;
`package name`	is the name of the package that contains the SQL statement;
`query number`	is equal to the statement number (*`stmtno`*), which is generated by the DB2 precompiler.

Invoking the EXPLAIN_TABLE Function

Explanations can be selected by either plan name, DBRM name, and query number or collection name, package name, and query number. If you issue an `EXPLAIN` command various times, it is possible that multiple explanations are identified by a given combination of these selection fields. Thus, you can select either all explanations or only the most recent one. A list with all selected explanations is displayed, from which you can select individual rows for a more detailed description.

The individual rows of a `PLAN_TABLE` are displayed one row per line. Rows that describe the same SQL statement are shown together as one explanation. Different explanations, are separated by empty lines. You can browse through the list and select a detailed report for individual explanations. If rows have been inserted into your `PLAN_TABLE` as a result of a Natural system command `LISTSQL`, the names of the Natural library and program are also displayed.

To invoke the Explain PLAN_TABLE facility

- On the **Natural Tools for DB2 Main Menu**, enter function code `X`.

The **Explain PLAN_TABLE** screen is displayed:

```
16:45:35              ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                              - Explain PLAN_TABLE -




                     Code Function


                      L   List PLAN_TABLE - Latest Explanations

                      A   List PLAN_TABLE - All    Explanations

                      D   Delete from PLAN_TABLE

                      ?   Help

                      .   Exit


              Code .. _   Mode ........ DYNAMIC_ ( Dynamic, Plan, Package )

                          Plan ........ ________

                          Collection .. ________

                          DBRM/Package  ________

                          Queryno ..... _____ - _____




 Command ===>

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Setup Exit                                                     Canc
```

With PF2 (Setup) the maximum length of one column and the number of fixed characters when scrolling left may be specified. The default values for both parameters may be changed in the `CONFIG` subprogram in library `SYSDB2`.

When a column value is longer than the maximum length, it will be truncated and marked with a greater than symbol (>), which means that strings are truncated at the right end, or a or a less than symbol (<), which means that numbers are truncated at the left end. Note, that for further commands on a line, for example, the line command `I`, only the visible value can be taken as input. This means that commands on lines will fail, when values for further processing are truncated.

```
16:45:35              ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
                             - Explain PLAN_TABLE -




                    Code Function    +----------Explain PLAN_TABLE----------+

                                       !
!
                       L   List PLAN_T ! Maximum length of columns ... ___12
!
                       A   List PLAN_T ! Number of fixed characters .. ____0
!
                       D   Delete from !
!
                       ?   Help        !
!
                     .   Exit       +-------------------------------------+


               Code .. _   Mode ........ DYNAMIC_ ( Dynamic, Plan, Package )

                           Plan ........ ________

                           Collection .. ________

                           DBRM/Package  ________

                           Queryno ..... _____ - _____





  Command ===>

  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
        Help  Setup Exit                                                     Canc
```

The following functions are available:

Code	Description
L	The **List PLAN_TABLE - Latest Explanations** function lists the last explanation for any combination of the parameters described below.
A	The **List PLAN_TABLE - All Explanations** function lists all explanations for any combination of the parameters described below.
D	The **Delete from PLAN_TABLE** function deletes the specified explanations from your PLAN_TABLE.

The following parameters can be specified:

Parameter	Description
Mode	Specifies the explanation mode (Dynamic, Plan, or Package).
Plan *plan-name*	Specifies a valid plan name. The parameter Plan is only required in Plan mode.
Collection *collection-name*	Specifies a valid collection name. The parameter Collection is only required in Package mode.
DBRM/Package *dbrm/package-name*	In Plan mode, specifies a valid DBRM name. In Package mode,specifies a valid package name. In dynamic mode, specifies the DBRM used by the dynamic SQL processor. If a value followed by an asterisk (*) is specified, all DBRMs/packages of the specified plan/collection whose names start with the specified value are considered. If asterisk notation is specified only, all DBRMs/packages of the specified plan/collection are considered. The DBRM/Package parameter is used to limit the display to individual DBRMs/packages.
Queryno *no.1 - no.2*	This parameter specifies a valid range of query numbers, where the following rules apply: ■ If no query number is specified, all query numbers are displayed; ■ If only the first query number is specified, only this query number is displayed; ■ If only the second query number is specified, all query numbers up to and including the second query number are displayed; ■ If both query numbers are specified, all query numbers between and including the first and the second query number are displayed.

List PLAN_TABLE - Latest Explanations

This function only lists the most recent explanation for any specified combination of either plan name, DBRM name, and query number or package name, collection name and query number.

List PLAN_TABLE - All Explanations

This function lists all explanations for any combination of either plan name, DBRM name, and query number or package name, collection name and query number. The query number parameters are interpreted as above.

Sample Listing of Explanations

```
11:04:04              ***** NATURAL TOOLS FOR DB2 *****             2007-09-05
 Plan TESTPLAN                              S 01    Row 0 of 152 Columns 032 075
 ====>                                                     Scroll ===>  PAGE
    DBRM          QNO    ME ACC    MA IO    PRE SORTN SORTC TCREATOR TABLENAME
 ** ******************************** top of data ********************************
 __ TEST          722       I       1 -          ----  ---- SAGCRE   DEPT

 __ TEST          722     1 I       1 -          ----  ---- SAGCRE   EMP

 __ TEST          722     3           -          ----  --O-

 __ TEST          722       I       1 -          ----  ---- SAGCRE   DEPT

 __ TEST          722       I       1 Y          ----  ---- SAGCRE   EMP

 __ TEST          722       I       1 -          ----  ---- SAGCRE   DEPT

 __
 __ TEST          761       I       1 -          ----  ---- SAGCRE   EMP

 __ TEST          761     1 I       1 -          ----  ---- SAGCRE   DEPT

 __ TEST          761     3           -          ----  --O-

 __ TEST          761       I       1 -          ----  ---- SAGCRE   EMP

 __ TEST          761       I       1 Y          ----  ---- SAGCRE   DEPT

 __
 __ TEST          793       I       1 -          ----  ---- SAGCRE   DEPT

 __ TEST          793     1 I       1 -          ----  ---- SAGCRE   EMP
```

```
 __ TEST          793     1 I       1 -          ----  ---- SAGCRE   EMP


Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind        -     +           <     >    Canc
```

Commands Available

The following line commands are available within listings of the **Explain PLAN_TABLE** facility. Line commands are entered in front of any of the rows of the desired explanation(s).

Command	Description
I	Displays a window where additional information about an explanation can be selected
S	Selects an explanation to be used with the INFO command described below.
U	Unselects an explanation for use with the INFO command.

A list of the line commands available can be invoked as a window by entering the help character, that is a question mark (?), in front of any of the listed rows.

Apart from the line commands, the INFO command can be specified, too. The INFO command must be entered in the command line of the listing screen and is the equivalent of the line command I. INFO displays a window where additional information can be selected on all explanations previously selected by the line command S.

In Plan mode, the following window is displayed, where you can select which additional information you want to be displayed or printed.

```
 16:48:24              ***** NATURAL TOOLS FOR DB2 *****              2009-10-30
  Plan TESTPLAN                              S 01     Row 0 of 82 Columns 048 100
  ====>                                                        Scroll ===>  PAGE
     DBRM     QNO   ME ACC MA IO     PRE SORTN SORTC TCREATOR TABLENAME
  ** **** +-------------------------------------------------------+***********
  __ TEST !                                                       !
  __ TEST !                 Select what to display                !
  __ TEST !                                                       !
  __ TEST !                 _ information about plan              !
  __ TEST !                 _ statements of plan                  !
  __ TEST !                 _ data from PLAN_TABLE                !
  __      !                 _ evaluation of PLAN_TABLE            !
  __ TEST !                 _ catalog statistics                  !
  __ TEST !                 _ columns of used indexes             !
  __ TEST !                                                       !
  __ TEST !                 Mark  _ to print output               !
  __ TEST !                                                       !
  __      +-------------------------------------------------------+
  __ TEST     793      I   1  -           ----  ---- SAGCRE   DEPT
  __ TEST     793   1  I   1  -           ----  ---- SAGCRE   EMP
```

```
 __ TEST     793   1  I   1  -           ----  ---- SAGCRE   EMP

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind        -     +           <     >    Canc
```

Accordingly, the following window is displayed in Package mode:

```
16:48:24              ***** NATURAL TOOLS FOR DB2 *****             2009-10-30
 Package TESTPACK                         S 01     Row 0 of 82 Columns 048 100
 ====>                                                     Scroll ===>  PAGE
    DBRM +-------------------------------------------------------+
 ** **** !                                                       ! **********
 __ TEST !                                                       ! ES
 __ TEST !                 Select what to display                ! ES
 __ TEST !                                                       ! ES
 __ TEST !                 _ information about package           ! ES
 __ TEST !                 _ statements of package               ! ES
 __ TEST !                 _ data from PLAN_TABLE                ! ES
 __      !                 _ evaluation of PLAN_TABLE            ! ES
 __ TEST !                 _ catalog statistics                  ! ES
 __ TEST !                 _ columns of used indexes             ! ES
 __ TEST !                                                       ! ES
 __ TEST !                 Mark  _ to print output               ! ES
 ** **** +-------------------------------------------------------+ **********




Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Rfind        -     +           <     >    Canc
```

Browsing of data displayed is performed with browse commands, of which the most important can also be issued via PF keys; see *Editing within the Natural Tools for DB2*.

Option	Description
Information about plan/package	If a plan/package name has been specified, this option includes information from the DB2 catalog, such as date and time of the bind, as well as several bind options. In Dynamic mode, this option is not available.
Statements of plan/package	If a plan/package name has been specified, this option provides information on the explained SQL statements contained in this package. This information is taken from the DB2 catalog. In Dynamic mode, this option is not available.
Data from PLAN_TABLE	This option provides information from the `PLAN_TABLE` about the selected rows.

Option	Description
Evaluation of PLAN_TABLE	This option provides a description of the PLAN_TABLE. For each execution step, it describes: the locks chosen by DB2, whether a join operation is performed, whether the data is sorted and why the sort is performed, the access path in detail.
Catalog statistics	This option provides statistical information from the DB2 catalog.
Columns of used indexes	This option provides the columns of used indexes including catalog statistics on this columns.

Delete from PLAN_TABLE

The **Delete from PLAN_TABLE** function is also used to select PLAN_TABLE explanations depending on the specified combination of either plan name, DBRM name, and query number or collection name, package name, and query number. This time, however, the selected PLAN_TABLE explanations are not displayed but deleted.

The **Delete from PLAN_TABLE** function is useful to delete old data before either binding or re-binding a plan, or before executing an SQL EXPLAIN command.

To prevent PLAN_TABLE explanations from being deleted unintentionally, you are prompted for confirmation:

```
16:50:23              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                          - Delete from PLAN_TABLE -



        The SQL Command

             DELETE FROM PLAN_TABLE
                WHERE APPLNAME = ' '
                  AND COLLID = 'OLD'
                  AND PROGNAME LIKE 'ANY%'
                  AND QUERYNO BETWEEN 1 AND 2

        will be executed.



        Press PF5 to delete the data from the PLAN_TABLE or
              PF3 to return to the menu without deleting data

Command ===>
```

```
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit        Del                                       Canc
```

Apart from the **global PF-key settings**, with the **Delete from PLAN_TABLE** function of the **Explain PLAN_TABLE** facility, PF5 (Del) is used to confirm the deletion of previously selected explanations.

Explain PLAN_TABLE Facility for Mass and Batch Processing

An adapted version of the **Explain PLAN_TABLE** facility is also available for online mass processing and for batch mode execution.

EXPLAINB for Mass Processing

For online mass processing, a modified version of the **Explain PLAN_TABLE** facility is available.

To invoke the modified version of the Explain PLAN_TABLE facility

1 Logon to the Natural system library `SYSDB2`.

2 In the command line, enter the command `EXPLAINB` and press Enter.

The following screen is displayed:

```
16:45:35              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                            - Explain PLAN_TABLE -









                     Code Function


                      L   List PLAN_TABLE - Latest Explanations

                      A   List PLAN_TABLE - All    Explanations

                      O   Output Options

                      .   Exit
```

```
            Code .. _   Mode .......... DYNAMIC_ ( Dynamic, Plan, Package )

                         Plan .......... ________

                         Collection .... ________________

                         DBRM/Page .. ________

                         Queryno ....... _____ - _____





Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                                   Canc
```

In addition to function codes `L` (**List PLAN_TABLE - Latest Entries** function) and `A` (**List PLAN_TABLE - All Entries** function), function code `O` (**Output Options**) is available.

The **Output Options** function enables you to restrict the output of information on `PLAN_TABLE` entries. The various options are listed in a window invoked by entering function code `O` on the above **Explain PLAN_TABLE** menu. The window is similar to the one invoked by the online `I` or `INFO` commands.

```
16:53:20             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                           - Explain PLAN_TABLE -



          +-------------------------------------------------------+

           !                                                       !

           !                                                       !

           !                 Select what to display                !

           !                                                       !

           !                 _ information about plan/package      !

           !                 _ statements of plan/package          !

           !                 _ data from PLAN_TABLE                !
```

```
           !                 _ evaluation of PLAN_TABLE              !

           !                 _ catalog statistics                    !

           !                 _ columns of used indexes              ! kage )

           !                                                         !

           !                                                         !

           +-----------------------------------------------------------+

                          Queryno ....... _____ - _____




 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
                    Exit                                                   Canc
```

If the **Output Options** function has been selected, only information covered by the options marked for output are printed.

If function code `O` has not been selected, all information on `PLAN_TABLE` entries covered by the options listed in the above window are printed.

In both cases, you are prompted for a printer.

EXPLAINB in Batch Mode

Apart from being used for online mass processing, the functionality of `EXPLAINB` is especially intended for batch processing. If `EXPLAINB` is used in batch mode, output is sent to a dataset referred to by DD name `CMPRT01` (logical printer 1).

13 File Server Statistics

If a file server has been installed, the file server statistics part of the **Natural Tools for DB2** is used to display statistics on the use of the file server.

To invoke the File Server Statistics function

- On the **Natural Tools for DB2 Main Menu**, enter function code `F` and press Enter

  The **File Server - Generation Statistics** screen is displayed:

```
16:53:20              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                    - File Server - Generation Statistics -




  File Server Dataset Name ......: SAG.N2122.FSERV


  Enqueue Resource Name .........: FSERVV609


  Total Number of File Server Blocks ..........: 1000


  File Server Block Size ......................: 4080
```

```
  Number of Space Map Blocks ..................: 2



  Number of Global Directory Blocks ...........: 1

                             Entries ..........: 203

  User Space Allocation Quantities Primary ....: 50

                                   Secondary ..: 10

  Total Number of Blocks permitted per User ...: 200



Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                Dire        Next  Canc
```

This screen provides information on parameters that must be specified when generating the **file server**.

If the file server storage medium is the Software AG Editor buffer pool, the **File Server - Generation Statistics** screen looks as follows:

```
16:53:20             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                   - File Server - Generation Statistics -




  File Server Dataset Name ......: STORAGE MEDIUM IS EDITOR BUFFER POOL



  Enqueue Resource Name .........:



  Total Number of File Server Blocks ..........: 0



  File Server Block Size ......................: 4088
```

```
  Number of Space Map Blocks ..................: 0



  Number of Global Directory Blocks ...........: 0

                             Entries ..........: 0

  User Space Allocation Quantities Primary ....: 20

                                   Secondary ..: 10

  Total Number of Blocks permitted per User ...: 100



Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                            Next  Canc
```

If you press PF11 (Next), a second screen is displayed, the **File Server - User Statistics** screen, showing statistics that have been kept since the file server was installed - **Statistics since Generation** -, and statistics about the current Natural session - **Current Session Statistics**.

```
16:53:20             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                       - File Server - User Statistics -



    Statistics since Generation:



   Active Users - Maximum Number: 3          Current Number: 1

   Maximum Number of used Blocks for single User ..........: 200

                                 for all Users ............: 200

   Number of Block Allocations PRIMARY ....................: 13

                               SECONDARY ..................: 17

   Number of free Blocks ..................................: 997

   Number of INIT SESSION Calls ...........................: 65
```

```
     Current Session Statistics:



    Total Number of Blocks ................. ...: 0

                    Free Blocks ................: 0

                    Secondary  Allocations ......: 0

    VSAM I/O Buffer inside DB2AREA ........... ..: YES   (Yes/No)



 Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                Dire  Prev        Canc
```

If you press PF10 (Prev), you are returned to the **File Server - Generation Statistics** screen.

Statistics are updated, each time you press Enter, PF10, or PF11.

If the file server storage medium is the Software AG Editor buffer pool, the **File Server - User Statistics** screen looks as follows:

```
16:53:20             ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                       - File Server - User Statistics -



    Statistics since Generation:



    Active Users - Maximum Number: 3          Current Number: 0

    Maximum Number of used Blocks for single User ..........: 0

                                   for all Users ............: 0

    Number of Block Allocations PRIMARY ....................: 0

                                SECONDARY ..................: 0

    Number of free Blocks ..................................: 0

    Number of INIT SESSION Calls ...........................: 0
```

```
    Current Session Statistics:



    Total Number of Blocks ................. ...: 20

                    Free Blocks ................: 20

                    Secondary  Allocations ......: 0

    VSAM I/O Buffer inside DB2AREA ........... ..: YES   (Yes/No)



  Command ===>

  Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
        Help        Exit                                       Prev        Canc
```

Note that the section **Statistics since Generation** could not be provided by this display.

For file server VSAM files, Natural for DB2 also provides file server directory display and maintenance.

If you press PF9 (Dire), the active directory entries are listed showing the session identifiers and their allocated file server blocks. The display looks like the following:

```
12:47:40              ***** NATURAL TOOLS FOR DB2 *****             2009-11-03
User XYZ             - File Server - Directory Entries -        TID TCD4

C  No  Tpsessid Birth       1st Block Last Block     Blocks Comment
-------------------------------------------------------------------------------
_    0 Free Chn                   826        964        597 Checked
_    1 TCKK     pre NDB43         902        951         50 Checked
_    2 TCLB     pre NDB43          50         99         50 Checked
_    3 TCR0     pre NDB43         301        250         50 Checked
_    4 TCR7     pre NDB43         251        350         50 Checked
_    5 TCDW     pre NDB43         604        503         50 Checked
_    6 TCEX     pre NDB43         504        653         50 Checked
_    7 TCBW     2009-09-25        957        374         50 Checked
_    8 TC42     2009-10-15        357        993         50 Checked
_    9 - free -                     0          0          0 Empty Chain
_   10 - free -                     0          0          0 Empty Chain




Command ===>
```

```
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
Cont  Help        Exit  List  Pos   --    -     +     ++    Delet Fresh Canc
```

Birth denotes a rough creation date of the file server session, if it was created by Natural for DB2 Version 4.3. If the file server session was created by an earlier version of Natural for DB2, the birthday of the file server session appears as `pre NDB43`.

The **Directory Entries** screen provides the functionality to scroll through the directory entries and to position a particular entry to the top of the screen.

In addition, **Directory Entries** allows you to list all file server block numbers of a directory entry (PF4, line command `L`) or to delete a directory entry from the file server (PF10, line command `D`). You should only delete directory entries, if you are sure the associated Natural session is no longer alive, otherwise the deletion could destroy the file server structure.

Directory Entries reflects the file server sessions at one particular point in time. By pressing PF11, the display will be refreshed from the file at another (actual) point in time.

14 Issuing DB2 Commands from Natural

The **DB2 Command** part of the **Natural Tools for DB2** enables you to issue DB2 commands from a Natural environment.

A file is maintained for each user on the system file `FUSER`. This file is stored under the object name `DB2$CMD` in the Natural library of the current user.

You can select a command and submit it, save the command file and save and/or print the output report.

Invoking the DB2 Command Part

To invoke the Interactive SQL function

- On the **Natural Tools for DB2 Main Menu**, enter function code `D` and press Enter.

  The **Execute DB2 Command** screen is displayed:

```
 16:07:56             ***** NATURAL TOOLS FOR DB2 *****           2009-10-30
                            - Execute DB2 Command -




                       Code   Function

                         C    Display Commands
                         O    Display Output
                         ?    Help
                         .    Exit

                  Code .. _    Library .. DBA_____




 Command ===>
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                                    Canc
```

The following functions are available:

Code	Description
C	Displays your command file. If you have not saved a command file yet, a default file is displayed.
O	If an output file exists, the output report is displayed.

The following parameter can be specified:

Parameter	Description
Library	You can enter a user name or library. The default is the currrent user ID.

Displaying the Command File

To display the command file

- On the **Execute DB2 Command** menu, enter function code C and press Enter.

  The **DB2 Commands** screen is displayed:

```
16:12:11              ***** NATURAL TOOLS FOR DB2 *****            2009-10-30
                                - DB2 Commands -


  Mark the line of the command you want to execute with 'S' and press PF4

  Cmd 1    _    -DISPLAY THREAD (*)........................................
  Cmd 2    _    -DISPLAY LOCATION...........................................
  Cmd 3    _    -DISPLAY DATABASE(*) LIMIT(2500)............................
                ............................................................
  Cmd 4    _    -DISPLAY PROCEDURE (*)......................................
                ............................................................
  Cmd 5    _    -DISPLAY DATABASE(DSNDB04) LIMIT (*)........................
                ............................................................
  Cmd 6    _    ............................................................
                ............................................................
  Cmd 7    _    ............................................................
                ............................................................
  Cmd 8    _    ............................................................
                ............................................................
                ............................................................

Command ===>
```

```
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
                   Exit  Subm  Save                                Next  Canc
```

Use PF11 (Next) to scroll to the next page.

You can modify the command file. Save your modifications with PF5 (Save).

To execute a command

- Mark the command with an S and press PF4 (Subm).

The results are displayed on the **DB2 Commands Output** screen:

```
16:13:23              ***** NATURAL TOOLS FOR DB2 *****          2009-10-30
                            - DB2 Commands Output -


  Command:           -DISPLAY DATABASE(DSNDB04) LIMIT (*)
  Return Code 1:     00000000          Return Code 2:   00000000
  Length of Output:  00001AFB

  DSNT360I - ***********************************
  DSNT361I - *  DISPLAY DATABASE SUMMARY
             *    GLOBAL
  DSNT360I - ***********************************
  DSNT362I -     DATABASE = DSNDB04  STATUS = RW
                 DBD LENGTH = 72674
  DSNT397I -
  NAME     TYPE PART STATUS             PHYERRLO PHYERRHI CATALOG  PIECE
  -------- ---- ---- ------------------ -------- -------- -------- -----
  ADRESSE  TS        RW
  ALIASRBY TS        RW
  ALLDATA0 TS        RW


Command ===>
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
                   Exit        Save  --    -     +     ++                Canc
```

To save the command file

1 Press PF5 (Save).

The output file is stored under the object name DB2$OUT in the Natural library of the current user.

2 Press PF3 (Exit) to return to the command file.

You can submit further commands.

Displaying the Output Report

To display the last output record

- On the **Execute DB2 Command** menu, enter function code 0 and press Enter.

  The **DB2 Commands Output** screen is displayed:

```
16:13:57              ***** NATURAL TOOLS FOR DB2 *****           2009-10-30
                            - DB2 Commands Output -

  Command:            -DISPLAY DATABASE(*) LIMIT(2500)
  Return Code 1:      00000000          Return Code 2:   00000000
  Length of Output:   00007468

  DSNT360I - ***********************************
  DSNT361I - *  DISPLAY DATABASE SUMMARY       *
             *    GLOBAL                       *
  DSNT360I - ***********************************
  DSNT362I -     DATABASE = DSNDB01  STATUS = RW
                 DBD LENGTH = 8000
  DSNT397I -
  NAME     TYPE PART STATUS             PHYERRLO PHYERRHI CATALOG  PIECE
  -------- ---- ---- ------------------ -------- -------- -------- -----
  DBD01    TS        RW
  SPT01    TS        RW
  SCT02    TS        RW


 Command ===>
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
                  Exit        Print --    -     +     ++                Canc
```

To print the output record, press PF5 (Print).

15 Using Natural System Commands for DB2

The following Natural system commands have been incorporated into the **Natural Tools for DB2**:

Natural System Command	Explanation
`LISTSQL`	Lists Natural DML statements and their corresponding SQL statements.
`LISTSQLB`	Provides explanations of SQL statements for a specific object.
`SQLERR`	Provides information of the SQLCA on a DB2 error.
`SQLDIAG`	Provides diagnostic information about the last SQL statement (other than a `GET DIAGNOSTICS` statement) that was executed.
`LISTDBRM`	Displays either a list of DBRMs (database request modules) for a particular Natural program or a list of Natural programs that reference a particular DBRM.

For a description of these commands, follow the links leading to the Natural *System Commands* documentation.

16 Generating Natural Data Definition Modules (DDMs)

To enable Natural to access a DB2 table, a logical Natural data definition module (DDM) of the table must be generated. This is done either with Predict (see the relevant Predict documentation for details) or with the Natural utility `SYSDDM`; see also *SYSDDM Utility* in the Natural *Editors* documentation.

If you do not have Predict installed, use the `SYSDDM` function **SQL Services** to generate Natural DDMs from DB2 tables. This function is invoked from the main menu of `SYSDDM` and is described on the following pages.

For further information on Natural DDMs, see *Data Definition Modules - DDMs* in the Natural *Programming Guide*.

SQL Services (NDB/NSQ)

The **SQL Services (NDB/NSQ)** function of the Natural `SYSDDM` utility (see *Using SYSDDM Maintenance and Service Functions* in the Natural *Editors* documentation) is used to access DB2 tables. You access the catalog of the DB2 server to which you are connected, for example, by using the **Environment Setting** function as described in *Natural Tools for DB2*, or by entering the name of a server in the **Server Name** field on the **SQL Services Menu**. The name of the DB2 server to which you are connected is then displayed in the top left-hand corner of the screen **SQL Services Menu**. You can access any DB2 server that is located on either a mainframe (z/OS or z/VSE) or a UNIX platform if the servers have been connected via DRDA (Distributed Relational Database Architecture). For further details on connecting DB2 servers and for information on binding the application package (`SYSDDM` uses I/O module `NDBIOMO`) to access data on remote servers, refer to the relevant IBM literature.

The **SQL Services** function determines whether you are connected to a mainframe DB2 (z/OS or z/VSE) or a UNIX DB2, access the appropriate DB2 catalog and performs the functions listed below.

Note: If you use `SYSDDM` **SQL Services** in a CICS environment without file server, specify `CONVERS=ON` in the `NDBPARM` module (see the relevant section in *Installing Natural for DB2*); otherwise you might get SQL code `-518`.

- Using SQL Services
- Select SQL Table from a List
- Generate DDM from an SQL Table

- List Columns of an SQL Table

Using SQL Services

To invoke the SQL Services function

1 In the command line, enter the Natural system command `SYSDDM` and press Enter.

Or:

1. From the Natural main menu, choose **Maintenance and Transfer Utilities** to display the **Maintenance and Transfer Utilities** menu.
2. From the **Maintenance and Transfer Utilities** menu, choose **Maintain DDMs**.

The menu of the `SYSDDM` utility is displayed. The fields and functions provided on the `SYSDDM` utility menu are explained in the section *Using SYSDDM Maintenance and Service Functions*.

2 In the **Code** field of the Natural `SYSDDM` utility **Menu**, enter code `B` and press Enter.

The **SQL Services Menu** is displayed.

```
11:31:39              ***** NATURAL SYSDDM UTILITY *****              2009-11-27
 Server DAEFDB29            - SQL Services: Menu -




                   Code  Function

                     S   Select SQL Table from a List
                     G   Generate DDM from an SQL Table
                     L   List Columns of an SQL Table
                     ?   Help
                     .   Exit

            Code ... _
      Table name ... ________________________________
      Creator ...... ________________________________
      Replace ...... N (Y,N)          DDM Name with Creator .. Y (Y/N)
      Server name .. DAEFDB29__________



Command ===>
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                                   Canc
```

The functions available on this screen are described in the corresponding sections.

Select SQL Table from a List

This function is used to select a DB2 table from a list for further processing.

To invoke the Select SQL Table from a List function

- On the **SQL Services Menu**, enter Function Code S.
  - If you enter the function code only, you obtain a list of all tables defined to the DB2 catalog.
  - If you do not want a list of all tables but would like only a certain range of tables to be listed, you can, in addition to the function code, specify a start value in the **Table Name** and/or **Creator** fields. You can also use asterisk notation (*) for the start value.

  Press Enter.

  The **Select SQL Table From A List** screen is invoked displaying a list of all DB2 tables requested. On the list, you can mark a DB2 table with a function code:

Code	Function	Description
G	**Generate DDM from an SQL Table**	This function can be used to generate a Natural DDM from a DB2 table, based on the definitions in the DB2 catalog.
L	**List Columns of an SQL Table**	This function lists all columns of a specific DB2 table.

Generate DDM from an SQL Table

This function is used to generate a Natural DDM from a DB2 table, based on the definitions in the DB2 catalog.

The following topics are covered below:

- Invoking the Generate DDM from an SQL Table function
- DBID/FNR Assignment
- Long Field Generation
- Length Indicator for Variable Length Fields: VARBINARY, VARCHAR, LONG VARCHAR, VARGRAPHIC, LONG VARGRAPHIC, BLOB, CLOB, DBCLOB
- Null Values

- Locator Field for LOB Column

Invoking the Generate DDM from an SQL Table function

To invoke the function

- On the **SQL Services Menu**, enter function code `G` along with the name and creator of the table for which you wish a DDM to be generated.
  - If you do not know the table name/creator, you can use the function **Select SQL Table from a List** to choose the table you want.
  - If you do not want the creator of the table to be part of the DDM name, enter an `N` (No) in the field **DDM Name with Creator** when you invoke the Generate function. The default setting is is `Y` (Yes).

    Important: Since the specification of any special characters as part of a field or DDM name does not comply with Natural naming conventions, any special characters allowed within DB2 must be avoided. DB2 delimited identifiers must be avoided, too.

  - If you wish to generate a DDM for a table for which a DDM already exists and you want the existing one to be replaced by the newly generated one, enter a `Y` (Yes) in the **Replace** field when you invoke the **Generate** function.
  - By default, **Replace** is set to `N` (No) to prevent an existing DDM from being replaced accidentally.

    Note: If **Replace** is `N`, you cannot generate another DDM for a table for which a DDM has already been generated.

DBID/FNR Assignment

When the **Generate DDM from an SQL Table** function is invoked for a table for which a DDM is to be generated for the first time, the **DBID/FNR Assignment** screen is displayed. If a DDM is to be generated for a table for which a DDM already exists, the existing DBID and FNR are used and the **DBID/FNR Assignment** screen is suppressed.

On the **DBID/FNR Assignment** screen, enter one of the database IDs (DBIDs) chosen at Natural installation time, and the file number (FNR) to be assigned to the DB2 table. Natural requires these specifications for identification purposes only.

The range of DBIDs which is reserved for DB2 tables is specified in the `NTDB` macro of the Natural parameter module (see the Natural *Parameter Reference* documentation) in combination with the `NDBID` macro of the parameter module `NDBPARM`. Any DBID not within this range is not accepted. The FNR can be any valid file number within the database (between 1 and 255).

After a valid DBID and FNR have been assigned, a DDM is automatically generated from the specified table.

Long Field Generation

The maximum field length supported by Natural is 1 GB-1 (1073741823 bytes). If a DB2 table contains a column which is longer than 253 bytes or if a DB2 column is defined as a DB2 LOB field, the pop-up window Long Field Generation will be invoked automatically. A DB2 LOB field may be defined as a simple Natural variable with a maximum length of 1GB-1, or as a dynamic Natural variable.

A field which is longer than 253 bytes and which is not a DB2 LOB field may be defined as a simple Natural field with a maximum length of 1GB-1, or as an array. In the DDM, such an array is represented as a multiple-value variable.

If, for example, a DB2 column has a length of 2000 bytes, you can specify an array element length of 200 bytes, and you receive a multiple-value field with 10 occurrences, each occurrence with a length of 200 bytes.

Since generated long fields are not multiple-value fields in the sense of Natural, the Natural C* notation makes no sense here and is therefore not supported.

When such a generated long field is defined in a Natural view to be referenced by Natural SQL statements (that is, by host variables which represent multiple-value fields), both when defined and when referenced, the specified range of occurrences (index range) must always start with occurrence 1. If not, a Natural syntax error is returned.

Example:

```
UPDATE table SET varchar = #arr(*)
SELECT ... INTO #arr(1:5)
```

Note: When such a generated long field is updated with the Natural DML `UPDATE` statement, care must be taken to update each occurrence appropriately.

Length Indicator for Variable Length Fields: VARBINARY, VARCHAR, LONG VARCHAR, VARGRAPHIC, LONG VARGRAPHIC, BLOB, CLOB, DBCLOB

For each of the column types listed above, an additional length indicator field (format/length I2 or I4 for `LOB` fields) is generated in the DDM. The length is always measured in number of characters, not in bytes. To obtain the number of bytes of a `VARGRAPHIC`, `LONG VARGRAPHIC` or `DBCLOB` field, the length must be multiplied by 2.

The name of a length indicator field begins with `L@` followed by the name of the corresponding field. The value of the length indicator field can be checked or updated by a Natural program.

If the length indicator field is not part of the Natural view and if the corresponding field is a re-defined long field, the length of this field with `UPDATE` and `STORE` operations is calculated without trailing blanks.

Null Values

With Natural, it is possible to distinguish between a null value and the actual value zero (0) or blank in a DB2 column.

When a Natural DDM is generated from the DB2 catalog, an additional `NULL` indicator field is generated for each column which can be `NULL`; that is, which has neither `NOT NULL` nor `NOT NULL WITH DEFAULT` specified.

The name of the `NULL` indicator field begins with `N@` followed by the name of the corresponding field.

When the column is read from the database, the corresponding indicator field contains either zero (`0`) (if the column contains a value, including the value `0` or blank) or `-1` (if the column contains no value).

Example:

The column `NULLCOL CHAR(6)` in a DB2 table definition would result in the following view fields:

```
NULLCOL          A 6.0
N@NULLCOL    I 2.0
```

When the field `NULLCOL` is read from the database, the additional field `N@NULLCOL` contains:

- `0` (zero) if `NULLCOL` contains a value (including the value `0` or blank),
- `-1` (minus one) if `NULLCOL` contains no value.

A null value can be stored in a database field by entering `-1` as input for the corresponding `NULL` indicator field.

Note: If a column is `NULL`, an implicit `RESET` is performed on the corresponding Natural field.

Locator Field for LOB Column

For each LOB column, an additional locator field will be generated in the I4 format.

A LOB locator may be used to reference a LOB value in the DB2 database server, when a LOB value is not needed locally in a program.

List Columns of an SQL Table

This function lists all columns of a specific DB2 table.

To invoke the List Columns function

- On the **SQL Services Menu**, enter function code L along with the name and creator of the table whose columns you wish to be listed, and press Enter.

  The **List Columns** screen for this table is invoked, which lists all columns of the specified table and displays the following information for each column:

Variable	Content	
Name	The DB2 name of the column.	
Type	The column type.	
Length	The length (or precision if type is DECIMAL) of the column as defined in the DB2 catalog.	
Scale	The decimal scale of the column (only applicable if type is DECIMAL).	
Update	Y	The column can be updated.
	N	The column cannot be updated.
Nulls	Y	The column can contain null values.
	N	The column cannot contain null values.
Note	A column whose scale length or whose type is not supported by Natural is marked with an asterisk (*). For such a column, a view field cannot be generated. The maximum scale length supported is 7 bytes. The following SQL types are supported: BIGINT, BINARY, VARBINARY, DECFLOAT, XML CHAR, VARCHAR, LONG VARCHAR, GRAPHIC, VARGRAPHIC, LONG VARGRAPHIC, DECIMAL, INTEGER, SMALLINT, DATE, TIME, TIMESTAMP, FLOAT, ROWID, BLOB, CLOB and DBCLOB.	

  The data types DATE, TIME, TIMESTAMP, FLOAT and ROWID are converted into numeric or alphanumeric fields of various lengths: DATE is converted into A10, TIME into A8, TIMESTAMP into A26, FLOAT into F8 and ROWID into A40. DATE and TIME could be mapped alternatively to Natural DATE and Natural TIME respectively

  For DB2, Natural provides a DB2 TIMESTAMP column as an alphanumeric field (A26) in the format *YYYY-MM-DD-HH.SS.MMMMMM*.

17 Dynamic and Static SQL Support

This section describes the dynamic and static SQL support provided by Natural.

Related Documentation

- For a list of error messages that may be issued during static generation, see *Static Generation Messages and Codes Issued under NDB/NSQ* in the Natural *Messages and Codes* documentation.
- For information on Static SQL with Natural Security, see ***Integration with Natural Security***.

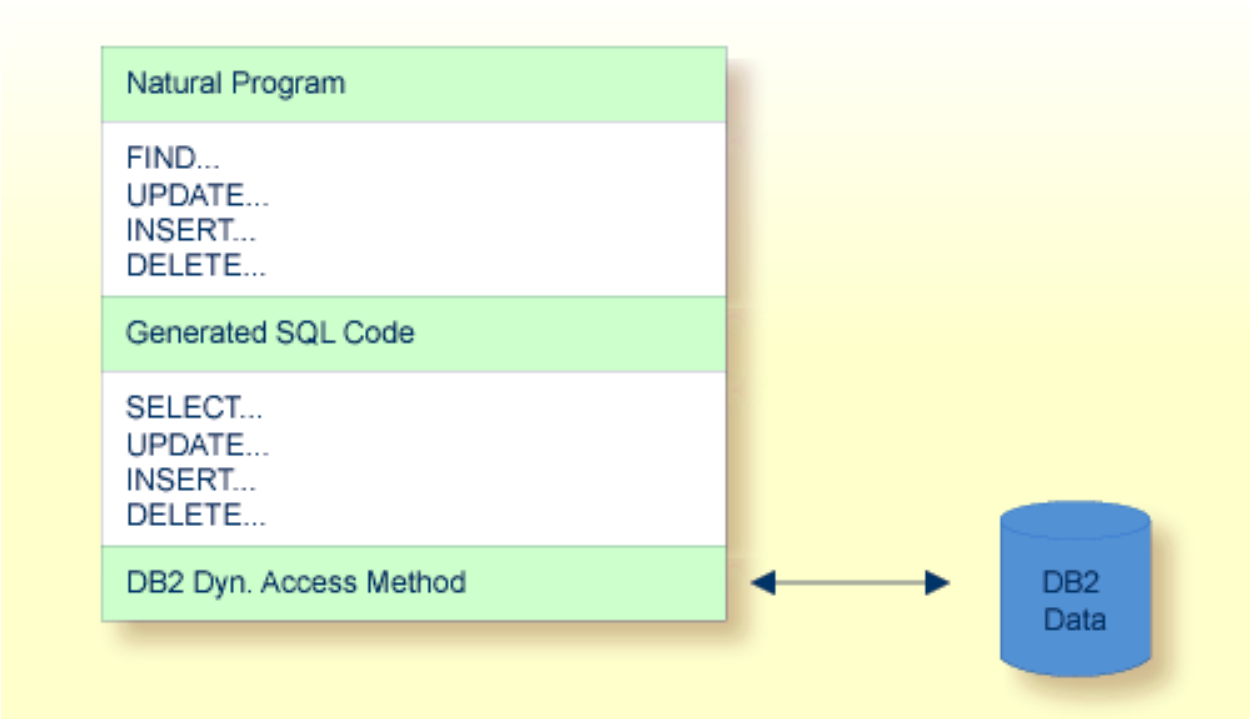
SQL Support - General Information

The SQL support of Natural combines the flexibility of dynamic SQL support with the high performance of static SQL support.

In contrast to static SQL support, the Natural dynamic SQL support does not require any special consideration with regard to the operation of the SQL interface. All SQL statements required to execute an application request are generated automatically and can be executed immediately with the Natural `RUN` command. Before executing a program, you can look at the generated SQL code, using the `LISTSQL` command.

Access to DB2 through Natural has the same form whether dynamic or static SQL support is used. Thus, with static SQL support, the same SQL statements in a Natural program can be executed in either dynamic or static mode. An SQL statement can be coded within a Natural program and, for testing purposes, it can be executed using dynamic SQL. If the test is successful, the SQL statement remains unchanged and static SQL for this program can be generated.

Thus, during application development, the programmer works in dynamic mode and all SQL statements are executed dynamically, whereas static SQL is only created for applications that have been transferred to production status.



Internal Handling of Dynamic Statements

Natural automatically provides for the preparation and execution of each SQL statement and handles the opening and closing of cursors used for scanning a table.

The following topics are covered:

- I/O Module NDBIOMO for Dynamic SQL Statement Execution
- Statement Table
- Processing of SQL Statements Issued by Natural

I/O Module NDBIOMO for Dynamic SQL Statement Execution

As each dynamic execution of an SQL statement requires a statically defined `DECLARE STATEMENT` and `DECLARE CURSOR` statement, a special I/O module named `NDBIOMO` is provided which contains a fixed number of these statements and cursors. This number is specified during the generation of the `NDBIOMO` module in the course of the Natural for DB2 installation process.

Statement Table

If possible, an SQL statement is only prepared once and can then be executed several times if required. For this purpose, Natural internally maintains a table of all SQL statements that have been prepared and assigns each of these statements to a `DECLAREd STATEMENT` in the module `NDBIOMO`. In addition, this table maintains the cursors used by the SQL statements `SELECT`, `FETCH`, `UPDATE` (positioned), and `DELETE` (positioned).

Each SQL statement is uniquely identified by:

- the name of the Natural program that contains this SQL statement,
- the line number of the SQL statement in this program,
- the name of the Natural library into which this program was stowed,
- the time stamp when this program was stowed.

Once a statement has been prepared, it can be executed several times with different variable values, using the dynamic SQL statement `EXECUTE USING DESCRIPTOR` or `OPEN CURSOR USING DESCRIPTOR`.

When the full capacity of the statement table is reached, the entry for the next prepared statement overwrites the entry for a free statement whose latest execution is the least recent one.

When a new `SELECT` statement is requested, a free entry in the statement table with the corresponding cursor is assigned to it and all subsequent `FETCH`, `UPDATE`, and `DELETE` statements referring to this `SELECT` statement will use this cursor. Upon completion of the sequential scanning of the table, the cursor is released and free for another assignment. While the cursor is open, the entry in the statement table is marked as used and cannot be reused by another statement.

If the number of nested `FIND` (`SELECT`) statements reaches the number of entries available in the statement table, any further SQL statement is rejected at execution time and a Natural error message is returned.

The size of the statement table depends on the size specified for the module `NDBIOMO`. Since the statement table is contained in the DB2 buffer area, the setting of Natural profile parameter `DB2SIZE` (see also ***Natural Parameter Modification for DB2***) may not be sufficient and may need to be increased.

Processing of SQL Statements Issued by Natural

The embedded SQL uses cursor logic to handle `SELECT` statements. The preparation and execution of a `SELECT` statement is done as follows:

1. The typical `SELECT` statement is prepared by a program flow which contains the following embedded SQL statements (note that *X* and *SQLOBJ* are SQL variables, not program labels):

   ```
   DECLARE SQLOBJ STATEMENT
   DECLARE X CURSOR FOR SQLOBJ
   INCLUDE SQLDA (copy SQL control block)
   ```

   Then, the following statement is moved into `SQLSOURCE`:

   ```
   SELECT PERSONNEL_ID, NAME, AGE
    FROM EMPLOYEES
    WHERE NAME IN (?, ?)
       AND AGE BETWEEN ? AND ?
   ```

   Note: The question marks (?) above are parameter markers which indicate where values are to be inserted at execution time.

   ```
   PREPARE SQLOBJ FROM SQLSOURCE
   ```

2. Then, the `SELECT` statement is executed as follows:

   ```
   OPEN X USING DESCRIPTOR SQLDA
   FETCH X USING DESCRIPTOR SQLDA
   ```

   The descriptor `SQLDA` is used to indicate a variable list of program areas. When the `OPEN` statement is executed, it contains the address, length, and type of each value which replaces a parameter marker in the `WHERE` clause of the `SELECT` statement. When the `FETCH` statement is executed, it contains the address, length, and type of all program areas which receive fields read from the table.

   When the `FETCH` statement is executed for the first time, it sets the Natural system variable `*NUMBER` to a non-zero value if at least one record is found that meets the search criteria. Then, all records satisfying the search criteria are read by repeated execution of the `FETCH` statement.

   To help improve performance, especially when using distributed databases, the DB2-specific `FOR FETCH ONLY` clause can be used. This clause is generated and executed if rows are to be retrieved only; that is, if no updating is to take place.

3. Once all records have been read, the cursor is released by executing the following statement:

```
CLOSE X
```

Preparing Programs for Static Execution

This section describes how to prepare Natural programs for static execution.

The following topics are covered:

- Basic Principles
- Generation Procedure: CMD CREATE Command
- Precompilation of the Generated Assembler Program
- Modification Procedure: CMD MODIFY Command
- BIND of the Precompiled DBRM

For an explanation of the symbols used in this section to describe the syntax of Natural statements, see *Syntax Symbols* in the Natural *Statements* documentation.

Basic Principles

Static SQL is generated in Natural batch mode for one or more Natural applications which can consist of one or more Natural object programs. The number of programs that can be modified for static execution in one run of the generation procedure is limited to 999.

During the generation procedure, the database access statements contained in the specified Natural objects are extracted, written to work files, and transformed into a temporary Assembler program. If no Natural program is found that contains SQL access or if any error occurs during static SQL generation, batch Natural terminates and condition code 40 is returned, which means that all further JCL steps must no longer be executed.

The Natural modules `NDBCHNK` and `NDBSTAT` must reside in a steplib of the generation step. Both are loaded dynamically during the execution of the generation step.

The temporary Assembler program is written to a temporary file (the Natural work file `CMWKF06`) and precompiled. The size of the workfile is proportional to the maximum number of programs, the number of SQL statements and the number of variables used in the SQL statements. During the precompilation step, a database request module (DBRM) is created, and after the precompilation step, the precompiler output is extracted from the Assembler program and written to the corresponding Natural objects, which means that the Natural objects are modified (prepared) for static execution. The temporary Assembler program is no longer used and deleted.

A static database request module is created by using either the sample job provided on the installation tape or an appropriate job created with the **Create DBRM** function.

Generation Procedure: CMD CREATE Command

The following topics are covered:

- Generating Static SQL for Natural Programs
- Static Name
- USING Clause

Generating Static SQL for Natural Programs

To generate static SQL for Natural programs

1 Logon to the Natural system library `SYSDB2`.

Since a new `SYSDB2` library has been created when installing Natural for DB2, ensure that it contains all Predict interface programs necessary to run the static SQL generation. These programs are loaded into `SYSDB2` at Predict installation time (see the relevant *Predict* product documentation).

2 Specify the `CMD CREATE` command and the Natural input necessary for the static SQL generation process; the `CMD CREATE` command has the following syntax:

```
CMD CREATE DBRM static-name USING using-clause
{application-name,object-name,excluded-object}
:
:
```

The generation procedure reads but does not modify the specified Natural objects. If one of the specified programs was not found or had no SQL access, return code 4 is returned at the end of the generation step.

Static Name

If the `PREDICT DOCUMENTATION` option is to be used, a corresponding Predict static SQL entry must be available and the *`static-name`* must correspond to the name of this entry. In addition, the *`static-name`* must correspond to the name of the DBRM to be created during precompilation. The *`static-name`* can be up to 8 characters long and must conform to Assembler naming conventions.

USING Clause

The *using-clause* specifies the Natural objects to be contained in the DBRM. These objects can either be specified explicitly as INPUT DATA in the JCL or obtained as PREDICT DOCUMENTATION from Predict.

```
{ INPUT DATA    } [ WITH XREF { YES } ] [ FS { OFF } ] [LIB
{ PREDICT       }             { NO  }       { ON  }   lib-name
{ DOCUMENTATION }             { FORCE }                ]
```

If the parameters to be specified do not fit in one line, specify the command identifier (CMD) and the various parameters in separate lines and use both the input delimiter (as specified with the Natural profile/session parameter ID - default is a comma (,) - and the continuation character indicator - as specified with the Natural profile/session parameter CF; default is a percent (%) - as shown in the following example:

Example:

```
CMD
CREATE,DBRM,static,USING,PREDICT,DOCUMENTATION,WITH,XREF,NO,%
LIB,library
```

Alternatively, you can also use abbreviations as shown in the following example:

Example:

```
CMD CRE DBRM static US IN DA W XR Y FS OFF LIB library
```

The sequence of the parameters USING, WITH, FS, and LIB is optional.

INPUT DATA

As input data, the applications and names of the Natural objects to be included in the DBRM must be specified in the subsequent lines of the job stream (*application-name*,*object-name*). A subset of these objects can also be excluded again (*excluded-objects*). Objects in libraries whose names begin with SYS can be used for static generation, too.

The applications and names of Natural objects must be separated by the input delimiter - as specified with the Natural profile parameter ID; default is a comma (,). If you wish to specify all objects whose names begin with a specific string of characters, use an *object-name* or *excluded-objects* name that ends with asterisk notation (*). To specify all objects in an application, use asterisk notation only.

Example:

```
LIB1,ABC*
  LIB2,A*,AB*
  LIB2,*
  :
  .
```

The specification of applications/objects must be terminated by a line that contains a period (.) only.

PREDICT DOCUMENTATION

Since Predict supports static SQL for DB2, you can also have Predict supply the input data for creating static SQL by using already existing `PREDICT DOCUMENTATION`.

WITH XREF Option

Since Predict Active References supports static SQL for DB2, the generated static DBRM can be documented in Predict, and the documentation can be used and updated with Natural.

`WITH XREF` is the option which enables you to store cross-reference data for a static SQL entry in Predict each time a static DBRM is created (`YES`). You can instead specify that no cross-reference data are stored (`NO`) or that a check is made to determine whether a Predict static SQL entry for this static DBRM already exists (`FORCE`). If so, cross-reference data are stored; if not, the creation of the static DBRM is not allowed. For more detailed information on Predict Active References, refer to the relevant Predict documentation.

When `WITH XREF (YES/FORCE)` is specified, `XREF` data are written for both the Predict static SQL entry (if defined in Predict) and each generated static Natural program. However, static generation with `WITH XREF (YES/FORCE)` is possible only if the corresponding Natural programs have been cataloged with `XREF ON`.

`WITH XREF FORCE` only applies to the `USING INPUT DATA` option.

Note: If you do not use Predict, the `XREF` option must be omitted or set to `NO` and the module `NATXRF2` need not be linked to the Natural nucleus.

FS Option

If the `FS` (file server) option is set to `ON`, a second `SELECT` is generated for the **Natural file server for DB2**. `ON` is the default setting.

If the `FS` option is set to `OFF`, no second `SELECT` is generated, which results in less SQL statements being generated in your static DBRM and thus in a smaller DBRM.

LIB Option

With the LIB (library) option, a Predict library other than the default library (*SYSSTA*) can be specified to contain the Predict static SQL entry and XREF data. The name of the library can be up to eight characters long.

Precompilation of the Generated Assembler Program

In this step, the precompiler is invoked to precompile the generated temporary Assembler program. The precompiler output consists of the DBRM and a precompiled temporary Assembler program which contains all the database access statements transformed from SQL into Assembler statements.

Later, the DBRM serves as input for the BIND step and the Assembler program as input for the modification step.

Modification Procedure: CMD MODIFY Command

The modification procedure modifies the Natural objects involved by writing precompiler information into the object and by marking the object header with the *static-name* as specified with the CMD CREATE command.

In addition, any existing copies of these objects in the Natural global buffer pool (if available) are deleted and XREF data are written to Predict (if specified during the generation procedure).

To perform the modification procedure

1 Logon to the Natural system library SYSDB2.

2 Specify the CMD MODIFY command which has the following syntax:

```
CMD MODIFY [XREF]
```

The input for the modify step is the precompiler output which must reside on a dataset defined as the Natural work file CMWKF01.

The output consists of precompiler information which is written to the corresponding Natural objects. In addition, a message is returned telling you whether it was the first time an object was modified for static execution (modified) or whether it had been modified before (re-modified).

Assembler/Natural Cross-References

If you specify the XREF option of the MODIFY command, an output listing is created on the work file CMWKF02, which contains the DBRM name and the Assembler statement number of each statically generated SQL statement together with the corresponding Natural source code line number, program name, library name, database ID and file number.

```
-----------------------------------------------------------------------....
  DBRMNAME STMTNO      LINE NATPROG  NATLIB   DB  FNR COMMENT            ....
-----------------------------------------------------------------------....
  TESTDBRM 000627      0390 TESTPROG SAG      010 042 INSERT             ....
           000641      0430                           INSERT             ....
           000652      0510                           SELECT             ....
           000674      0570                           SELECT             ....
           000698      0570                           SELECT      2ND    ....
           000728      0650                           UPD/DEL            ....
           000738      0650                           UPD/DEL     2ND    ....
           000751      0700                           SELECT             ....
           000775      0700                           SELECT      2ND    ....
```

Column	Explanation
DBRMNAME	Name of the DBRM which contains the static SQL statement.
STMTNO	Assembler statement number of the static SQL statement.
LINE	Corresponding Natural source code line number.
NATPROG	Name of the Natural program that contains the static SQL statement.
NATLIB	Name of the Natural library that contains the Natural program.
DB / FNR	Natural database ID and file number.
COMMENT	Type of SQL statement, where 2ND indicates that the corresponding statement is used for a reselection; see also the *Concept of the File Server*.

BIND of the Precompiled DBRM

It is recommended to run the BIND job *after* the MODIFY job.

This step performs the BIND against DB2. One or more DBRMs (as created by the precompiler) are processed to create a DB2 application plan. In addition to the static DBRMs created above, this application plan contains the dynamic DBRM NDBIOMO module provided by Natural itself.

A DBRM can be bound into any number of application plans where it might be required. A plan is physically independent of the environment where the program is to be run. However, you can group your DBRMs logically into plans which are to be used for either batch or online processing, where the same DBRM can be part of both a batch plan and an online plan.

Unless you are using plan switching, only one plan can be executed per Natural session. Thus, you must ensure that the plan name specified in the BIND step is the same as the one used to execute Natural.

Execution of Natural in Static Mode

To be able to execute Natural in static mode, all users of Natural must have the DB2 `EXECUTE PLAN/PACKAGE` privilege for the plan created in the `BIND` step.

To execute static SQL, start Natural and execute the corresponding Natural program. Internally, the Natural runtime interface evaluates the precompiler data written to the Natural object and then performs the static accesses.

To the user there is no difference between dynamic and static execution.

Mixed Dynamic/Static Mode

It is possible to operate Natural in a mixed static and dynamic mode where for some programs static SQL is generated and for some not.

The mode in which a program is run is determined by the Natural object program itself. If a static DBRM is referenced in the executing program, all statements in this program are executed in static mode.

Note: Natural programs which return a runtime error do not automatically execute in dynamic mode. Instead, either the error must be corrected or, as a temporary solution, the Natural program must be recataloged to be able to execute in dynamic mode.

Within the same Natural session, static and dynamic programs can be mixed without any further specifications. The decision which mode to use is made by each individual Natural program.

Messages and Codes

For a list of error messages that may be issued during static generation, refer to *Static Generation Messages and Codes Issued under NDB/NSQ* in the Natural *Messages and Codes* documentation.

Application Plan Switching in Static SQL

This section describes how to switch application plans within the same Natural session in different TP-monitor environments or in batch mode.

The following topics are covered:

Basic Principles of Plan Switching

When using application plan switching, you can switch to a different application plan within the same Natural session.

If a second application plan is to be used, this can be specified by executing the Natural program `NATPLAN`. `NATPLAN` is contained in the Natural system library `SYSDB2` and can be invoked either from within a Natural program or dynamically by entering the command `NATPLAN` at the `NEXT` prompt. The only input value required for `NATPLAN` is an eight-character plan name. If no plan name is specified, you are prompted by the system to do so.

Before executing `NATPLAN`, ensure that any open DB2 recovery units are closed.

Since the `NATPLAN` program is also provided in source form, user-written plan switching programs can be created using similar logic.

The actual switch from one plan to another differs in the various environments supported. The feature is available under Com-plete, CICS, and IMS TM MPP. When using the Call Attachment Facility (CAF) or Resource Recovery Services Attachment Facility (RRSAF), it is also available in TSO and batch environments.

In some of these environments, a transaction ID or code must be specified instead of a plan name.

Plan Switching under CICS

Under CICS, you have the option of using either plan switching by transaction ID (default) or dynamic plan selection exit routines. Thus, by setting the field `#SWITCH-BY- TRANSACTION-ID` in the `NATPLAN` program to either `TRUE` or `FALSE`, either the subroutine `CMTRNSET` or the desired plan name is written to temporary storage queue.

For more information on activating plan switching under CICS, see ***Installation Steps Specific to CICS*** in *Installing Natural for DB2*.

Below is information on:

- Plan Switching by CICS/DB2 Exit Routine

Plan Switching by CICS/DB2 Exit Routine

If `#SWITCH-BY-TRANSACTION-ID` is set to `FALSE`, the desired plan name is written to a temporary storage queue for a CICS/DB2 exit routine specified as PLANExit attribute of a DB2ENTRY or of the DB2CONN definition, the `NATPLAN` program must be invoked before the first DB2 access. Natural for DB2 provides `NDBUEXT` as CICS DB2 plan selection exit program. For additional information on CICS/DB2 exit routines, refer to the relevant IBM literature.

The name of the temporary storage queue is `PLAN`*`xxxx`*, where *`xxxx`* is the CICS terminal identifier.

When running in a CICSplex environment, the CICS temporary storage queue `PLAN`*`xxxx`* containing the plan name must be defined with `TYPE=SHARED` or `TYPE=REMOTE` in a CICS TST.

For each new DB2 unit of recovery, the appropriate plan selection exit routine is automatically invoked. This exit routine reads the temporary storage record and uses the contained plan name for plan selection.

When no temporary storage record exists for the Natural session, a default plan name, contained in the plan exit, can be used. If no plan name is specified by the exit, the name of the plan used is the same as the name of the static program (DBRM) issuing the SQL call. If no such plan name exists, an SQL error results.

Plan Switching under Com-plete

In Com-plete environments, plan switching is accomplished by using the Call Attachment Facility (CAF), which releases the thread in use and attaches another one that has a different plan name.

Once the DB2 connection has been established, the same plan name continues to be used until the plan is explicitly changed with IBM's call attachment language interface (`DSNALI`). For additional information on the CAF interface, refer to the relevant IBM literature.

Under Com-plete, the NATPLAN program first issues an `END TRANSACTION` statement and then invokes an Assembler routine by using `DB2SERV`.

The assembler routine performs the actual switching. It issues a CLOSE request to DSNALI to terminate the DB2 connection (if one exists). It then issues an OPEN request to re-establish the DB2 connection and to allocate the resources needed to execute the specified plan.

If NATPLAN has not been executed before the first SQL call, the default plan used is the one defined in the Com-plete startup parameters. Once a plan has been changed using NDBPLAN, it remains scheduled until another plan is scheduled by NDBPLAN or until the end of the Natural session.

Plan Switching under IMS TM

In an IMS MPP environment, the switch is accomplished by using direct or deferred message switching. As a different application plan is associated with each IMS application program, message switching from one transaction code to another automatically switches the application plan being used.

Since Natural applications can perform direct or deferred message switches by calling the appropriate supplied routines, use of the NATPLAN program for plan switching is optional.

NATPLAN calls the Assembler routine CMDEFSW, which sets the new transaction code to be used with the next following terminal I/O.

Plan Switching under TSO and in Batch Mode

In the TSO and batch environments, plan switching is accomplished by using the Call Attachment Facility (CAF) or the Resource Recovery Services Attachment Facility (RRSAF). Either facility releases the thread in use and attaches another one that has a different plan name.

Below is information on:

- Plan Selection with CAF
- Plan Selection with RRSAF

Plan Selection with CAF

When using the Call Attachment Facility (CAF), plan selection is either implicit or explicit. If no DB2 connection has been made before the first SQL call, a plan name is selected by DB2. If so, the plan name used is the same as the name of the program (DBRM) issuing the SQL call.

Once the DB2 connection has been established, the plan name is retained until explicitly changed by IBM's call attachment language interface (DSNALI). For additional information on the CAF interface, refer to the relevant IBM literature.

Under TSO and in batch mode, the NATPLAN program first issues an END TRANSACTION statement and then invokes an Assembler routine by using DB2SERV.

Note: Modify the NATPLAN program by setting the #SSM field to the current DB2 subsystem name; the default name is DB2.

The assembler routine performs the actual switching. It issues a CLOSE request to DSNALI to terminate a possible DB2 connection. It then issues an OPEN request to re-establish the DB2 connection and to allocate the resources needed to execute the specified plan.

If NATPLAN has not been executed before the first SQL call, plan selection is done by DSNALI. If so, the plan name used is the same as the name of the program issuing the SQL call. The subsystem ID used is the one specified during the DB2 installation. If no such plan name or subsystem ID exists, a Natural error message is returned.

If a static DBRM is issuing the SQL call, a plan name must exist with the same name as the one of the static DBRM.

If dynamic SQL is being used, a plan name of NDBIOMO must exist which must contain a DBRM called NDBIOMO, too. NDBIOMO is the default plan name.

Note: To avoid any confusion concerning the chosen plan name and/or subsystem ID, always call NATPLAN before the first SQL call.

Plan Selection with RRSAF

When using the Resource Recovery Services Attachment Facility (RRSAF), plan selection is explicit.

RRSAF is used if IBM's DSNRLI interface module is linked to Natural. Once the DB2 connection has been established, the plan name is retained until explicitly changed with RRSAF. For additional information on RRSAF, refer to the relevant IBM literature.

The NATPLAN program performs the actual switching. It issues a TERMINATE IDENTIFY request to DSNRLI to terminate a possible DB2 connection. NATPLAN then issues an IDENTIFY request to re-establish the DB2 connection. This request is followed by SIGNON and CREATE THREAD requests.

In an RRSAF environment, up to four of the following parameters can be specified in NATPLAN where #PLAN is mandatory:

Parameter	Default Value	Format	Explanation
#PLAN	None	A8	Name of the plan used for SQL processing in the thread created (CREATE THREAD).
#SSM	DB2	A4	Subsystem ID of the DB2 server connected (IDENTIFY).
#COLLID	COLLID	A18	Only used if the first character of #PLAN is a question mark (?). Collection ID used for SQL processing in the thread created (CREATE THREAD).
#XID	1	I4	Indicates that a global transaction ID is used. If set to 0 (SIGNON), no global transaction ID is used.

Example of Plan Selection with RRSAF under TSO

The example below demonstrates plan selection under TSO by using RRSAF.

```
NATPLAN
<Enter>
Please enter new plan name  NDBPLAN4
            ,SUB SYSTEM ID DB27
            ,COLLECTION ID
         ,global XID (0/1) __________1
<Enter>
```

Example of Plan Selection with RRSAF in Batch Mode

The example below demonstrates plan selection in batch mode by using RRSAF:

```
NATPLAN NDBPLAN4,DB27, ,1
```

18 Using Natural Statements and System Variables

This section contains special considerations concerning Natural data manipulation language (DML) statements (that is, Natural native DML statements and Natural SQL DML statements), and Natural system variables when used with DB2.

It mainly consists of information also contained in the Natural basic documentation set where each Natural statement and variable is described in detail.

For an explanation of the symbols used in this section to describe the syntax of Natural statements, see *Syntax Symbols* in the Natural *Statements* documentation.

For information on logging SQL statements contained in a Natural program, refer to *DBLOG Trace Screen for SQL Statements* in the *DBLOG Utility* documentation.

DB2 Special Register Consideration

NDB refreshes the following DB2 special registers automatically to the values, which applied to the least previous executed transaction.

- `CURRENT SQLID`
- `CURRENT SCHEMA`
- `CURRENT PATH`
- `CURRENT PACKAGE PATH`

NDB refreshes the following DB2 special registers only automatically to the values, which applied to the least previous executed transaction, if the parameter `REFRESH=ON` is set.

- `CURRENT PACKAGESET`
- `CURRENT SERVER`

Those special registers are refreshed regardless whether the previously executed transaction was rolled back or was committed.

All other special registers are not implicitly manipulated by NDB.

Using Natural Native DML Statements

This section summarizes particular points you have to consider when using Natural data manipulation language (DML) statements with DB2. Any Natural statement not mentioned in this section can be used with DB2 without restriction.

Below is information on the following Natural DML statements:

- BACKOUT TRANSACTION
- DELETE
- END TRANSACTION
- FIND
- HISTOGRAM
- READ
- STORE
- UPDATE

BACKOUT TRANSACTION

The Natural native DML statement `BACKOUT TRANSACTION` undoes all database modifications made since the beginning of the last logical transaction. Logical transactions can start either after the beginning of a session or after the last `SYNCPOINT`, `END TRANSACTION`, or `BACKOUT TRANSACTION` statement.

How the statement is translated and which command is actually issued depends on the TP-monitor environment:

- If this command is executed within a Natural stored procedure or Natural user-defined function (UDF), Natural for DB2 executes the underlying rollback operation. This sets the caller into a must-rollback state. If this command is executed within a Natural stored procedure or UDF for Natural error processing (implicit `ROLLBACK`), Natural for DB2 does not execute the underlying rollback operation, thus allowing the caller to receive the original Natural error.
- Under CICS, the `BACKOUT TRANSACTION` statement is translated into an `EXEC CICS ROLLBACK` command. However, in pseudo-conversational mode, only changes made to the database since the last terminal I/O are undone. This is due to CICS-specific transaction processing, see ***Natural for DB2 under CICS***.

  Note: Be aware that with terminal input in database loops, Natural switches to conversational mode if no file server is used.

- In batch mode and under TSO, the `BACKOUT TRANSACTION` statement is translated into an SQL `ROLLBACK` command.

Note: If running in a DSNMTV01 environment, the `BACKOUT TRANSACTION` statement is ignored if the used PSB has been generated without the `CMPAT=YES` option.

- Under IMS TM, the `BACKOUT TRANSACTION` statement is translated into an IMS Rollback (`ROLB`) command. However, only changes made to the database since the last terminal I/O are undone. This is due to IMS TM-specific transaction processing, see ***Natural for DB2 under IMS TM***.

As all cursors are closed when a logical unit of work ends, a `BACKOUT TRANSACTION` statement must not be placed within a database loop; instead, it has to be placed outside such a loop or after the outermost loop of nested loops.

If an external program written in another standard programming language is called from a Natural program, this external program must not contain its own ROLLBACK command if the Natural program issues database calls, too. The calling Natural program must issue the `BACKOUT TRANSACTION` statement for the external program.

If a program tries to backout updates which have already been committed, for example by a terminal I/O, a corresponding Natural error message (NAT3711) is returned.

DELETE

The Natural native DML statement `DELETE` is used to delete a row from a table which has been read with a preceding `FIND`, `READ`, or `SELECT` statement. It corresponds to the SQL statement `DELETE WHERE CURRENT OF` *`cursor-name`*, which means that only the row which was read last can be deleted.

Example:

```
FIND EMPLOYEES WITH NAME = 'SMITH'
     AND FIRST_NAME = 'ROGER'
DELETE
```

Natural would translate the above Natural statements into SQL and assign a cursor name (for example, `CURSOR1`) as follows:

```
DECLARE CURSOR1 CURSOR FOR
SELECT FROM EMPLOYEES
 WHERE NAME = 'SMITH' AND FIRST_NAME = 'ROGER' FOR UPDATE OF NAME
DELETE FROM EMPLOYEES
 WHERE CURRENT OF CURSOR1
```

Both the `SELECT` and the `DELETE` statement refer to the same cursor.

Natural translates a Natural native DML `DELETE` statement into a Natural SQL `DELETE` statement in the same way it translates a Natural native DML `FIND` statement into a Natural SQL `SELECT` statement.

A row read with a `FIND SORTED BY` cannot be deleted due to DB2 restrictions explained with the `FIND` statement. A row read with a `READ LOGICAL` cannot be deleted either.

DELETE when Using the File Server

If a row rolled out to the file server is to be deleted, Natural rereads automatically the original row from the database to compare it with its image stored in the file server. If the original row has not been modified in the meantime, the `DELETE` operation is performed. With the next terminal I/O, the transaction is terminated, and the row is deleted from the actual database.

If the `DELETE` operates on a scrollable cursor, the row on the file server is marked as `DELETE` hole and is deleted from the base table.

However, if any modification is detected, the row will not be deleted and Natural issues the NAT3703 error message for non-scrollable cursors.

If the `DELETE` operates on a scrollable cursor, Natural for DB2 simulates SQLCODE -224 THE RESULT TABLE DOES NOT AGREE WITH THE BASE TABLE USING for DB2 compliance.

If the `DELETE` operates on a scrollable cursor and the row has become a hole, Natural for DB2 simulates SQLCODE -222 AN UPDATE OR DELETE OPERATION WAS ATTEMPTED AGAINST A HOLE.

Since a `DELETE` statement requires that Natural rereads a single row, a unique index must be available for the respective table. All columns which comprise the unique index must be part of the corresponding Natural view.

END TRANSACTION

The Natural native DML statement `END TRANSACTION` indicates the end of a logical transaction and releases all DB2 data locked during the transaction. All data modifications are committed and made permanent.

How the statement is translated and which command is actually issued depends on the TP-monitor environment:

- If this command is executed from a Natural stored procedure or user defined function (UDF), Natural for DB2 does not execute the underlying commit operation. This allows the stored procedure or UDF to commit updates against non DB2 databases.
- Under CICS, the `END TRANSACTION` statement is translated into an `EXEC CICS SYNCPOINT` command. If the file server is used, an implicit end-of-transaction is issued after each terminal I/O. This is due to CICS-specific transaction processing in pseudo-conversational mode, see ***Natural for DB2 under CICS***.
- In batch mode and under TSO, the `END TRANSACTION` statement is translated into an SQL `COMMIT WORK` command.

Note: If running in a DSNMTV01 environment the `END TRANSACTION` statement is ignored if the used PSB has been generated without the `CMPAT=YES` option.

- Under IMS TM, the `END TRANSACTION` statement is not translated into an IMS CHKP call, but is ignored. Due to IMS TM-specific transaction processing (see ***Natural for DB2 under IMS TM***), an implicit end-of-transaction is issued after each terminal I/O.

Except when used in combination with the SQL `WITH HOLD` clause (see `SELECT - SQL` in ***Using Natural SQL Statements***), an `END TRANSACTION` statement must not be placed within a database loop, since all cursors are closed when a logical unit of work ends. Instead, it has to be placed outside such a loop or after the outermost loop of nested loops.

If an external program written in another standard programming language is called from a Natural program, this external program must not contain its own `COMMIT` command if the Natural program issues database calls, too. The calling Natural program must issue the `END TRANSACTION` statement on behalf of the external program.

Note: With DB2, the `END TRANSACTION` statement cannot be used to store transaction data.

FIND

The Natural native DML statement `FIND` corresponds to the Natural SQL statement `SELECT`.

Example:

Natural native DML statements:

```
FIND EMPLOYEES WITH NAME = 'BLACKMORE'
   AND AGE EQ 20 THRU 40
OBTAIN PERSONNEL_ID NAME AGE
```

Equivalent Natural SQL statement:

```
SELECT PERSONNEL_ID, NAME, AGE
  FROM EMPLOYEES
    WHERE NAME = 'BLACKMORE'
      AND AGE BETWEEN 20 AND 40
```

Natural internally translates a `FIND` statement into an SQL `SELECT` statement as described in ***Processing of SQL Statements Issued by Natural*** in the section ***Internal Handling of Dynamic Statements***. The `SELECT` statement is executed by an `OPEN CURSOR` statement followed by a `FETCH` command. The `FETCH` command is executed repeatedly until either all records have been read or the program flow exits the `FIND` processing loop. A `CLOSE CURSOR` command ends the `SELECT` processing.

The `WITH` clause of a `FIND` statement is converted to the `WHERE` clause of the `SELECT` statement. The basic search criterion for a DB2 table can be specified in the same way as for an Adabas file. This

implies that only database fields which are defined as descriptors can be used to construct basic search criteria and that descriptors cannot be compared with other fields of the Natural view (that is, database fields) but only with program variables or constants.

Note: As each database field (column) of a DB2 table can be used for searching, any database field can be defined as a descriptor in a Natural DDM.

The `WHERE` clause of the `FIND` statement is evaluated by Natural *after* the rows have been selected via the `WITH` clause. Within the `WHERE` clause, non-descriptors can be used and database fields can be compared with other database fields.

Note: DB2 does not have sub-, super-, or phonetic descriptors.

A `FIND NUMBER` statement is translated into a `SELECT` statement containing a `COUNT(*)` clause. The number of rows found is returned in the Natural system variable `*NUMBER` as described in the Natural *System Variables* documentation.

The `FIND UNIQUE` statement can be used to ensure that only one record is selected for processing. If the `FIND UNIQUE` statement is referenced by an `UPDATE` statement, a non-cursor (Searched) `UPDATE` operation is generated instead of a cursor-oriented (Positioned) `UPDATE` operation. Therefore, it can be used if you want to update a DB2 primary key. It is, however, recommended to use the Natural SQL Searched `UPDATE` statement to update a primary key.

In static mode, the `FIND NUMBER` and `FIND UNIQUE` statements are translated into a `SELECT SINGLE` statement as described in the section ***Using Natural SQL Statements***.

The `FIND FIRST` statement cannot be used. The `PASSWORD`, `CIPHER`, `COUPLED` and `RETAIN` clauses cannot be used either.

The `SORTED BY` clause of a `FIND` statement is translated into the SQL `SELECT ... ORDER BY` clause, which follows the search criterion. Because this produces a read-only result table, a row read with a `FIND` statement that contains a `SORTED BY` clause cannot be updated or deleted.

A limit on the depth of nested database loops can be specified at installation time. If this limit is exceeded, a Natural error message is returned.

Notes:

1. If a processing limit is specified as a constant integer number, for example, `FIND (5)`, the limitation value will be translated into a `FETCH FIRST` *`integer`* `ROWS ONLY` clause in the generated SQL string.
2. Natural for DB2 supports DB2 multiple row processing on behalf of the `MULTIFETCH` clause of the `FIND` statement.

FIND when using the File Server

As far as the file server is concerned, there are no programming restrictions with selection statements. It is, however, recommended to make yourself familiar with its functionality considering performance and file server space requirements.

HISTOGRAM

The Natural DML statement `HISTOGRAM` returns the number of rows in a table which have the same value in a specific column. The number of rows is returned in the Natural system variable `*NUMBER` as described in the Natural *System Variables* documentation.

Example:

Natural native DML statements:

```
HISTOGRAM EMPLOYEES FOR AGE
OBTAIN AGE
```

Equivalent Natural SQL statement:

```
SELECT COUNT(*), AGE FROM EMPLOYEES
  WHERE AGE > -999
  GROUP BY AGE
  ORDER BY AGE
```

Natural translates the `HISTOGRAM` statement into an SQL `SELECT` statement, which means that the control flow is similar to the flow explained for the `FIND` statement.

Note: With Universal Database Server for z/OS Version 8, Natural for DB2 supports DB2 multiple row processing on behalf of the `MULTIFETCH` clause of the `HISTOGRAM` statement.

READ

The Natural native DML statement `READ` can also be used to access DB2 tables. Natural translates a `READ` statement into an SQL `SELECT` statement.

`READ PHYSICAL` and `READ LOGICAL` can be used; `READ BY ISN`, however, cannot be used, as there is no DB2 equivalent to Adabas ISNs. The `PASSWORD` and `CIPHER` clauses cannot be used either.

Since a `READ LOGICAL` statement is translated into a `SELECT ... ORDER BY` statement, which produces a read-only table, a row read with a `READ LOGICAL` statement cannot be updated or deleted (see Example 1). The start value can only be a constant or a program variable; any other field of the Natural view (that is, any database field) cannot be used.

A `READ PHYSICAL` statement is translated into a `SELECT` statement without an `ORDER BY` clause and can therefore be updated or deleted (see Example 2).

Example 1:

Natural native DML statements:

```
READ PERSONNEL BY NAME
OBTAIN NAME FIRSTNAME DATEOFBIRTH
```

Equivalent Natural SQL statement:

```
SELECT NAME, FIRSTNAME, DATEOFBIRTH FROM PERSONNEL
  WHERE NAME >= ' '
    ORDER BY NAME
```

Example 2:

The Natural native DML statements:

```
READ PERSONNEL PHYSICAL
OBTAIN NAME
```

Equivalent Natural SQL statement:

```
SELECT NAME FROM PERSONNEL
```

If the `READ` statement contains a `WHERE` clause, this clause is evaluated by the Natural processor *after* the rows have been selected according to the descriptor value(s) specified in the search criterion.

Processing Limit

If a processing limit is specified as a constant integer number, for example, `READ (5)`, in the SQL string generated, the value that defines the limitation will be translated into the clause

```
FETCH FIRST integer ROWS ONLY
```

Cursors for DB2 Clauses

Natural for DB2 uses insensitive scrollable cursors to process the following READ statement:

```
READ .. [IN] [LOGICAL] VARIABLE/DYNAMIC operand5 [SEQUENCE]
```

Natural for DB2 uses insensitive scrollable cursors to process the READ statement below. If relating to a Positioned UPDATE or Positioned DELETE statement, Natural for DB2 uses insensitive static cursors.

```
READ .. [IN] [PHYSICAL] DESCENDING/VARIABLE/DYNAMIC operand5 [SEQUENCE]
```

operand5

Value A will be translated into a FETCH FIRST/NEXT DB2 access, and value D into a FETCH LAST/PRIOR DB2 access.

Note: Natural for DB2 supports DB2 multiple row processing on behalf of the MULTIFETCH clause of the READ statement.

READ when Using the File Server

As far as the file server is concerned there are no programming restrictions with selection statements. It is, however, recommended to make yourself familiar with its functionality considering performance and file server space requirements.

STORE

The Natural native DML statement STORE is used to add a row to a DB2 table. The STORE statement corresponds to the SQL statement INSERT.

Example:

The Natural native DML statement:

```
STORE RECORD IN EMPLOYEES
  WITH PERSONNEL_ID = '2112'
       NAME         = 'LIFESON'
       FIRST_NAME   = 'ALEX'
```

Equivalent Natural SQL statement:

```
INSERT INTO EMPLOYEES (PERSONNEL_ID, NAME, FIRST_NAME)
  VALUES ('2112', 'LIFESON', 'ALEX')
```

The PASSWORD, CIPHER and USING/GIVING NUMBER clauses of the STORE statement cannot be used.

UPDATE

The Natural native DML statement UPDATE updates a row in a DB2 table which has been read with a preceding FIND, READ, or SELECT statement. It corresponds to the SQL statement UPDATE WHERE CURRENT OF *cursor-name* (Positioned UPDATE), which means that only the row which was read last can be updated.

UPDATE when Using the File Server

If a row rolled out to the file server is to be updated, Natural automatically rereads the original row from the database to compare it with its image stored in the file server. If the original row has not been modified in the meantime, the UPDATE operation is performed. With the next terminal I/O, the transaction is terminated and the row is definitely updated on the database.

If the UPDATE operates on a scrollable cursor, the row on the file server and the row in the base table are updated. If the row no longer qualifies for the search criteria of the related SELECT statement after the update, the row is marked as UPDATE hole on the file server.

However, if any modification is detected, the row will not be updated and Natural issues the NAT3703 error message for non-scrollable cursors.

If the UPDATE operates on a scrollable cursor, Natural for DB2 simulates SQLCODE -224 THE RESULT TABLE DOES NOT AGREE WITH THE BASE TABLE USING for DB2 compliance.

If the UPDATE operates on a scrollable cursor and the row has become a hole, Natural for DB2 simulates SQLCODE -222 AN UPDATE OR DELETE OPERATION WAS ATTEMPTED AGAINST A HOLE.

Since an UPDATE statement requires rereading a single row by Natural, a unique index must be available for this table. All columns which comprise the unique index must be part of the corresponding Natural view.

UPDATE with FIND/READ

As explained with the Natural native DML statement FIND, Natural translates a FIND statement into an SQL SELECT statement. When a Natural program contains a DML UPDATE statement, this statement is translated into an SQL UPDATE statement and a FOR UPDATE OF clause is added to the SELECT statement.

Example:

```
FIND EMPLOYEES WITH SALARY < 5000
  ASSIGN SALARY = 6000
  UPDATE
```

Natural would translate the above Natural statements into SQL and assign a cursor name (for example, CURSOR1) as follows:

```
DECLARE CURSOR1 CURSOR FOR
SELECT SALARY FROM EMPLOYEES WHERE SALARY < 5000
  FOR UPDATE OF SALARY
UPDATE EMPLOYEES SET SALARY = 6000
  WHERE CURRENT OF CURSOR1
```

Both the SELECT and the UPDATE statement refer to the same cursor.

Due to DB2 logic, a column (field) can only be updated if it is contained in the FOR UPDATE OF clause; otherwise updating this column (field) is rejected. Natural includes automatically all columns (fields) into the FOR UPDATE OF clause which have been modified anywhere in the Natural program or which are input fields as part of a Natural map.

However, an DB2 column is not updated if the column (field) is marked as “not updateable” in the Natural DDM. Such columns (fields) are removed from the FOR UPDATE OF list without any warning or error message. The columns (fields) contained in the FOR UPDATE OF list can be checked with the LISTSQL command.

The Adabas short name in the Natural DDM determines whether a column (field) can be updated.

The following table shows the ranges that apply:

Short-Name Range	Type of Field
AA - N9	non-key field that can be updated
Aa - Nz	non-key field that can be updated
OA - O9	primary key field
PA - P9	ascending key field that can be updated
QA - Q9	descending key field that can be updated
RA - X9	non-key field that cannot be updated

Short-Name Range	Type of Field
Ra - Xz	non-key field that cannot be updated
YA - Y9	ascending key field that cannot be updated
ZA - Z9	descending key field that cannot be updated
1A - 9Z	non-key field that cannot be updated
1a - 9z	non-key field that cannot be updated

Be aware that a primary key field is never part of a `FOR UPDATE OF` list. A primary key field can only be updated by using a non-cursor `UPDATE` operation (see also Natural SQL `UPDATE` statement in the section *Using Natural SQL Statements*).

A row read with a `FIND` statement that contains a `SORTED BY` clause cannot be updated (due to DB2 limitations as explained with the `FIND` statement). A row read with a `READ LOGICAL` statement cannot be updated either (as explained with the `READ` statement).

If a column is to be updated which is redefined as an array, it is strongly recommended to update the whole column and not individual occurrences; otherwise, results are not predictable. To do so, in reporting mode you can use the `OBTAIN` statement, which must be applied to all field occurrences in the column to be updated. In structured mode, however, all these occurrences must be defined in the corresponding Natural view.

The data locked by an `UPDATE` statement are released when an `END TRANSACTION` (`COMMIT WORK`) or `BACKOUT TRANSACTION` (`ROLLBACK WORK`) statement is executed by the program.

Note: If a length indicator field or `NULL` indicator field is updated in a Natural program without updating the field (column) it refers to, the update of the column is not generated for DB2 and thus no updating takes place.

UPDATE with SELECT

In general, the Natural native DML statement `UPDATE` can be used in both structured and reporting mode. However, after a `SELECT` statement, only the syntax defined for Natural structured mode is allowed:

```
UPDATE [RECORD] [IN] [STATEMENT] [(r)]
```

This is due to the fact that in combination with the `SELECT` statement, the Natural native DML `UPDATE` statement is only allowed in the special case of:

```
...
SELECT ...
   INTO VIEW view-name
   ...
```

Thus, only a whole Natural view can be updated; individual columns (fields) cannot.

Example:

```
DEFINE DATA LOCAL
01 PERS VIEW OF SQL-PERSONNEL
  02 NAME
  02 AGE
END-DEFINE

SELECT *
  INTO VIEW PERS
  FROM SQL-PERSONNEL
  WHERE NAME LIKE 'S%'

    IF NAME = 'SMITH'
      ADD 1 TO AGE
    UPDATE
    END-IF

END-SELECT
    ...
```

In combination with the Natural native DML `UPDATE` statement, any other form of the `SELECT` statement is rejected and an error message is returned.

In all other respects, the Natural native DML `UPDATE` statement can be used with the `SELECT` statement in the same way as with the Natural `FIND` statement.

Using Natural SQL Statements

This section covers points you have to consider when using Natural SQL statements with DB2. These DB2-specific points partly consist in syntax enhancements which belong to the Extended Set of Natural SQL syntax. The Extended Set is provided in addition to the Common Set to support database-specific features; see *Common Set and Extended Set* in the section *SQL Statements* in the Natural *Statements* documentation.

For information on logging SQL statements contained in a Natural program, refer to *DBLOG Trace Screen for SQL Statements* in the *DBLOG Utility* documentation.

Below is information on the following Natural SQL statements and on common syntactical items:

- Syntactical Items Common to Natural SQL Statements
- CALLDBPROC - SQL
- COMMIT - SQL
- DELETE - SQL
- INSERT - SQL
- MERGE - SQL
- PROCESS SQL
- READ RESULT SET - SQL
- ROLLBACK - SQL
- SELECT - SQL
- UPDATE - SQL

Syntactical Items Common to Natural SQL Statements

The following common syntactical items are either DB2-specific and do not conform to the standard SQL syntax definitions (that is, to the Common Set of Natural SQL syntax) or impose restrictions when used with DB2 (see also *SQL Statements* in the Natural *Statements* documentation).

Below is information on the following common syntactical items:

- atom
- comparison
- factor
- scalar-function
- column-function
- scalar-operator
- special-register
- units
- case-expression

atom

An atom can be either a parameter (that is, a Natural program variable or host variable) or a constant. When running dynamically, however, the use of host variables is restricted by DB2. For further details, refer to the relevant DB2 literature by IBM.

comparison

The comparison operators specific to DB2 belong to the Natural Extended Set. For a description, refer to *Comparison Predicate* in *Search Condition*, Natural *SQL Statements* in the Natural *Statements* documentation.

factor

The following factors are specific to DB2 and belong to the Natural SQL Extended Set:

```
special-register
scalar-function(scalar-expression, ...)
scalar-expression unit
case-expression
```

scalar-function

A scalar function is a built-in function that can be used in the construction of scalar computational expressions. Scalar functions are specific to DB2 and belong to the Natural SQL Extended Set.

The scalar functions Natural for DB2 supports are listed below in alphabetical order:

A - H	I - R	S - Z
ABS	IDENTITY_VAL_LOCAL	SCORE
ABSVAL	IFNULL	SECOND
ACOS	INSERT	SIGN
ADD_MONTHS	INTEGER	SIN
ASIN	JULIAN_DAY	SINH
ASCII_CHR	LAST_DAY	SMALLINT
ASCII_STR	LCASE	SOAPHTTPC
ATAN	LEFT	SOAPHTTPV
ATAN2	LENGTH	SOAPHTTPNC
ATANH	LN	SOAPHTTPNV
BIGINT	LOCATE	SOUNDEX
BINARY	LOCATE_IN_STRING	SPACE
BLOB	LOG	SQRT
CCSID_ENCODING	LOG10	STRIP
CEIL	LOWER	SUBSTR
CEILING	LPAD	SUBSTRING
CHAR	LTRIM	TAN
CHARACTER_LENGTH	MAX	TANH
CLOB	MICROSECOND	TIME
COALESCE	MIDNIGHT_SECONDS	TIMESTAMP
COLLATION_KEY	MIN	TIMESTAMPADD
COMPARE_DECFLOAT	MINUTE	TIMESTAMP_FORMAT
CONCAT	MOD	TIMESTAMP_ISO

A - H	I - R	S - Z
CONTAINS	MONTH	TO_CHAR
COS	MONTHS_BETWEEN	TO_DATE
COSH	MQPUBLISH	TOTALORDER
DATE	MQPUBLISHXML	TRANSLATE
DAY	MQREAD	TRUNC
DAYOFMONTH	MQREADCLOB	TRUNC_TIMESTAMP
DAYOFWEEK	MQREADXML	TRUNCATE
DAYOFWEEK_ISO	MQRECEIVE	UCASE
DAYOFYEAR	MQRECEIVECLOB	UNICODE
DAYS	MQRECEIVEXML	UNICODE_STR
DBCLOB	MQSEND	UNISTR
DEC	MQSENDXML	UPPER
DECFLOAT	MQSENDXMLFILE	VALUE
DECFLOAT_SORTKEY	MQSENDXMLFILECLOB	VARBINARY
DECIMAL	MQSUBSCRIBE	VARCHAR
DECRYPT_BIT	MQUNSUBSCRIBE	VARCHAR_FORMAT
DECRYPT_CHAR	MULTIPLY_ALT	VARGRAPHIC
DECRYPT_DB	NEXT_DAY	WEEK
DEGREES	NORMALIZE_DECFLOAT	WEEK_ISO
DIFFERENCE	NORMALIZE_STRING	XMLATTRIBUTES
DIGITS	NULLIF	XMLCONCAT
DOUBLE	OVERLAY	XMLCOMMENT
DOUBLE_PRECISION	POSSTR	XMLDOCUMENT
DSN_XMLVALIDATE	POWER	XMLELEMENT
EBCDIC_CHR	QUANTIZE	XMLFOREST
EBCDIC_STR	QUARTER	XMLNAMESPACES
ENCRYPT_TDES	RADIANS	XMLPARSE
ENCRYPT	RAISE_ERROR	XMLPI
EXP	RAND	XMLQUERY
EXTRACT	REAL	XMLSERIALIZE
FLOAT	REPEAT	XMLTEXT
FLOOR	REPLACE	YEAR
GRAPHIC	RID	
GENERATE_UNIQUE	RIGHT	
GETHINT	ROUND	
GETVARIABLE	ROUND_TIMESTAMP	
HEX	ROWID	
HOUR	RPAD	
	RTRIM	

Each scalar function is followed by one or more scalar expressions in parentheses. The number of scalar expressions depends upon the scalar function. Multiple scalar expressions must be separated from one another by commas.

Example:

```
SELECT NAME
  INTO NAME
  FROM SQL-PERSONNEL
  WHERE SUBSTR ( NAME, 1, 3 ) = 'Fri'
       ...
```

column-function

A column function returns a single-value result for the argument it receives. The argument is a set of like values, such as the values of a column. Column functions are also called aggregating functions.

The following column functions conform to standard SQL. They are not specific to DB2:

```
AVG
COUNT
MAX
MIN
SUM
```

The following column functions do not conform to standard SQL. They are specific to DB2 and belong to the Natural SQL Extended Set.

```
COUNT_BIG
CORRELATION
COVARIANCE
COVARIANCE_SAMP
STDDEV
STDDEV_POP
STDDEV_SAMP
VAR
VAR_POP
VAR_SAMP
VARIANCE
VARIANCE_SAMP
XMLAGG
```

scalar-operator

The concatenation operator (`CONCAT` or `||`) does not conform to standard SQL. It is specific to DB2 and belongs to the Natural Extended Set.

special-register

The following special registers do not conform to standard SQL. They are specific to DB2 and belong to the Natural SQL Extended Set:

```
CURRENT APPLICATION ENCODING SCHEME
CURRENT CLIENT_ACCNTG
CURRENT CLIENT_APPLNAME
CURRENT CLIENT_USERID
CURRENT CLIENT_WRKSTNNAME
CURRENT DATE
CURRENT_DATE
CURRENT DEBUG MODE
CURRENT DECFLOAT ROUNDING MODE
CURRENT DEGREE
CURRENT FUNCTION PATH
CURRENT_LC_CTYPE
CURRENT LC_CTYPE
CURRENT LOCALE LC_CTYPE
CURRENT OPTIMIZATION HINT
CURRENT PACKAGESET
CURRENT_PATH
CURRENT PRECISION
CURRENT MAINTAINED TABLE TYPES FOR OPTIMIZATION
CURRENT_MEMBER
CURRENT PACKAGE PATH
CURRENT REFRESH AGE
CURRENT ROUTINE VERSION
CURRENT SCHEMA
CURRENT RULES
CURRENT SQLID
CURRENT SERVER
CURRENT TIME
CURRENT_TIME
CURRENT TIMESTAMP
CURRENT TIMEZONE
CURRENT_TIMEZONE USER
```

A reference to a special register returns a scalar value.

Using the command `SET CURRENT SQLID`, the creator name of a table can be substituted by the current SQLID. This enables you to access identical tables with the same table name but with different creator names.

units

Units, also called "durations", are specific to DB2 and belong to the Natural SQL Extended Set.

The following units are supported:

```
DAY
DAYS
HOUR
HOURS
MICROSECOND
MICROSECONDS
MINUTE
MINUTES
MONTH
MONTHS
SECOND
SECONDS
YEAR
YEARS
```

case-expression

```
CASE { searched-when-clause } [ ELSE { NULL              } ] END
     { ...                   }       { scalar expression }
     { simple-when-clause    }
```

Case-expressions do not conform to standard SQL and are therefore supported by the Natural SQL Extended Set only.

Example:

```
DEFINE DATA LOCAL
   01 #EMP
   02 #EMPNO (A10)
   02 #FIRSTNME (A15)
   02 #MIDINIT  (A5)
   02 #LASTNAME (A15)
   02 #EDLEVEL   (A13)
   02 #INCOME (P7)
   END-DEFINE
  SELECT EMPNO, FIRSTNME, MIDINIT, LASTNAME,
         (CASE WHEN EDLEVEL < 15 THEN 'SECONDARY'
```

```
              WHEN EDLEVEL < 19 THEN 'COLLEGE'
              ELSE             'POST GRADUATE'
         END ) AS EDUCATION, SALARY + COMM AS INCOME
        INTO
        #EMPNO, #FIRSTNME, #MIDINIT, #LASTNAME,
        #EDLEVEL, #INCOME
          FROM DSN8510-EMP
          WHERE (CASE WHEN SALARY = 0 THEN NULL
                                      ELSE SALARY / COMM
                                      END ) > 0.25
DISPLAY #EMP
END-SELECT
END
```

CALLDBPROC - SQL

The Natural SQL statement `CALLDBPROC` is used to call DB2 stored procedures. It supports the result set mechanism of DB2 and it enables you to call DB2 stored procedures. For further details and statement syntax, see `CALLDBPROC` in the Natural *Statements* documentation.

The following topics are covered below:

- Static and Dynamic Execution
- Result Sets
- List of Parameter Data Types
- CALLMODE=NATURAL
- Example of CALLDBPROC/READ RESULT SET

Static and Dynamic Execution

If the `CALLDBPROC` statement is executed dynamically, all parameters and constants are mapped to the variables of the following DB2 SQL statement:

```
CALL :hv USING  DESCRIPTOR :sqlda statement
```

`:hv` denotes a host variable containing the name of the procedure to be called and *`:sqlda`* is a dynamically generated sqlda describing the parameters to be passed to the stored procedure.

If the `CALLDBPROC` statement is executed statically, the constants of the `CALLDBPROC` statement are also generated as constants in the generated assembler SQL source for the DB2 precompiler.

Result Sets

If the SQLCODE created by the `CALL` statement indicates that there are result sets (SQLCODE `+466` and `+464`), Natural for DB2 runtime executes a `DESCRIBE PROCEDURE :hv INTO :sqlda` statement in order to retrieve the result set locator values of the result sets created by the invoked stored procedure. These values are put into the `RESULT SETS` variables specified in the `CALLDBPROC` statement. Each `RESULT SETS` variable specified in a `CALLDBPROC` for which no result set locator value is present is reset to zero. The result set locator values can be used to read the result sets by means of the `READ RESULT SET` statement as long as the database transaction which created the result set has not yet issued a `COMMIT` or `ROLLBACK`.

If the result set was created by a cursor `WITH HOLD`, the result set locator value remains valid after a `COMMIT` operation.

Unlike other Natural SQL statements, `CALLDBPROC` enables you (optionally!) to specify an `SQLCODE` variable following the `GIVING` keyword which will contain the `SQLCODE` of the underlying `CALL` statement. If `GIVING` is specified, it is up to the Natural program to react on the `SQLCODE` (error message NAT3700 is not issued by the runtime).

List of Parameter Data Types

Below are the parameter data types supported by the `CALLDBPROC` statement:

Natural Format/Length	DB2 Data Type
A*n*	`CHAR(n)`
B2	`SMALLINT`
B4	`INT`
B*n* (*n* = not equal 2 or 4)	`CHAR(n)`
F4	`REAL`
F8	`DOUBLE PRECISION`
I2	`SMALLINT`
I4	`INT`
N*nn.m*	`NUMERIC(nn+m,m)`
P*nn.m*	`NUMERIC(nn+m,n)`
G*n*	`GRAPHIC(n)`
A*n*/1:m	`VARCHAR(n*m)`
D	`DATE`
T	`TIME` **Note:** The Natural format T has a wider data range than the equivalent DB2 `TIME` data type. Compared with DB2 `TIME`, in addition, the Natural T variable has a date

Natural Format/Length	DB2 Data Type
	fraction (year, month, day) and the tenths of a second. As a result, when converting a Natural T variable into a DB2 TIME value, Natural for DB2 cuts off the date fraction and the tenths of a second part. When converting DB2 TIME into Natural T format, the date fraction is reset to 0000-01-02 and the tenths of a second part is reset to 0 in Natural.

CALLMODE=NATURAL

This parameter is used to invoke Natural stored procedures defined with PARAMETER STYLE GENERAL/WITH NULL.

If the CALLMODE=NATURAL parameter is specified, an additional parameter describing the parameters passed to the Natural stored procedure is passed from the client, that is, caller, to the server, that is, the Natural for DB2 server stub. The parameter is the Stored Procedure Control Block (STCB; see also ***STCB Layout*** in ***PARAMETER STYLE*** in the section ***Processing Natural Stored Procedures and UDFs***) and has the format VARCHAR from the viewpoint of DB2. Therefore, every Natural stored procedure defined with PARAMETER STYLE GENERAL/WITH NULL has to be defined with the CREATE PROCEDURE statement by using this VARCHAR parameter as the first in its PARMLIST row.

From the viewpoint of the caller, that is, the Natural program, and from the viewpoint of the stored procedure, that is, Natural subprogram, the STCB is invisible. It is passed as first parameter by the Natural for DB2 runtime and it is used as on the server side to build the copy of the passed data in the Natural thread and the corresponding CALLNAT statement. Additionally, this parameter serves as a container for error information created during execution of the Natural stored procedure by the Natural runtime. It also contains information on the library where you are logged on and the Natural subprogram to be invoked.

Example of CALLDBPROC/READ RESULT SET

Below is a sample program for issuing CALLDBPROC and READ RESULT SET statements:

```
DEFINE DATA LOCAL
  1 ALPHA       (A8)
  1 NUMERIC     (N7.3)
  1 PACKED      (P9.4)
  1 VCHAR       (A20/1:5) INIT     <'DB25SGCP'>
  1 INTEGER2    (I2)
  1 INTEGER4    (I4)
  1 BINARY2     (B2)
  1 BINARY4     (B4)
  1 BINARY12    (B12)
  1 FLOAT4      (F4)
  1 FLOAT8      (F8)
  1 INDEX-ARRAY (I2/1:11)
  1 INDEX-ARRAY1(I2)
  1 INDEX-ARRAY2(I2)
```

```
1 INDEX-ARRAY3(I2)
1 INDEX-ARRAY4(I2)
1 INDEX-ARRAY5(I2)
1 INDEX-ARRAY6(I2)
1 INDEX-ARRAY7(I2)
1 INDEX-ARRAY8(I2)
1 INDEX-ARRAY9(I2)
1 INDEX-ARRAY10(I2)
1 INDEX-ARRAY11(I2)
1 #RESP        (I4)
1 #RS1         (I4) INIT <99>
1 #RS2         (I4) INIT <99>
LOCAL
1 V1 VIEW OF SYSIBM-SYSTABLES
2 NAME
1 V2 VIEW OF SYSIBM-SYSPROCEDURES
2 PROCEDURE
2 RESULT_SETS
1 V (I2) INIT <99>
END-DEFINE
CALLDBPROC 'DAEFDB25.SYSPROC.SNGSTPC'  DSN8510-EMP
 ALPHA  INDICATOR :INDEX-ARRAY1
 NUMERIC INDICATOR :INDEX-ARRAY2
 PACKED  INDICATOR :INDEX-ARRAY3
 VCHAR(*) INDICATOR :INDEX-ARRAY4
 INTEGER2 INDICATOR :INDEX-ARRAY5
 INTEGER4 INDICATOR :INDEX-ARRAY6
 BINARY2  INDICATOR :INDEX-ARRAY7
 BINARY4  INDICATOR :INDEX-ARRAY8
 BINARY12 INDICATOR :INDEX-ARRAY9
 FLOAT4   INDICATOR :INDEX-ARRAY10
 FLOAT8   INDICATOR :INDEX-ARRAY11
  RESULT SETS #RS1 #RS2
 CALLMODE=NATURAL
READ (10) RESULT SET #RS2 INTO VIEW V2 FROM SYSIBM-SYSTABLES
WRITE 'PROC F RS  :' PROCEDURE 5OT RESULT_SETS
END-RESULT
END
```

COMMIT - SQL

The Natural SQL `COMMIT` statement indicates the end of a logical transaction and releases all DB2 data locked during the transaction. All data modifications are made permanent.

`COMMIT` is a synonym for the Natural native DML statement `END TRANSACTION` as described in the section ***Using Natural Native DML Statements***.

No transaction data can be provided with the `COMMIT` statement.

If this command is executed from a Natural stored procedure or user-defined function (UDF), Natural for DB2 does not execute the underlying commit operation. This allows the Natural stored procedure or UDF to commit updates against non DB2 databases.

Under CICS, the `COMMIT` statement is translated into an `EXEC CICS SYNCPOINT` command. If the file server is used, an implicit end-of-transaction is issued after each terminal I/O. This is due to CICS-specific transaction processing in pseudo-conversational mode, see ***Natural for DB2 under CICS***.

Under IMS TM, the `COMMIT` statement is not translated into an IMS `CHECKPOINT` command, but is ignored. An implicit end-of-transaction is issued after each terminal I/O. This is due to IMS TM-specific transaction processing, see ***Natural for DB2 under IMS TM***.

Unless when used in combination with the `WITH HOLD` clause (see *SELECT - Cursor-Oriented* in the Natural *Statements* documentation), a `COMMIT` statement must not be placed within a database loop, since all cursors are closed when a logical unit of work ends. Instead, it has to be placed outside such a loop or after the outermost loop of nested loops.

If an external program written in another standard programming language is called from a Natural program, this external program must not contain its own `COMMIT` command if the Natural program issues database calls, too. The calling Natural program must issue the `COMMIT` statement on behalf of the external program.

For further details and statement syntax, see `COMMIT - SQL` in the Natural *Statements* documentation.

DELETE - SQL

Both the cursor-oriented or Positioned `DELETE`, and the non-cursor or Searched `DELETE` statements are supported as part of Natural SQL; the functionality of the Positioned `DELETE` statement corresponds to that of the Natural DML `DELETE` statement. For further details and statement syntax, see `DELETE` in the Natural *Statements* documentation.

With DB2, a table name in the `FROM` clause of a Searched `DELETE` statement can be assigned a *`correlation-name`*. This does not correspond to the standard SQL syntax definition and therefore belongs to the Natural SQL Extended Set.

The Searched `DELETE` statement must be used, for example, to delete a row from a self-referencing table, since with self-referencing tables a Positioned `DELETE` is not allowed by DB2.

For further details and statement syntax, see *DELETE - SQL* in the Natural *Statements* documentation.

INSERT - SQL

The Natural SQL `INSERT` statement is used to add one or more new rows to a table.

Since the `INSERT` statement can contain a select expression, all the DB2-specific **common syntactical items** described above apply.

For further details and statement syntax, see *INSERT - SQL* in the Natural *Statements* documentation.

MERGE - SQL

The `MERGE` statement is a hybrid SQL statement consisting of an `UPDATE` component and an `INSERT` component. It allows you either to insert a row into a DB2 table or to update a row of a DB2 table if the input data matches an already existing row of a table.

The `MERGE` statement belongs to the SQL Extended Set.

For further details and statement syntax, see *MERGE - SQL* in the Natural *Statements* documentation.

PROCESS SQL

The Natural `PROCESS SQL` statement is used to issue SQL statements to the underlying database. The statements are specified in a *`statement-string`*, which can also include constants and parameters. The set of statements which can be issued is also referred to as Flexible SQL and comprises those statements which can be issued with the SQL statement `EXECUTE`.

In addition, Flexible SQL includes the following DB2-specific statements:

```
CALL
CONNECT
GET DIAGNOSTICS
SET APPLICATION ENCODING SCHEME
SET CONNECTION
SET CURRENT DEGREE
SET CURRENT LC_CTYPE
SET CURRENT OPTIMIZATION HINT
SET CURRENT MAINTAINED TABLE TYPES FOR OPTIMIZATION
SET CURRENT PACKAGE PATH
SET CURRENT PACKAGESET
SET CURRENT PATH
SET CURRENT PRECISION
SET CURRENT REFRESH AGE
SET CURRENT RULES
SET CURRENT SCHEMA
SET CURRENT SQLID
SET ENCRYPTION PASSWORD
```

```
SET host-variable=special-register
RELEASE
```

Notes:

1. SQL statements issued by `PROCESS SQL` are skipped during static generation. Thus they are always executed dynamically via `NDBIOMO`.
2. To avoid transaction synchronization problems between the Natural environment and DB2, the `COMMIT` and `ROLLBACK` statements must not be used within `PROCESS SQL`.

For further details and statement syntax, see `PROCESS SQL` in the Natural *Statements* documentation.

READ RESULT SET - SQL

The Natural SQL `READ RESULT SET` statement reads a result set created by a Natural stored procedure that was invoked by a `CALLDBPROC` statement. For details on how to specify the scroll direction by using the variable *`scroll-hv`*, see the `SELECT` statement.

For further details and statement syntax, see `READ RESULT SET` in the Natural *Statements* documentation.

ROLLBACK - SQL

The Natural SQL `ROLLBACK` statement undoes all database modifications made since the beginning of the last logical transaction. Logical transactions can start either after the beginning of a session or after the last `COMMIT/END TRANSACTION` or `ROLLBACK/BACKOUT TRANSACTION` statement. All records held during the transaction are released.

For further details and statement syntax, see `ROLLBACK -SQL` in the Natural *Statements* documentation.

`ROLLBACK` is a synonym for the Natural statement `BACKOUT TRANSACTION` as described in the section ***Using Natural Native DML Statements***.

If this command is executed from a Natural stored procedure or user-defined function (UDF), Natural for DB2 executes the underlying rollback operation. This sets the caller into a must-rollback state. If this command is executed by Natural error processing (implicit `ROLLBACK`), Natural for DB2 does not execute the underlying rollback operation, thus allowing the caller to receive the original Natural error.

Under CICS, the `ROLLBACK` statement is translated into an `EXEC CICS ROLLBACK` command. However, if the file server is used, only changes made to the database since the last terminal I/O are undone. This is due to CICS-specific transaction processing in pseudo-conversational mode, see ***Natural for DB2 under CICS***.

Under IMS TM, the ROLLBACK statement is translated into an IMS Rollback (ROLB) command. However, only changes made to the database since the last terminal I/O are undone. This is due to IMS TM-specific transaction processing, see ***Natural for DB2 under IMS TM***.

As all cursors are closed when a logical unit of work ends, a ROLLBACK statement must not be placed within a database loop; instead, it has to be placed outside such a loop or after the outermost loop of nested loops.

If an external program written in another standard programming language is called from a Natural program, this external program must not contain its own ROLLBACK command if the Natural program issues database calls, too. The calling Natural program must issue the ROLLBACK statement on behalf of the external program.

SELECT - SQL

The Natural SQL SELECT statement supports both the cursor-oriented selection, which is used to retrieve an arbitrary number of rows and the non-cursor selection (Singleton SELECT), which retrieves at most one single row.

For full details and statement syntax, see SELECT -SQL in the Natural *Statements* documentation.

SELECT - Cursor-Oriented

Like the Natural native DML FIND statement, the cursor-oriented SELECT statement is used to select a set of rows (records) from one or more DB2 tables, based on a search criterion. Since a database loop is initiated, the loop must be closed by a LOOP statement (in reporting mode) or by an END-SELECT statement (in structured mode). With this construction, Natural uses the same loop processing as with the FIND statement. In addition, no cursor management is required from the application program; it is automatically handled by Natural.

For further details and syntax, see *SELECT - SQL*, *Syntax 1 - Cursor-Oriented Selection* in the Natural *Statements* documentation.

SELECT SINGLE - Non-Cursor-Oriented

The Natural SQL statement SELECT SINGLE provides the functionality of a non-cursor selection (Singleton SELECT); that is, a select expression that retrieves at most one row without using a cursor.

Since DB2 supports the Singleton SELECT command in static SQL only, in dynamic mode, the Natural SELECT SINGLE statement is executed in the same way as a set-level SELECT statement, which results in a cursor operation. However, Natural checks the number of rows returned by DB2. If more than one row is selected, a corresponding error message is returned.

For further details and syntax, see *SELECT - SQL*, *Syntax 2 - Non-Cursor Selection* in the Natural *Statements* documentation.

UPDATE - SQL

Both the cursor-oriented or Positioned `UPDATE` and the non-cursor or Searched `UPDATE` statements are supported as part of Natural SQL. Both of them reference either a table or a Natural view.

With DB2, the name of a table or Natural view to be referenced by a Searched `UPDATE` can be assigned a *`correlation-name`*. This does not correspond to the standard SQL syntax definition and therefore belongs to the Natural Extended Set.

The Searched `UPDATE` statement must be used, for example, to update a primary key field, since DB2 does not allow updating of columns of a primary key by using a Positioned `UPDATE` statement.

Note: If you use the `SET *` notation, all fields of the referenced Natural view are added to the `FOR UPDATE OF` and `SET` lists. Therefore, ensure that your view contains only fields which can be updated; otherwise, a negative `SQLCODE` is returned by DB2.

For further details and syntax, see *UPDATE - SQL* in the Natural *Statements* documentation.

Using Natural System Variables

When used with DB2, there are restrictions and/or special considerations concerning the following Natural system variables:

- `*ISN`
- `*NUMBER`
- `*ROWCOUNT`

For information on restrictions and/or special considerations, refer to the section *Database-Specific Information* in the corresponding system variable documentation.

Multiple Row Processing

This section describes the multiple row functionality for DB2 databases.

You have to operate against DB2 for z/OS Version 8 or higher to use these features.

Natural for DB2 provides two kinds of multiple row processing features:

- **Standard multiple row processing**
- This feature does not influence the program logic. Although the Natural native DML and Natural SQL DML provide clauses for specification of the multi-fetch-factor, the Natural program

operates with one database row and from the program point of view only one row is received from or is send to the database.

- **Advanced multiple row processing**

  This feature is only available with Natural SQL DML and has a lot of impact on the program logic, as it allows the retrieval of multiple rows from the database into the program storage by a single Natural SQL `SELECT` statement into a set of arrays. Additionally it is possible to insert multiple rows into the database from a set of arrays by the Natural SQL `INSERT` statement.

Below is information on the following topics:

Purpose of Multi-Fetch Feature (Standard)

In standard mode, Natural does not read multiple records with a single database call; it always operates in a one-record-per-fetch mode. This kind of operation is solid and stable, but can take some time if a large number of database records are being processed.

To improve the performance of those programs, you can use the Multi-Fetch Clause in the Natural DML `FIND`, `READ` or `HISTOGRAM` statements. This allows you to specify the number of records read per database access.

```
{ FIND      } [ MULTI-FETCH { ON                    } ]
{ READ      }               { OFF                   }
{ HISTOGRAM }               { OF multi-fetch-factor }
```

Where the *`multi-fetch-factor`* is either a constant or a variable with a format integer (I4).

To improve the performance of the Natural SQL `SELECT` statements, you can use the `WITH ROWSET POSITIONING FOR` Clause to specify a multi-fetch-factor.

```
[ WITH ROWSET POSITIONING FOR { [:] row_hv } ROWS ]
                              { integer   }
```

At statement execution time, the runtime checks if a *`multi-fetch-factor`* greater than 1 is supplied for the database statement.

If the *multi-fetch-factor* is

less than or equal to 1	the database call is continued in the usual one-record-per-access mode.
greater than 1	the database call is prepared dynamically to read multiple records (e.g. 10) with a single database access into an auxiliary buffer (multi-fetch buffer). If successful, the first record is transferred into the underlying data view. Upon the execution of the next loop, the data view is filled directly from the multi-fetch buffer, without database access. After all records are fetched from the multi-fetch buffer, the next loop results in the next record set being read from the database. If the database loop is terminated (either by end-of-records, `ESCAPE`, `STOP`, etc.), the content of the multi-fetch buffer is released.

Considerations for Multi-Fetch Usage (Standard)

- The program does not receive "fresh" records from the database for every loop, but operates with images retrieved at the most recent multi-fetch access.
- If a dynamic direction change (`IN DYNAMIC...SEQUENCE`) is coded for a Natural DML `READ` or `HISTOGRAM` statement, the multi-fetch feature is not possible and leads to a corresponding syntax error at compilation.
- The size occupied by a database loop in the multi-fetch buffer is determined according to the rule:

```
header + sqldaheader + columns*(sqlvar+lise) + mf*(udind + sum(collen) + sum(LF(columns) +
sum(nullind))
=
32 + 16 + columns*(44+12) + mf*(1 + sum(collen) + sum(LF(column)) + sum(2))
```

where

- header denotes the length of the header of a entry in the DB2 multifetch buffer, that is, 32
- sqldaheader denotes the length of the header of a sqlda, that is, 16
- columns denotes the number of receiving fields of a SQL request
- sqlvar denotes the length of a sqlvar, that is, `44`
- lise denotes the length of a Natrual for DB2 specific sqlvar extension
- mf denotes the multifetch factor, that is, the number of rows fetched by one database call
- collen denotes the length of the receiving field
- LF(column) denotes the size of the length field of the receiving field, that is, 0 for fixed length fields, 2 for variable length fields, and 4 for large object columns (LOBs)
- nullind denotes the length of a null indicator, that is, 2

Size of the Multi-Fetch Buffer (Standard)

The multifetch buffer is released at terminal i/o in pseudo conversional mode. Therefore there is no size limitation for the DB2 multifetch buffer (`DB2SIZE6`). The buffer will be automatical enlarged if necessary.

Support of TEST DBLOG Q (Standard)

When multi-fetch is used, real database calls are only submitted to get a new set of records.

The `TEST DBLOG Q` facility is also called from the Natural for DB2 multi fetch handler for every rowset fetch from DB2 and for every record moved from the multi fetch buffer to the program storage. The events are distinguished by the literal `MULTI FETCH ...` and `<BUFF FETCH ...`

Example: TEST DBLOG List Break-Out

```
10:51:57              ***** NATURAL Test Utilities *****            2006-01-27
User HGK                        - DBLOG Trace -                Library NDB42
M No   R SQL Statement (truncated)     CU SN SREF M Typ SQLC/W Program  Line LV
_    1   SELECT EMPNO,FIRSTNME,LASTNAM 01 01 0260 D DB2        MF000001 0260 01
_    2     MULTI FETCH  NEX            01 01 0260 D DB2        MF000001 0260 01
_    3     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_    4     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_    5     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_    6     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_    7     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_    8     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_    9     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_   10     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_   11     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_   12     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_   13     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_   14     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_   15     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_   16     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
_   17     <BUFF FETCH  NEX            00 00 0260 D DB2        MF000001 0260 01
Command ===>
```

where column **No** represents the following:

1	is a open cursor DB2 call.
2	is a "real" database call that reads a set of records via multi-fetch (see `MULTI FETCH NEX` in column **SQL Statement**).
3-17	are "no real" database calls, but only entries that document that the program has received these records from the multi-fetch buffer (see `<BUFF FETCH NEX` in column **SQL Statement**).

Multiple Rows to Program (Advanced)

The feature allows programs to retrieve multiple rows from DB2 into arrays.

This feature is only available with the `SELECT` statement.

Prerequisites

To use this feature

1. Set the compiler option `DB2ARRY=ON` (by using an `OPTIONS` statement or the `COMPOPT` command or the `CMPO` profile parameter).
2. Specify a list of receiving arrays in the `INTO` Clause of the `SELECT`statement.
3. Specify the number of rows to be retrieved from the database by a single `FETCH` operation via the `WITH ROWSET POSITIONING` Clause.
4. Specify a variable receiving the number of rows retrieved from the database via the `ROWS_RETURNED` Clause.

DB2ARRY=ON

DB2ARRY=ON is necessary to allow the specification of arrays in the INTO Clause. DB2ARRY=ON also prevents the usage of arrays as sending or receiving fields for DB2 CHAR/VARCHAR /GRAPHIC/VARGRAPHIC columns. Instead Natural scalar fields with the appropriate length have to be used.

INTO Clause

Each array specified in the INTO Clause has to be contiguous (one occurrence following immediately by another, this is expected by DB2) and has to be one-dimensional. The arrays are filled from the first occurrence (low) to last occurrence (high). The first array occurrences compose the first row of the received rowset, the second array occurrences compose the second row of the received rowset. The array occurrences of the nth index compose the nth row returned from DB2. If an LINDICATOR or INDICATOR Clause is used in the INTO Clause for arrays, the specified length indicators or null indicators have also to be arrays. The number of occurrences of LINDICATOR and INDICATOR arrays have to equal or greater than the number of occurrences of the master array.

WITH ROWSET POSITIONING Clause

The WITH_ROWSET_POSITIONING Clause is used to specify the number of rows to be retrieved from the database by one processing cycle. The specified number has to be equal or smaller than the minimum of occurrences of all specified arrays. If a variable, not a constant, is specified the actual content of the variable will be used during each processing cycle. The specified number has to be greater 0 and smaller than 32768.

ROWS_RETURNED Clause

The ROWS_RETURNED Clause is used to specify a variable, which will contain the number of rows read from the database during the actual fetch operation. The format of the variable has to be I4.

Restrictions and Constraints

Natural Views: It is not possible to use Natural arrays of views in the INTO clause, that is, the use of keyword VIEW is not possible.

File Server Usage and Positioned UPDATE and DELETE

The purpose of this feature is to reduce the number of database and database interface calls for bulk batch processing. Therefore it is not recommended to use this kind of programming in online CICS or IMS environments, when terminal I/Os occur within open cursor loops; that is, the file server is used. A fortiori it is not possible to perform a Positioned `UPDATE` or Positioned `DELETE` statement after terminal I/O.

Example:

```
DEFINE DATA LOCAL
01 NAME            (A20/1:10)
01 ADDRESS         (A100/1:10)
01 DATEOFBIRTH     (A10/1:10)
01 SALARY          (P4.2/1:10)
01 L$ADDRESS       (I2/1:10)
01 ROWS            (I4)
01 NUMBER          (I4)
01 INDEX           (I4)
END-DEFINE
OPTIONS DB2ARRY=ON
ASSIGN NUMBER := 10
SEL.
SELECT NAME, ADDRESS , DATEOFBIRTH, SALARY
       INTO  :NAME(*),                            /* <-- ARRAY
             :ADDRESS(*) LINDICATOR :L$ADDRESS(*), /* <-- ARRAY
             :DATEOFBIRTH(1:10),                  /* <-- ARRAY
             :SALARY(01:10)                       /* <-- ARRAY
      FROM NAT-DEMO
      WHERE NAME > ' '
      WITH ROWSET POSITIONING FOR :NUMBER ROWS     /* <-- ROWS REQ
      ROWS_RETURNED :ROWS                          /* <-- ROWS RET
  IF ROWS > 0
    FOR INDEX = 1 TO  ROWS STEP 1
      DISPLAY
              INDEX (EM=99) *COUNTER (SEL.) (EM=99) ROWS (EM=99)
              NAME(INDEX)
              ADDRESS(INDEX) (AL=20)
              DATEOFBIRTH(INDEX)
              SALARY(INDEX)
    END-FOR
  END-IF
END-SELECT
END
```

Multiple Rows from Program (Advanced)

The feature allows programs to insert multiple rows into a DB2 table from arrays.

This feature is only available with the Natural SQL `INSERT` statement.

Prerequisites

To use this feature

1. Set the compiler option `DB2ARRY=ON` (by using an `OPTIONS` statement or the `COMPOPT` command or the `CMPO` profile parameter).
2. Specify a list of sending arrays in the `VALUES` Clause of the Natural SQL `INSERT` statement.
3. Specify the number of rows to be inserted into the database by a single Natural SQL `INSERT` statement via the `FOR n ROWS` Clause.

DB2ARRY=ON

`DB2ARRY=ON` is necessary to allow the specification of arrays in the `VALUES` Clause. `DB2ARRY=ON` also prevents the usage of arrays as sending or receiving fields for DB2 `CHAR`/`VARCHAR` /`GRAPHIC`/`VARGRAPHIC` columns. Instead Natural scalar fields with the appropriate length have to be used.

VALUES Clause

Each array specified in the `VALUES` Clause has to be contiguous (one occurrence following immediately by another, this is expected by DB2) and has to be one-dimensional. The arrays are read from the first occurrence (low) to last occurrence (high). The first array occurrences compose the first row inserted into the database, the second array occurrences compose the second row inserted into the database. The array occurrences of the nth index compose the nth row inserted into the database. If a `LINDICATOR` or `INDICATOR` Clauses are used in the `VALUES` Clause for arrays, the specified length indicators or null indicators have also to be arrays. The number of `LINDICATOR` and `INDICATOR` array occurrences has to be equal or greater than the number of occurrences of the master array.

FOR n ROWS Clause

The `FOR n ROWS` Clause is used to specify how many rows are to be inserted into the database table by one `INSERT` statement. The specified number has to be equal or smaller than the minimum of occurrences of all specified arrays in the `VALUES` Clause. The specified number has to be greater than `0` and smaller than `32768`.

Restrictions and Constraints

- **Natural Views**

  It is not possible to use Natural arrays of views in the `VALUES` clause, that is, the use of keyword `VIEW` is not possible.

- **Static Execution**

  Due to DB2 restrictions it is not possible to execute multiple row inserts in static mode. Therefore multiple row inserts are not generated static and are always dynamically prepared and executed by Natural for DB2.

  It is not possible to use Natural arrays of views in the `INTO` clause, that is, the use of keyword `VIEW` is not possible.

  Example:

```
DEFINE DATA LOCAL
01 NAME        (A20/1:10)  INIT <'ZILLER1','ZILLER2','ZILLER3','ZILLER4'
                                ,'ZILLER5','ZILLER6','ZILLER7','ZILLER8'
                                ,'ZILLER9','ZILLERA'>
01 ADDRESS     (A100/1:10) INIT <'ANGEL STREET 1','ANGEL STREET 2'
                                ,'ANGEL STREET 3','ANGEL STREET 4'
                                ,'ANGEL STREET 5','ANGEL STREET 6'
                                ,'ANGEL STREET 7','ANGEL STREET 8'
                                ,'ANGEL STREET 9','ANGEL STREET 10'>
01 DATENATD (D/1:10)  INIT <D'1954-03-27',D'1954-03-27',D'1954-03-27'
                           ,D'1954-03-27',D'1954-03-27',D'1954-03-27'
                           ,D'1954-03-27',D'1954-03-27',D'1954-03-27'
                           ,D'1954-03-27'>
01 SALARY      (P4.2/1:10) INIT <1000,2000,3000,4000,5000
                                ,6000,7000,8000,9000,9999>
01 SALARY_N    (N4.2/1:10) INIT <1000,2000,3000,4000,5000
                                ,6000,7000,8000,9000,9999>
01 L§ADDRESS   (I2/1:10) INIT <14,14,14,14,14,14,14,14,14,15>
01 N§ADDRESS   (I2/1:10) INIT <00,00,00,00,00,00,00,00,00,00>
01 ROWS        (I4)
01 INDEX       (I4)
01 V1 VIEW OF NAT-DEMO_ID
02 NAME
02 ADDRESS     (EM=X(20))
02 DATEOFBIRTH
```

```
02 SALARY
01 ROWCOUNT  (I4)
END-DEFINE
OPTIONS DB2ARRY=ON                  /* <-- ENABLE DB2 ARRAY
ROWCOUNT := 10
INSERT INTO NAT-DEMO_ID
       (NAME,ADDRESS,DATEOFBIRTH,SALARY)
       VALUES
       (:NAME(*),                   /* <-- ARRAY
        :ADDRESS(*)                 /* <-- ARRAY
        INDICATOR :N§ADDRESS(*)     /* <-- ARRAY
        LINDICATOR :L§ADDRESS(*),   /* <-- ARRAY DB2 VCHAR
        :DATENATD(1:10),            /* <-- ARRAY NATURAL DATES
        :SALARY_N(01:10)            /* <-- ARRAY NATURAL NUMERIC
       )
       FOR :ROWCOUNT ROWS
SELECT * INTO VIEW V1 FROM NAT-DEMO_ID WHERE NAME > 'Z'
DISPLAY V1                          /* <-- VERIFY INSERT
END-SELECT
BACKOUT
END
```

Error Handling

In contrast to the normal Natural error handling, where either an `ON ERROR` statement is used to intercept execution time errors or standard error message processing is performed and program execution is terminated, the enhanced error handling of Natural for DB2 provides an application controlled reaction to the encountered SQL error.

Two Natural subprograms, `NDBERR` and `NDBNOERR`, are provided to disable the usual Natural error handling and to check the encountered SQL error for the returned SQL code. This functionality replaces the `E` function of the `DB2SERV` interface, which is still provided but no longer documented.

For further information on Natural subprograms provided for DB2, see the section ***Interface Subprograms***.

Example:

```
DEFINE DATA LOCAL
  01 #SQLCODE             (I4)
  01 #SQLSTATE            (A5)
  01 #SQLCA               (A136)
  01 #DBMS                (B1)
  END-DEFINE
  *
  *        Ignore error from next statement
  *
  CALLNAT 'NDBNOERR'
  *
  *        This SQL statement produces an SQL error
  *
  INSERT INTO SYSIBH-SYSTABLES (CREATOR, NAME, COLCOUNT)
    VALUES ('SAG', 'MYTABLE', '3')
  *
  *        Investigate error
  *
  CALLNAT 'NDBERR' #SQLCODE #SQLSTATE #SQLCA #DBMS
  *
  IF #DBMS NE 2                            /* not DB2
    MOVE 3700 TO *ERROR-NR
  END-IF
  *
  DECIDE ON FIRST VALUE OF #SQLCODE
    VALUE 0, 100                           /* successful execution
      IGNORE
    VALUE -803                             /* duplicate row
      /* UPDATE existing record
      /*
      IGNORE
    NONE VALUE
      MOVE 3700 TO *ERROR-NR
  END-DECIDE
  *
  END
```

19 Processing Natural Stored Procedures and UDFs

Natural for DB2 supports the writing and executing of Natural stored procedures and Natural user-defined functions (Natural UDFs).

Natural stored procedures are user-written programs that are invoked by the SQL statement `CALL` and executed by DB2 in the SPAS (Stored Procedure Address Space). SPAS is a separate address space reserved for stored procedures.

A function is an operation denoted by a function name followed by zero or more operands that are enclosed in parentheses. A function represents a relationship between a set of input values and a set of result values. If a function has been implemented by a user-written program, DB2 refers to it as a user-defined function (UDF).

The following topics are covered below:

Types of Natural UDF

There are two types of Natural used defined functions (UDF):

- **Scalar UDF**

  The scalar UDF accepts several input arguments and returns one output value. It can be invoked by any SQL statement like a DB2 built-in-function.

- **Table UDF**

  The table UDF accepts several input arguments and returns a set of output values comprising one table row during each invocation.

  You invoke a table UDF with a Natural SQL `SELECT` statement by specifying the table-function name in the `FROM Clause`. A table UDF performs as a DB2 table and is invoked for each `FETCH` operation for the table-function specified in the `SELECT` statement.

PARAMETER STYLE

The `PARAMETER STYLE` identifies the linkage convention used to pass parameters to a DB2 stored procedure or a DB2 user defined functions (UDFs).

This section describes the `PARAMETER STYLE`s and the STCB Natural for DB2 uses for processing Natural for DB2 stored procedures or Natural UDFs.

Note: `PARAMETER STYLE GENERAL` (or `GENERAL WITH NULL`) and **STCB Layout** only apply to Natural stored procedures.

- GENERAL and GENERAL WITH NULL

- STCB Layout
- DB2SQL

GENERAL and GENERAL WITH NULL

Note: Only applies to Natural stored procedures.

A Natural stored procedure defined with `PARAMETER STYLE GENERAL` only receives the user parameters specified.

A Natural stored procedure defined with `PARAMETER STYLE GENERAL WITH NULL` receives the user parameters specified and, additionally, a `NULL` indicator array that contains one `NULL` indicator for each user parameter.

Natural stored procedures defined with `PARAMETER STYLE GENERAL`/`PARAMETER STYLE GENERAL WITH NULL`, require that the definition of the stored procedure within the DB2 catalog includes one additional parameter of the type `VARCHAR` in front of the user parameters of the stored procedure.

This parameter in front of the parameters is the Stored Procedure Control Block (STCB); see also ***STCB Layout*** below.

Below is information on:

- Stored Procedure Control Block
- Example of PARAMETER STYLE GENERAL
- Example of GENERAL WITH NULL

Stored Procedure Control Block

The Stored Procedure Control Block (STCB) contains information the Natural for DB2 server stub uses to execute Natural stored procedures, such as the library and the subprogram to be invoked. It also contains the format descriptions of the parameters passed to the stored procedure.

The STCB is invisible to the Natural stored procedure called. The STCB is evaluated by the Natural for DB2 server stub and stripped off the parameter list that is passed to the Natural stored procedure.

If the caller of a Natural stored procedure defined with `PARAMETER STYLE GENERAL`/`PARAMETER STYLE GENERAL WITH NULL` is a Natural program, the program must use a Natural SQL `CALLDBPROC` statement with the keyword `CALLMODE=NATURAL`.

If the caller of the Natural stored procedure is *not* a Natural program, the caller has to set up the STCB for the DB2 `CALL` statement and pass the STCB as the first parameter.

If an error occurs during the execution of a Natural stored procedure defined with `PARAMETER STYLE GENERAL`/`PARAMETER STYLE GENERAL WITH NULL`, the error message text is returned to the STCB.

If the caller is a Natural program that uses `CALLDBPROC` and `CALLMODE=NATURAL`, the Natural for DB2 runtime will wrap up the error text in the NAT3286 error message.

Example of PARAMETER STYLE GENERAL

In the Natural stored procedure, define the parameters as shown in the example program below:

```
DEFINE DATA PARAMETER
01 P1 ...
01 P2 ...
...
...
01 Pn ...
LOCAL
...
...
END-DEFINE
```

Example of GENERAL WITH NULL

In the Natural stored procedure, define the parameters as shown in the example program below:

```
DEFINE DATA PARAMETER
01 P1 ...
01 P2 ...
...
...
01 Pn ...
01 NULL-INDICATOR-ARRAY  (I2/1:n)
LOCAL
...
...
END-DEFINE
```

STCB Layout

Note: Only applies to Natural stored procedures.

The following table describes the first parameter passed between the caller and the Natural stored procedure if `CALLMODE=NATURAL` is specified in a Natural SQL `CALLDBPROC` statement.

Name	Format	Processing Mode Server
STCBL	I2	Input (size of following information)
Procedure Information		
STCBLENG	A4	Input (printable STCBL)
STCBID	A4	Input (STCB)
STCBVERS	A4	Input (version of STCB 310)
STCBUSER	A8	Input (user ID)
STCBLIB	A8	Input (library)
STCBPROG	A8	Input (calling program)
STCBPSW	A8	Unused (password)
STCBSTNR	A4	Input (`CALLDBPROC` statement number)
STCBSTPC	A8	Input (procedure called)
STCBPANR	A4	Input (number of parameters)
Error Information		
STCBERNR	A5	Output (Natural error number)
STCBSTAT	A1	Unused (Natural error status)
STCBLIB	A8	Unused (Natural error library)
STCBPRG	A8	Unused (Natural error program)
STCBLVL	A1	Unused (Natural error level)
STCBOTP	A1	Unused (error object type)
STCBEDYL	A2	Output (error text length)
STCBEDYT	A88	Output (error text)
	A100	Reserved for future use
Parameter Information		
STCBPADE	A variable	Input. See also *PARAMETER DESCRIPTION (STCBPADE)* below.

PARAMETER DESCRIPTION (STCBPADE)

PARAMETER DESCRIPTION contains a description for each parameter passed to the Natural stored procedure consisting of parameter type, format specification and length. Parameter type is the `AD` attribute of the Natural `CALLNAT` statement as described in the Natural *Statements* documentation.

Each parameter has the following format description element in the STCBPADE string

```
atl,p[,dl]....
```

where

- *a* is an attribute mark which specifies the parameter type:

Mark	Type	Equivalent AD Attribute	Equivalent DB2 Clause
M	modifiable	AD=M	INOUT
O	non-modifiable	AD=O	IN
A	input only	AD=A	OUT

- *t* is one of the following Natural format tokens:

t	Description	*l*	*p*	*d1*	Example
A	Alphanumeric	1-253	0	1-32767 or -	A30,0 or A30,0,10
N	Numeric unpacked	1-29	0-7	-	N10,3
P	Packed numeric	1-29	0-7	-	P13,4
I	Integer	2 or 4	0	-	I2,0
F	Floating point		0	-	I4,0
B	Binary		0	-	B23,0
D	Date	6	0	-	D6
T	Time	12	0	-	T12
L	Logical (unsupported)				

- *l* is an integer denoting the length/scale of the field. For numeric and packed numeric fields, *l* denotes the total number of digits of the field that is, the sum of the digits left and right of the decimal point. The Natural format N7.3 is, for example, represented by N10.3. See also the **table** above.
- *p* is an integer denoting the precision of the field. It is usually 0, except for numeric and packed fields where it denotes the number of digits right of the decimal point. See also the table above.
- *d1* is also an integer denoting the occurrences of the alphanumeric array (alphanumeric only). See also the **table** above.

This descriptive/control parameter is invisible to the calling Natural program and to the called Natural stored procedure, but it has to be defined in the parameter definition of the stored procedure row with the `CREATE PROCEDURE` statement and the DB2 `PARAMETER STYLE GENERAL`/`PARAMETER STYLE GENERAL WITH NULL`.

The following table shows the number of parameters which have to be defined with the `CREATE PROCEDURE` statement for a Natural stored procedure defined with `PARAMETER STYLE GENERAL` depending on the number of user parameters and whether the client (that is, the caller of a stored procedure for DB2) and the server (that is, the stored procedure for DB2) is written in Natural or in another standard programming host language. *n* denotes the number of user parameters.

Client\Server	Natural	not Natural
Natural	*n* + 1	*n* (`CALLMODE=NONE`)
non-Natural	*n* + 1	*n*

DB2SQL

Note: `PARAMETER DB2SQL` applies to Natural stored procedures and Natural UDFs.

A Natural stored procedure or Natural user defined function (UDF) with `PARAMETER STYLE DB2SQL` first receives the user parameters specified and then the parameters listed below, under *Additional Parameters Passed*. For a Natural UDF, the input parameters are passed before the output parameters.

Additional Parameters Passed:

- A `NULL` indicator for each user parameter of the `CALL` statement,
- the `SQLSTATE` to be returned to DB2,
- the qualified name of the Natural stored procedure or UDF,
- the specific name of the Natural stored procedure or UDF,
- the SQL DIAGNOSE field with a diagnostic string to be returned to DB2.

The `SQLSTATE`, the qualified name, the specific name and the `DIAGNOSE` field are defined in the Natural parameter data area (PDA) `DB2SQL_P` which is supplied in the Natural system library `SYSDB2`.

If the optional feature `SCRATCHPAD` *nnn* is specified additionally in the `CREATE FUNCTION` statement for the Natural UDF, the `SCRATCHPAD` storage parameter is passed to the Natural UDF.

Use the following definitions:

```
01 SCRATCHPAD A(4+nnn)
01 REDEFINE SCRATCHPAD
02 SCRATCHPAD_LENGTH(I4)
02 ...
```

Redefine the `SCRATCHPAD` in the Natural UDF according to your requirements.

The first four bytes of the `SCRATCHPAD` area contain an integer length field. Before initially invoking the Natural UDF with an SQL statement, DB2 resets the `SCRATCHPAD` area to `x'00'` and sets the size *nnn* specified for the `SCRATCHPAD` into the first four bytes as an integer value.

Thereafter, DB2 does not reinitialize the `SCRATCHPAD` between the invocations of the Natural UDF for the invoking SQL statement. Instead, after returning from the Natural UDF, the contents of the `SCRATCHPAD` is preserved and restored at the next invocation of the Natural UDF.

Below is information on:

Parameter CALL TYPE

Note: This parameter is optional and only applies to Natural UDFs.

The `CALL TYPE` parameter is passed if the `FINAL CALL` option is specified for a Natural scalar UDF, or if the Natural UDF is a table UDF. The `CALL TYPE` parameter is an integer indicating the type of call DB2 performs on the Natural UDF. See the *DB2 SQL GUIDE* for details on the parameter values provided in the `CALL_TYPE` parameter.

Parameter DBINFO

This parameter is optional.

If the option `DBINFO` is used, the `DBINFO` structure is passed to the Natural stored procedure or UDF. The `DBINFO` structure is described in the Natural PDA `DBINFO_P` supplied in the Natural system library `SYSDB2`.

Determining Library, Subprogram and Parameter Formats

The Natural for DB2 server stub determines the subprogram and the library from the qualified and specific name of the Natural stored procedure or UDF. The SCHEMA name is used as library name, and the procedure or function name is used as subprogram name.

The `ROUTINEN` subprogram is supplied in the Natural system library `SYSDB2`. This subprogram is used to access the DB2 catalog to determine the formats of the user parameters defined for the Natural stored procedure or UDF. After the formats have been determined, they are stored in the Natural buffer pool. During subsequent invocations of the Natural stored procedure, the formats are then retrieved from the Natural buffer pool. This requires that at least `READS SQL DATA` is specified for Natural stored procedures or UDFs with `PARAMETER STYLE DB2SQL`.

The `ROUTINEN` subprogram is generated statically. The DBRM of `ROUTINEN` is bound as package in the `COLLECTION SAGNDBROUTINENPACK`. Before starting to access the DB2 catalog, the subprogram will save the `CURRENT PACKAGESET` and set `SAGNDBROUTINENPACK` to `CURRENT PACKAGESET`. After processing, the `ROUTINEN` subprogram will restore the `CURRENT PACKAGESET` saved.

Invoking a Natural Stored Procedure

If the caller of the Natural stored procedure with `PARAMETER STYLE DB2SQL` is a Natural program, the caller must use the Natural SQL `CALLDBPROC` statement with the specification `CALLMODE=NATURAL`, which is the default.

Error Handling

If a Natural runtime error occurs during the execution of a Natural stored procedure or UDF with `PARAMETER STYLE DB2SQL`, `SQLSTATE` is set to `38N99` and the diagnostic string contains the text of the Natural error message.

If an error occurs in the Natural for DB2 server stub during the execution of the Natural stored procedure or UDF with `PARAMETER STYLE DB2SQL`, the `SQLSTATE` is set to `38S99` and the diagnostic string contains the text of the error message.

If the application wants to raise an error condition during the execution of a Natural stored procedure or UDF, the `SQLSTATE` parameter must be set to a value other than `'00000'`. See the *DB2 SQL Guide* for specifications of user errors in the `SQLSTATE` parameter.

Additionally, a text describing the errors can be placed in the `DIAGNOSE` parameter.

If a Natural table UDF wants to signal to DB2 that it has found no row to return, `'02000'` must be returned in the `SQLSTATE` parameter.

Lifetime of Natural Session

For a Natural UDF that contains the attributes `DISALLOW PARALLEL` and `FINAL CALL`, the Natural for DB2 server stub retains the Natural session allocated earlier. This Natural session will then be reused by all subsequent UDF invocations until Natural encounters the final call.

Example of DB2SQL - Natural Stored Procedure

In a Natural stored procedure, define the parameters as shown in the example program below:

```
DEFINE DATA PARAMETER
01 P1 ...
01 P2 ...
...
...
01 PN ...
01 N1 (I2)
01 N2 (I2)
...
...
01 N
n (I2)
PARAMETER USING DB2SQL_P
[ PARAMETER USING DBINFO_P ]   /*  only if DBINFO is defined
LOCAL
...
...
END-DEFINE
```

Example of DB2SQL - Natural UDF

In a Natural UDF, define the parameters as shown in the example program below:

```
DEFINE DATA PARAMETER
01 PI1 ...  /* first input parameter
01 PI2 ...
...
...
01 PIn ...  /*  last input parameter
01 RS1...  /* first result parameter
...
...
01 RSn ...  /* last result parameter
01 N_PI1 (I2)  /* first NULL indicator
01 N_PI2 (I2)
...
...
01 N_Pin (I2)
01 N_RS1 (I2)
```

```
...
...
01 N_RSn (I2) /* last NULL indicator
PARAMETER USING DB2SQL_P /* function, specific, sqlstate, diagnose
PARAMETER
01 SCRATCHPAD A(4+nnn)  /* only if SCRATCHPAD nnn is specified
  01 REDEFINES SCRATCHPAD
02 SCRATCHPAD_LENGTH (I4)
02 ...
01 CALL_TYPE (I4) /* --- only if FINAL CALL is specified or table UDF


PARAMETER USING DBINFO_P   /* ---- only if DBINFO is specified
LOCAL
...
...
END-DEFINE
```

Writing a Natural Stored Procedure

This section provides a general guideline of how to write a Natural Stored Procedure and what to consider when writing it.

To write a Natural stored procedure

1. Determine the format and attributes of the parameters that are passed between the caller and the stored procedure. Consider creating a Natural parameter data area (PDA). Stored procedures do not support data groups and redefinition within their parameters.
2. Determine the `PARAMETER STYLE` of the stored procedure: `GENERAL`, `GENERAL WITH NULL` or `DB2SQL`.
   - If you use `GENERAL WITH NULL`, append the parameters to the Natural stored procedure by defining a `NULL` indicator array that contains a `NULL` indicator (I2) for each other parameter.
   - If you use `DB2SQL`, append the parameters of the Natural stored procedure by defining `NULL` indicators (one for each parameter), include the PDA `DB2SQL_P` and the PDA `DBINFO_P` (only with `DBINFO` specified), if desired. See also the relevant DB2 literature by IBM.
3. Decide which and how many result sets the stored procedure will return to the caller.
4. Code your stored procedure as a Natural subprogram.

- **Returning result sets**
  To return result sets, code a Natural SQL `SELECT` statement with the `WITH RETURN` option.

  To return the whole result set, code an `ESCAPE BOTTOM` statement immediately after the `SELECT` statement.

  To return part of the result set code, an `IF *COUNTER = 1 ESCAPE TOP END-IF` immediately following the `SELECT` statement. This ensures that you do not process the first empty row that is returned by the `SELECT WITH RETURN` statement. To stop row processing, execute an `ESCAPE BOTTOM` statement.

  If you do not leave the processing loop initiated by the `SELECT WITH RETURN` via `ESCAPE BOTTOM`, the result set created is closed and nothing is returned to the caller.
- **Attention when accessing other databases**
  You can access other databases (for instance Adabas) within a Natural stored procedure. However, keep in mind that your access to other databases is synchronized neither with the updates done by the caller of the stored procedure, nor with the updates done against DB2 within the stored procedure.
- **Natural for DB2 handling of COMMIT and ROLLBACK statements**
  DB2 does not allow a stored procedure to issue Natural SQL `COMMIT` or `ROLLBACK` statements (the execution of those statements puts the caller into a must-rollback state). Therefore, the Natural for DB2 runtime handles those statements as follows when they are issued from a stored procedure:

  `COMMIT` against DB2 will be skipped. This allows the stored procedure to commit Adabas updates without getting a must-rollback state from DB2.

  `ROLLBACK` against DB2 will be skipped if it is created by Natural itself.

  `ROLLBACK` against DB2 will be executed if it is user-programmed. Thus, after a Natural error, the caller receives the Natural error information and not the unqualified must-rollback state. Additionally, this function ensures that, if the user program backs out the transaction, every database transaction of the stored procedure is backed out.

5 **For DB2 UDB:** Issue a `CREATE PROCEDURE` statement that defines your stored procedure, for example:

```
CREATE PROCEDURE <PROCEDURE>
  (INOUT  STCB       VARCHAR(274+13*N),
   INOUT  <PARM1>    <FORMAT>,
   INOUT  <PARM2>    <FORMAT>,
   INOUT  <PARM3>    <FORMAT>
   .
  )
  DYNAMIC RESULT SET <RESULT_SETS>
  EXTERNAL NAME <LOADMOD>
```

```
LANGUAGE ASSEMBLE
PROGRAM TYPE <PGM_TYPE>
PARAMETER STYLE GENERAL <WITH NULLS depending on LINKAGE>;
```

The data specified in angle brackets (< >) correspond to the data listed in the **table** above, `PARM1` - `PARM3` and `FORMAT` depend on the call parameter list of the stored procedure. See also ***Example Stored Procedure NDBPURGN***, Member `CR6PURGN`.

6 Code your Natural program invoking the stored procedure via the Natural SQL `CALLDBPROC` statement.

Code the parameters in the `CALLDBPRO`C statement in the same sequence as they are specified in the stored procedure. Define the parameters in the calling program in a format that is compatible with the format defined in the stored procedure.

If you use result sets, specify a `RESULT SETS` clause in the `CALLDBPROC` statement followed by a number of result set locator variables of `FORMAT (I4)`. The number of result set locator variables should be the same as the number or result sets created by the stored procedure. If you specify fewer than are created, some result sets are lost. If you specify more than are created, the remaining result set locator variables are lost. The sequence of locator variables corresponds to the sequence in which the result sets are created by the stored procedure.

Keep in mind that the fields into which the result set rows are read have to correspond to the fields used in the `SELECT WITH RETURN` statement that created the result set.

Writing a Natural UDF

This section provides a general guideline of how to write a Natural user defined function (UDF) and what to consider when writing it.

See also the section ***Writing a Natural Stored Procedure***.

To write a Natural UDF

1 Determine the format and attributes of the parameters, which are passed between the caller and the stored procedure.

2 Create a Natural parameter data area (PDA).

3 Append the parameter definitions of the Natural UDF by defining `NULL` indicators (one for each parameter) and include the PDA `DB2SQL_P`.

4 If required, code a `SCRATCHPAD` area in the parameter list.

5 If required, code a call-type parameter. If you have specified `DBINFO`, include the PDA `DBINFO_P`. See also the relevant DB2 literature by IBM.

6 Code your UDF as a Natural subprogram and consider the following:

- **Attention when accessing other databases**
  You can access other databases (for example, Adabas) within a Natural UDF. However, keep in mind that your access to other databases is synchronized neither with the updates done by the caller of the stored procedure, nor with the updates done against DB2 within the stored procedure.
- **Natural for DB2 handling of COMMIT and ROLLBACK statements**
  DB2 does not allow a stored procedure to issue `COMMIT` or `ROLLBACK` statements; the execution of these statements results in a must-rollback state. If a Natural stored procedure issues a COMMIT or ROLLBACK, the Natural for DB2 runtime processes these statements as follows:

  `COMMIT` against DB2 is skipped. This allows the stored procedure to commit Adabas updates without entering a must-rollback state by DB2.

  `ROLLBACK` against DB2 is skipped if it is implicitly issued by the Natural runtime.

  `ROLLBACK` against DB2 is executed if it is user-programmed. Thus, after a Natural error, the caller receives a corresponding Natural error message text, but does not enter an unqualified must-rollback state. Additionally, this reaction ensures that every database transaction the stored procedure performs is backed out if the user program backs out the transaction.

7 Issue a `CREATE FUNCTION` statement that defines your UDF, for example:

```
CREATE FUNCTION <FUNCTION>
  ([PARM1]    <FORMAT>,
   [PARM2]    <FORMAT>,
   [PARM3]    <FORMAT>

  )
  RETURNS <FORMAT>

  EXTERNAL NAME <LOADMOD>
  LANGUAGE ASSEMBLE
  PROGRAM TYPE <PGM TYPE>
  PARAMETER STYLE DB2SQL
.
.
.;
```

In the example above, the variable data are enclosed in angle brackets (< >) and refer to the keywords preceding the brackets. Specify a valid value, for example:

`LOADMOD` denotes the Natural for DB2 server stub module, for example, `NDB`*`vr`*`SRV`, where *`vr`* stands for the Natural version number. `PARM1` - `PARM3` and `FORMAT` relate to the call parameter list of the UDF. See also the ***Example Natural User Defined Function***.

8 Code a Natural program containing SQL statements that invoke the UDF.

Specify the parameters of the Natural UDF invocation in the same sequence as specified in the Natural UDF definition. The format of the parameters in the calling program must be compatible with the format defined in the Natural UDF.

Example Stored Procedure

This section describes the example stored procedure NDBPURGN, a Natural subprogram which purges Natural objects from the buffer pool used by the Natural stored procedures server.

The following topics are covered below:

- Members of NDBPURGN
- Defining the Stored Procedure NDBPURGN

Members of NDBPURGN

The example stored procedure NDBPURGN comprises the following text members which are stored in the Natural system library SYSDB2:

Member	Explanation
CR6PURGN	Input member for SYSDB2 ISQL. Contains SQL statements used to declare NDBPURGN in DB2.
NDBPURGP	The client (Natural) program which ■ Requests the name of the program to be purged and the library where it resides, ■ Invokes the stored procedure NDBPURGN and ■ Reports the outcome of the request.
NDBPURGN	The stored procedure which purges objects from the buffer pool. NDBPURGN invokes the application programming interface USR0340N supplied in the Natural system library SYSEXT. Therefore, USR0340N must be available in the library defined as the steplib for the execution environment.

Defining the Stored Procedure NDBPURGN

To define the example stored procedure NDBPURGN

1. Define the stored procedure in the DB2 catalog by using the SQL statements provided as text members `CR5PURGN` (for DB2 Version 5) and `CR6PURGN` (for DB2 Version 6).
2. Specify the name of the Natural stored procedure stub (here: `NDB`*`vr`*`SRV`, where *`vr`* stands for the Natural version number) as `LOADMOD` (V5) or `EXTERNAL NAME` (V6). The Natural stored procedure stub is generated during the installation by assembling the `NDBSTUB` macro.
3. As the first parameter, pass the internal Natural parameter `STCB` to the stored procedure. The `STCB` parameter is a `VARCHAR` field which contains information required to invoke the stored procedure in Natural:

   - The program name of the stored procedure and the library where it resides,
   - The description of the parameters passed to the stored procedure and
   - The error message created by Natural if the stored procedure fails during the execution.

   The `STCB` parameter is generated automatically by the `CALLMODE=NATURAL` clause of the Natural SQL `CALLDBPROC` statement and is removed from the parameters passed to the Natural stored procedure by the server stub. Thus, `STCB` is invisible to the caller and the stored procedure. However, if a non-Natural client intends to call a Natural stored procedure, the client has to pass the `STCB` parameter explicitly. See also *Stored Procedure Control Block* below.

Stored Procedure Control Block (STCB)

Below is the Stored Procedure Control Block (STBC) generated by the `CALLMODE=NATURAL` clause as generated by the stored procedure `NDBPURGN` *before* and *after* execution. Changed values are emphasized in boldface:

STCB before Execution:

```
004C82   0132F0F3  F0F6E2E3  C3C2F3F1  F040C8C7  *..0306STCB310 HG*    11097D42
004C92   D2404040  4040C8C7  D2404040  4040D5C4  *K     SAG     ND*    11097D52
004CA2   C2D7E4D9  C7D74040  40404040  4040F0F5  *BPURGP        05*    11097D62
004CB2   F7F0D5C4  C2D7E4D9  C7D5F0F0  F0F6F0F9  *70NDBPURGN000609*    11097D72
004CC2   F9F9F940  40404040  40404040  40404040  *999             *    11097D82
004CD2   40404040  40404040  40404040  40404040  *                *    11097D92
004CE2   40404040  40404040  40404040  40404040  *                *    11097DA2
004CF2   40404040  40404040  40404040  40404040  *                *    11097DB2
004D02   40404040  40404040  40404040  40404040  *                *    11097DC2
004D12   40404040  40404040  40404040  40404040  *                *    11097DD2
004D22   40404040  40404040  40404040  40404040  *                *    11097DE2
004D32   40404040  40404040  40404040  40404040  *                *    11097DF2
004D42   40404040  40404040  40404040  40404040  *                *    11097E02
004D52   40404040  40404040  40404040  40404040  *                *    11097E12
004D62   40404040  40404040  40404040  40404040  *                *    11097E22
```

```
004D72   40404040  40404040  40404040  40404040  *               *    11097E32
004D82   40404040  40404040  40404040  40404040  *               *    11097E42
004D92   40404040  D4C1F86B  F0D4C1F4  F06BF0D4  *    MA8,0MA40,0M*    11097E52
004DA2   C2F26BF0  D4C2F26B  F0D4C9F2  6BF0D4C9  *I2,0MI2,0MI2,0MI*    11097E62
004DB2   F26BF04B                                *2,0.           *    11097E72
```

STCB after Execution:

```
004C82   0132F0F3  F0F6E2E3  C3C2F3F1  F040C8C7  *..0306STCB310 HG*    11097D42
004C92   D2404040  4040C8C7  D2404040  4040D5C4  *K     SAG     ND*    11097D52
004CA2   C2D7E4D9  C7D74040  40404040  4040F0F5  *BPURGP        05*    11097D62
004CB2   F7F0D5C4  C2D7E4D9  C7D5F0F0  F0F6F0F0  *70NDBPURGN000600*    11097D72
004CC2   F0F0F040  40404040  40404040  40404040  *000             *    11097D82
004CD2   40404040  40404040  40404040  40404040  *               *    11097D92
004CE2   40404040  40404040  40404040  40404040  *               *    11097DA2
004CF2   40404040  40404040  40404040  40404040  *               *    11097DB2
004D02   40404040  40404040  40404040  40404040  *               *    11097DC2
004D12   40404040  40404040  40404040  40404040  *               *    11097DD2
004D22   40404040  40404040  40404040  40404040  *               *    11097DE2
004D32   40404040  40404040  40404040  40404040  *               *    11097DF2
004D42   40404040  40404040  40404040  40404040  *               *    11097E02
004D52   40404040  40404040  40404040  40404040  *               *    11097E12
004D62   40404040  40404040  40404040  40404040  *               *    11097E22
004D72   40404040  40404040  40404040  40404040  *               *    11097E32
004D82   40404040  40404040  40404040  40404040  *               *    11097E42
004D92   40404040  D4C1F86B  F0D4C1F4  F06BF0D4  *    MA8,0MA40,0M*    11097E52
004DA2   C2F26BF0  D4C2F26B  F0D4C9F2  6BF0D4C9  *I2,0MI2,0MI2,0MI*    11097E62
004DB2   F26BF04B                                *2,0.           *    11097E72
```

Example Natural User Defined Function

This section describes the example user defined function (UDF) `NAT.DEM2UDFN`, a Natural subprogram used to calculate the product of two numbers.

The example UDF `NAT.DEM2UDF` comprises the following members that are supplied in the Natural system library `SYSDB2`:

Member	Explanation
`DEM2CUDF`	Contains SQL statements used to create `DEM2UDFN` (see below).
`DEM2UDFP`	The client (Natural) program that ■ Fetches rows from the UDF `NAT.DEMO` table, ■ invokes the `NAT.DEM2UDFN` (see below) in the `WHERE` clause, and ■ Displays the rows fetched.

Member	Explanation
DEM2UDFN	The UDF that builds the product of two numbers. DEM2UDFN has to be copied to the Natural library NAT on the Natural sytem file FUSER in the executing environment.

20 Interface Subprograms

Several Natural and non-Natural subprograms are available to provide you with internal information from Natural for DB2 or specific functions for which no equivalent Natural statements exist.

Invoking Subprograms from within a Natural Program

- Natural subprograms are invoked with the Natural CALLNAT statement.
- Non-Natural subprograms are invoked with the Natural CALL statement.

Overview of Interface Subprograms

Subprogram	Function
NDBCONV	Sets or resets conversational mode 2.
NDBERR	Provides diagnostic information on the most recently executed SQL call.
NDBISQL	Executes SQL statements in dynamic mode.
NDBNOERR	Suppresses normal Natural error handling.
NDBNROW	Obtains the number of rows affected by a Natural SQL statement.
NDBSTMP	Provides a DB2 TIMESTAMP column as an alphanumeric field and vice versa.

All these subprograms are provided in the Natural system library SYSDB2 and the Natural library SYSTEM on the system file FNAT.

For detailed information on these subprgrams, follow the links shown in the table above and read the description of the call format and of the parameters in the text member provided with the subprogram (*subprogram-name*T).

NDBCONV Subprogram

The Natural subprogram NDBCONV is used to either set or reset the conversational mode 2 in CICS environments. Conversational mode 2 means that update transactions are spawned across terminal I/Os until either a COMMIT or ROLLBACK has been issued (Caution DB2 and CICS resources are kept across terminal I/Os!). This means conversational mode 2 has the same effect as the Natural profile parameter PSEUDO=OFF, except that the conversational mode is entered after an DB2 update statement (UPDATE, DELETE, INSERT) and left again after a COMMIT or ROLLBACK, while PSEUDO=OFF causes conversational mode for the total Natural session.

A sample program called CALLCONV is provided in library SYSDB2; it demonstrates how to invoke NDBCONV. A description of the call format and of the parameters is provided in the text member NDBCONVT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBCONV' #CONVERS #RESPONSE
```

The various parameters are described in the following table:

Parameter	Format/Length	Explanation
#CONVERS	I1	Contains the desired conversational mode(input)
#RESPONSE	I4	Contains the response of NDBCONV(output)

The #CONVERS parameter can contain the following values:

Code	Explanation
0	The conversational mode 2 has to be reset.
1	The conversational mode 2 has to be set.

The #RESPONSE parameter can contain the following response codes:

Code	Explanation
0	The conversational mode 2 has been successfully set or reset.
-1	The specified value of #CONVERS is invalid, the conversational mode has not been changed.
-2	NDBCONV is called in a environment, which is not a CICS environment, where the conversational mode 2 is not supported.

NDBERR Subprogram

The Natural subprogram NDBERR replaces Function E of the DB2SERV interface, which is still provided but no longer documented. It provides diagnostic information on the most recent SQL call. It also returns the database type which returned the error. NDBERR is typically called if a database call returns a non-zero SQL code (which means a NAT3700 error).

A sample program called CALLERR is provided on the installation tape; it demonstrates how to invoke NDBERR. A description of the call format and of the parameters is provided in the text member NDBERRT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBERR' #SQLCODE #SQLSTATE #SQLCA #DBTYPE
```

The various parameters are described in the following table:

Parameter	Format/Length	Explanation
#SQLCODE	I4	Returns the SQL return code.
#SQLSTATE	A5	Returns a return code for the output of the most recently executed SQL statement.
#SQLCA	A136	Returns the SQL communication area of the most recent DB2 access.
#DBTYPE	B1	Returns the identifier (in hexadecimal format) for the currently used database (where X'02' identifies DB2).

NDBISQL Subprogram

The Natural subprogram NDBISQL is used to execute SQL statements in dynamic mode. The SELECT statement and all SQL statements which can be prepared dynamically (according to the DB2 literature by IBM) can be passed to NDBISQL.

A sample program called CALLISQL is provided on the installation tape; it demonstrates how to invoke NDBISQL. A description of the call format and of the parameters is provided in the text member NDBISQLT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBISQL'#FUNCTION #TEXT-LEN #TEXT (*) #SQLCA #RESPONSE #WORK-LEN #WORK (*)
```

The various parameters are described in the following table:

Parameter	Format/Length	Explanation	
#FUNCTION	A8	For valid functions, see below.	
#TEXT-LEN	I2	Length of the SQL statement or of the buffer for the return area.	
#TEXT	A1(1:V)	Contains the SQL statement or receives the return code.	
#SQLCA	A136	Contains the SQLCA.	
#RESPONSE	I4	Returns a response code.	
#WORK-LEN	I2	Length of the workarea specified by #WORK (optional).	
#WORK	A1(1:V)	Workarea used to hold SQLDA/SQLVAR and auxiliary fields across calls (optional).	
#DBTYPE	I2	Database type (optional).	
		0	Default

Parameter	Format/Length	Explanation	
		2	DB2
		4	CNX

Valid functions for the #FUNCTION parameter are:

Function	Parameter	Explanation
CLOSE		Closes the cursor for the SELECT statement.
EXECUTE	#TEXT-LEN #TEXT (*)	Executes the SQL statement. Contains the length of the statement. Contains the SQL statement. The first two characters must be blank.
FETCH	#TEXT-LEN #TEXT (*)	Returns a record from the SELECT statement. Size of #TEXT (in bytes). Buffer for the record.
TITLE	#TEXT-LEN #TEXT (*)	Returns the header for the SELECT statement. Size of #TEXT (in bytes); receives the length of the header (= length of the record). Buffer for the header line.

The #RESPONSE parameter can contain the following response codes:

Code	Function	Explanation
5	EXECUTE	The statement is a SELECT statement.
6	TITLE, FETCH	Data are truncated; only set on first TITLE or FETCH call.
100	FETCH	No record / end of data.
-2		Unsupported data type (for example, GRAPHIC).
-3	TITLE, FETCH	No cursor open; probably invalid call sequence or statement other than SELECT.
-4		Too many columns in result table.
-5		SQL code from call.
-6		Version mismatch.
-7		Invalid function.
-8		Error from SQL call.
-9		Workarea invalid (possibly relocation).
-10		Interface not available.
-11	EXECUTE	First two bytes of statement not blank.

Call Sequence

The first call must be an EXECUTE call. NDBISQL has a fixed SQLDA AREA holding space for 50 columns. If this area is too small for a particular SELECT it is possible to supply an optional work area on the calls to NDBISQL by specifying #WORK-LEN (I2) and #WORK(A1/1:V).

This workarea is used to hold the SQLDA and temporary work fields like null indicators and auxiliary fields for numeric columns. Calculate 16 bytes for SQLDA header and 44 bytes for each result column and 2 bytes null indicator for each column and place for each numeric column, when supplying #WORK-LEN and #WORK(*) during NDBISQL calls. If these optional parameters are specified on an EXECUTE call they have also to be specified on any following call.

If the statement is a SELECT statement (that is, response code 5 is returned), any sequence of TITLE and FETCH calls can be used to retrieve the data. A response code of 100 indicates the end of the data.

The cursor must be closed with a CLOSE call.

Function code EXECUTE implicitly closes a cursor which has been opened by a previous EXECUTE call for a SELECT statement.

In TP environments, no terminal I/O can be performed between an EXECUTE call and any TITLE, FETCH or CLOSE call that refers to the same statement.

NDBNOERR Subprogram

The Natural subprogram NDBNOERR is used to suppress Natural NAT3700 errors caused by the next SQL call. This allows a program controlled continuation if an SQL statement produces a non-zero SQL code. After the SQL call has been performed, NDBERR is used to investigate the SQL code.

A sample program called CALLNOER is provided on the installation tape; it demonstrates how to invoke NDBNOERR. A description of the call format and of the parameters is provided in the text member NDBNOERT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBNOERR'
```

There are no parameters provided with this subprogram.

Note: Only NAT3700 errors (that is, non-zero SQL response codes) are suppressed, and also only errors caused by the next following SQL call.

Restrictions with Database Loops

- If NDBNOERR is called before a statement that initiates a database loop and an initialization error occurs, no processing loop will be initiated, unless a IF NO RECORDS FOUND clause has been specified.
- If NDBNOERR is called within a database loop, it does not apply to the processing loop itself, but only to the SQL statement subsequently executed inside this loop.

NDBNROW Subprogram

The Natural subprogram NDBNROW is used to obtain the number of rows affected by the Natural SQL statements Searched UPDATE, Searched DELETE, and INSERT. The number of rows affected is read from the SQL communication area (SQLCA). A positive value represents the number of affected rows, whereas a value of minus one (-1) indicates that all rows of a table in a segmented tablespace have been deleted; see also the Natural system variable *NUMBER as described in the Natural *System Variables* documentation.

A sample program called CALLNROW is provided on the installation tape; it demonstrates how to invoke NDBNROW. A description of the call format and of the parameters is provided in the text member NDBNROWT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBNROW' #NUMBER
```

The parameter #NUMBER (I4) contains the number of affected rows.

NDBSTMP Subprogram

For DB2, Natural provides a TIMESTAMP column as an alphanumeric field (A26) of the format *YYYY-MM-DD-HH.MM.SS.MMMMMM*.

Since Natural does not yet support computation with such fields, the Natural subprogram NDBSTMP is provided to enable this kind of functionality. It converts Natural time variables to DB2 time stamps and vice versa and performs DB2 time stamp arithmetics.

A sample program called CALLSTMP is provided on the installation tape; it demonstrates how to invoke NDBSTMP. A description of the call format and of the parameters is provided in the text member NDBSTMPT.

The functions available are:

Code	Explanation
ADD	Adds time units (labeled durations) to a given DB2 time stamp and returns a Natural time variable and a new DB2 time stamp.
CNT2	Converts a Natural time variable (format T) into a DB2 time stamp (column type TIMESTAMP) and labeled durations.
C2TN	Converts a DB2 time stamp (column type TIMESTAMP) into a Natural time variable (format T) and labeled durations.
DIFF	Builds the difference between two given DB2 time stamps and returns labeled durations.
GEN	Generates a DB2 time stamp from the current date and time values of the Natural system variable *TIMX and returns a new DB2 time stamp.
SUB	Subtracts labeled durations from a given DB2 time stamp and returns a Natural time variable and a new DB2 time stamp.
TEST	Tests a given DB2 time stamp for valid format and returns TRUE or FALSE.

Note: Labeled durations are units of year, month, day, hour, minute, second and micro-second.

21 Natural File Server for DB2

In all supported TP-monitor environments (CICS, IMS TM, and TSO), Natural for DB2 provides an intermediate work file, referred to as the File Server, to prevent database selection results from being lost with each terminal I/O. Exception: Com-plete.

Concept of the File Server

To avoid reissuing the selection statement used and repositioning the cursors, Natural writes the results of a database selection to an intermediate file. The saved selected rows, which may be required later, are then managed by Natural as if the facilities for conversational processing were available. This is achieved by automatically scrolling the intermediate file for subsequent screens, maintaining position in the work file rather than in DB2.

All rows of all open cursors are rolled out to the file server before the first terminal I/O operation. Subsequently, all data is retrieved from this file if Natural refers to one of the cursors which were previously rolled out (see the description of roll out in ***Logical Structure of File Server*** below).

If a row is to be updated or deleted, the row is first checked to see if it has been updated in the meantime by some other process. This is done by reselecting and fetching the row from the DB2 database, and then comparing it with the original version as retrieved from the file server. If the row is still unchanged, the update or delete operation can be executed. If not, a corresponding error message is returned. The reselection required when updating or deleting a row is possible in both dynamic mode and static mode.

Only the fields which are stored in the file server are checked for consistency against the record retrieved from DB2.

As the row must be uniquely identified, the Natural view must contain a field for which a unique row has been created. This field must be defined as a unique key in DB2. In a Natural data definition module (DDM), it will then be indicated as a unique key via the corresponding Natural-specific short name.

Preparations for Using the File Server

The size of a row which can be written to the file server is limited to 32 KB or 32767 bytes. If a row is larger, a corresponding error message is returned.

The File Server can use either a VSAM RRDS file or the Software AG Editor buffer pool as storage medium to save selected rows of DB2 tables.

This section covers the following topics:

- File Server - VSAM

- File Server - Editor Buffer Pool

File Server - VSAM

The file server is installed via a batch job, which defines and formats the intermediate file. Samples of this batch job are supplied on the installation tape as described in the relevant section.

Defining the Size of the File Server

The file server is created by defining an RRDS VSAM file using AMS (Access Method Services). Its physical size and its name must be specified.

Formatting the File Server

The file server is formatted by a batch job, which requires five input parameters specified by the user, and which formats the file server according to these parameters. The parameters specify:

1. The number of blocks to be formatted (logical size of the VSAM file); this value is taken from the first parameter of the `RECORD` subcommand of the AMS `DEFINE CLUSTER` command.
2. The number of users that can log on to Natural concurrently.
3. The number of formatted blocks to be defined as primary allocation per user.
4. The number of formatted blocks to be used as secondary allocation per user.
5. The maximum number of file server blocks to be allocated by each user. If this number is exceeded, a corresponding Natural error message is returned.

Immediately before the first access to the file server, a file server directory entry is allocated to the Natural session and the amount of blocks specified as primary allocation is allocated to the Natural session.

The primary allocation is used as intermediate storage for the result of a database selection and should be large enough to accommodate all rows of an ordinary database selection. Should more space in the file server be required for a large database selection, the file server modules allocate a secondary allocation equal to the amount that was specified for secondary allocation when the file server was formatted.

Thus, a secondary area is allocated only when your current primary allocation is not large enough to contain all of the data which must be written to the intermediate file. The number of secondary allocations allowed depends upon the maximum number of blocks you are allowed to allocate. This parameter is also specified when formatting the file server.

The number of blocks defined as the secondary allocation is allocated repeatedly, until either all selected data has been written to the file or the maximum number of blocks you are allowed to allocate is exceeded. If so, a corresponding Natural error message is returned. When the blocks received as a secondary allocation are no longer needed (that is, once the Natural loop associated with this allocation is closed), they are returned to the free blocks pool of the file server.

Your primary allocation of blocks, however, is always allocated to you, until the end of your Natural session.

Changes Required for a Multi-Volume File Server

To minimize channel contention or bottlenecks that can be caused by placing a large and heavily used file server on a single DASD volume, you can create a file server that spans several DASD volumes.

To create and format such a file server, two changes are needed in the job that is used to define the VSAM cluster:

1. Change `VOLUME ()` to `VOLUMES (vol1,vol2,...)`.
2. Divide the total number of records required for the file (as specified with the first format job parameter) by the number of volumes specified above. The result of the calculation is used for the RECORDS parameter of the `DEFINE CLUSTER` command.

This means that in the file server format job, the value of the first parameter is the result of multiplying two parameters taken from the `DEFINE CLUSTER` command: RECORDS and VOLUMES.

File Server - Editor Buffer Pool

The Software AG Editor buffer pool is used as storage medium when `EBPFSRV=ON` is set in the `NDBPARM` module. In this case, the primary, secondary and maximum allocation amounts for the file server are specified by `EBPPRAL`, `EBPSEC`, `EBPMAX` parameters of the `NDBPRM` macro. Before Natural for DB2 tries to write data from a Natural user session to the file server for the first time, a Software AG Editor buffer pool logical file is allocated with the Natural terminal identifier as user name and the number 2240 as session number.

The operation of the file server is in this case depending on the definition of the Software AG Editor buffer pool as described in the Natural Operations documentation.

The number of logical files for the buffer pool limits the number of users concurrently accessing the file server. The number of work file blocks limits the amount of data to be saved at a specific moment. (You also have to consider that there are other users than Natural for DB2 of the Software AG Editor.)

However, using the Software AG Editor buffer pool as storage medium for the file server enables Natural for DB2 to run in a Sysplex environment.

If you like to use the file server in a sysplex environment, it is recommended to use the Software AG Editor buffer pool as storage medium.

Logical Structure of the File Server

Immediately before a Natural user session accesses the file server, a file server directory entry (VSAM) or a logical file (Software AG Editor buffer pool) is allocated to the Natural user session and the number of blocks specified as primary allocation is reserved until the end of the session.

Generally, the file server is only used when a terminal I/O occurs within an active `READ`, `FIND`, or `SELECT` loop, where database selection results would be lost. Before each terminal I/O operation, Natural checks for any open cursors. For each non-scrollable cursor found, all remaining rows are retrieved from DB2 and written to an intermediate file. For each scrollable cursor, all rows are retrieved from DB2 and written to an intermediate file. In the Natural for DB2 documentation, this process is referred to as cursor roll out.

For each cursor roll out (scrollable and non-scrollable), a logical file is opened to hold all the rows fetched from this cursor. The space for the intermediate file is managed within the space allocated to your session. The logical file is then positioned on the row that was `CURRENT OF CURSOR` when the terminal I/O occurred.

Subsequent requests for data are then satisfied by reading the rows directly from the intermediate file. The database is no longer involved, and DB2 is only used for update, delete or store operations.

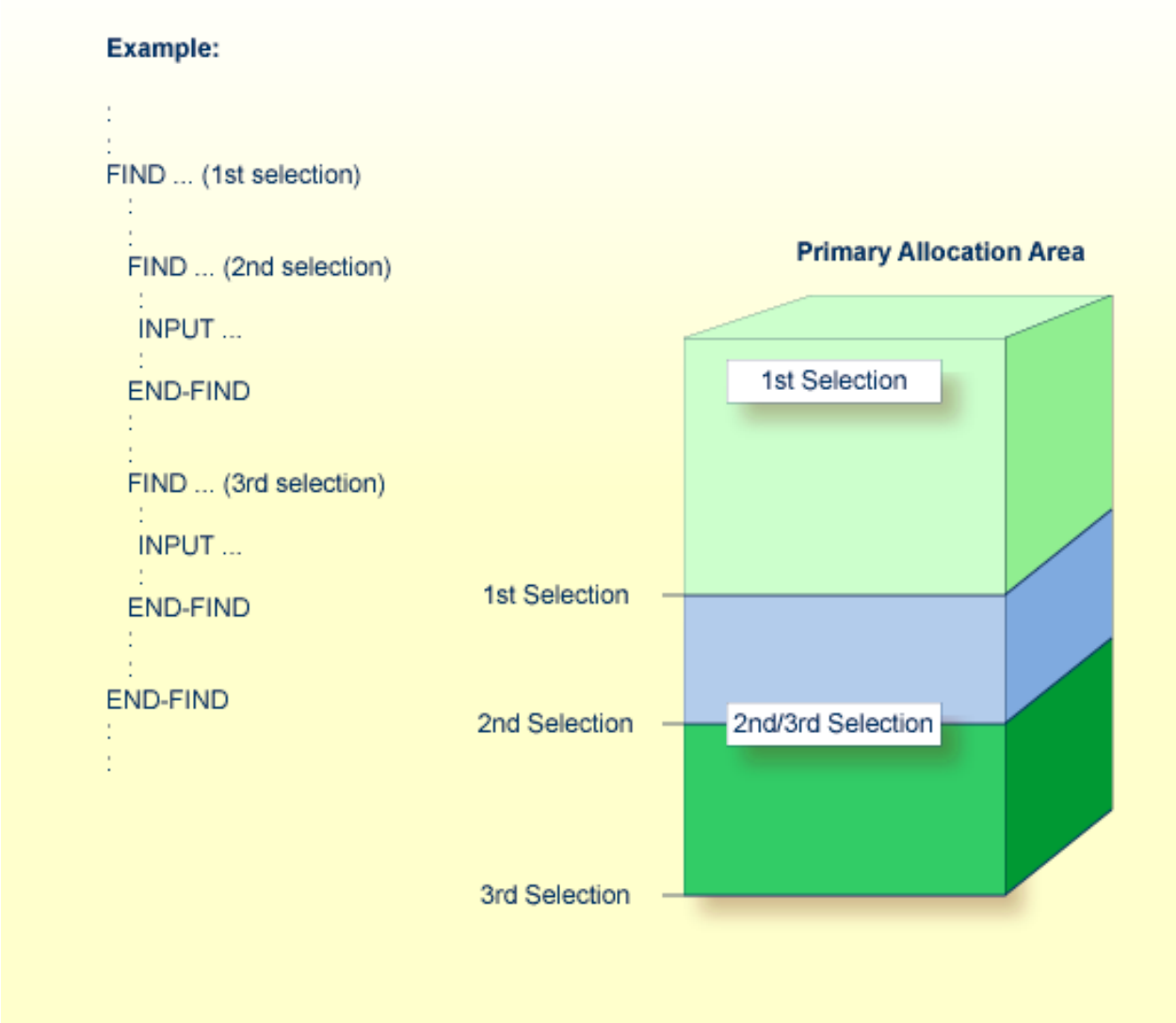
Positioned `UPDATE` and/or Positioned `DELETE` statements against rolled-out scrollable cursors are performed against the DB2 base table and against the logical file on the file server.

Once the corresponding processing loop in the application has been closed, the file is no longer needed and the blocks it occupies are returned to your pool of free blocks. From here, the blocks are returned to the free blocks pool of the file server, so that you are left with your primary allocation only.

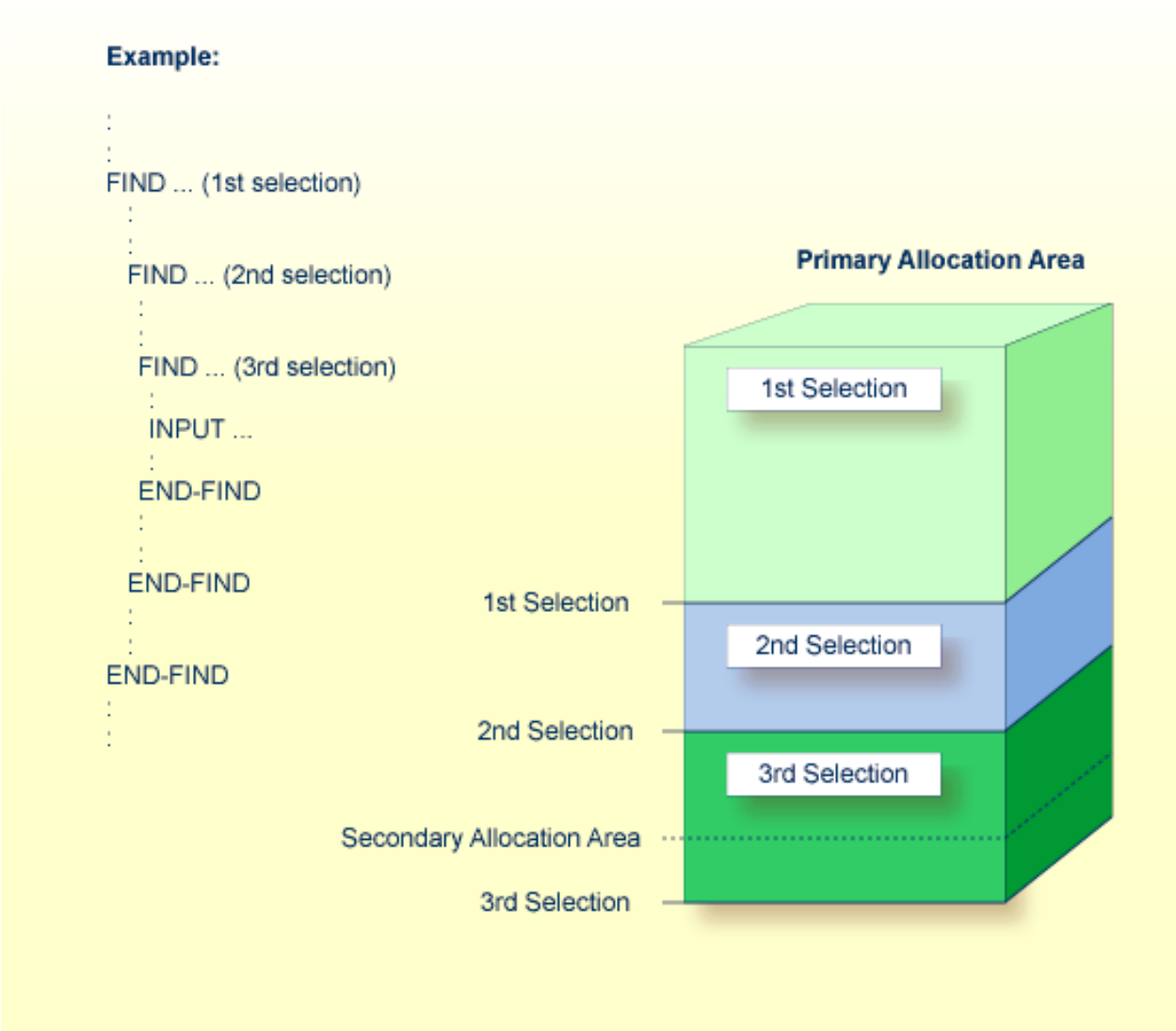
In the following example, the space allocated to the first selection is not released until all rows selected during the third selection have been retrieved. The same applies to the space allocated to the third selection.

The space allocated to the second selection, however, is released immediately after the last row of the corresponding selection result has been retrieved.

Therefore, the space allocated to the second selection can be used for the selection results of the third selection.



If the primary allocation area is not large enough, for example, if the third selection is nested within the second selection, the secondary allocation area is used.



When a session is terminated, all of a user's blocks are returned to the free blocks pool. If a session ends abnormally, Natural checks, where possible, whether a file server directory entry for the corresponding user exists. If so, all resources held by this user are released.

If Natural is unable to free the resources of an abnormally-ended user session, these resources are not released until the same user ID logs on from the same logical terminal again.

If the same user ID and/or logical terminal are not used again for Natural, the existing directory entry and the allocated space remain until the file server is formatted again. A new run of the formatting job deletes all existing data and recreates the directory.

22 Natural for SQL/DS

This documentation describes the functionality and the use of Natural for SQL/DS, which is a Natural interface required to access data in a SQL/DS database.

General Information	Information such as purpose, special considerations on the various environments supported by Natural for SQL/DS, integration with Software AG's Data Dictionary Predict, incompatibilities and constraints, error messages related to SQL/DS, and terms used in this documentation.
Installing Natural for SQL/DS	Installation of the Natural interface to SQL/DS and description of the Natural for SQL/DS parameter module.
Accessing an SQL/DS Table	Enable access to an SQL/DS table with a Natural program.
Database Management	Maintenance of SQL/DS tables and other SQL/DS objects with the `SYSSQL` utility; Natural system commands for SQL/DS.
Generating Natural Data Definition Modules (DDMs)	Generation of Natural data definition modules (DDMs) by using the **SQL Services** function of the Natural utility `SYSDDM`.
Dynamic and Static SQL Support	Internal handling of dynamic statements, creation and execution of static DB access modules (SQL/DS packages) in the various supported environments, mixed dynamic/static mode.
Using Natural Statements and System Variables	Special considerations on Natural native DML statements, Natural SQL statements, Natural system variables, and Natural for SQL/DS error handling.
Interface Subprograms	Several Natural and non-Natural subprograms to be used for various purposes.

Related Documentation

For the various aspects of accessing data in a database with Natural, see also *Accessing Data in a Database* in the Natural *Programming Guide*.

For information on logging SQL statements contained in a Natural program, refer to *DBLOG Trace Screen for SQL Statements* in the *DBLOG Utility* documentation.

23 General Information

This section covers the following topics:

Purpose

With the Natural interface to SQL/DS, a Natural user can access data in an SQL/DS database. Natural for SQL/DS is supported in CICS and batch environments under z/VSE.

In general, there is no difference between using Natural with SQL/DS and using it with Adabas, DB2 or DL/I. The Natural interface to SQL/DS allows Natural programs to access SQL/DS data by using the same Natural DML statements that are available for Adabas, DB2 and DL/I. Therefore, programs written for SQL/DS tables can also be used to access Adabas, DB2 or DL/I databases. In addition, Natural SQL statements are available.

All operations requiring interaction with SQL/DS are performed by the Natural interface module.

Environment-Specific Considerations

Natural for SQL/DS can be run in the TP-monitor environment CICS and in z/VSE batch mode.

Important: As all dynamic access to SQL/DS is performed by `NDBIOMO`, all users of Natural for SQL/DS must have `RUN` privilege on the package `NDBIOMO`. If running in static mode, users must also have `RUN` privilege on all static SQL/DS packages.

This section covers the following topics:

- Natural for SQL/DS under CICS
- Natural for SQL/DS in z/VSE Batch Mode

Natural for SQL/DS under CICS

Under CICS, Natural uses the SQL/DS online support to access SQL/DS. Therefore ensure that this attachment is started. If not, the Natural session is abnormally terminated with CICS abend code `AEY9`, which leads to Natural error message NAT0954 if the Natural profile parameter `DU` is set to `OFF`.

Since Natural for SQL/DS does not issue any explicit `CONNECT` statements, it takes advantage of the implicit `CONNECT` facility of the SQL/DS online support.

Under CICS, a Natural program which accesses an SQL/DS table can also be run in pseudo-conversational mode. Then, at the end of a CICS task, all SQL/DS cursors are closed, and there is no way to reposition an SQL/DS cursor when the task is resumed.

To circumvent the problem of CICS terminating a pseudo-conversational transaction during loop processing and thus causing SQL/DS to close all cursors and lose all selection results, Natural switches from pseudo-conversational mode to conversational mode for the duration of a Natural loop which accesses an SQL/DS table.

To enable multiple Natural sessions to run concurrently, all Natural areas are written to the threads just before a terminal I/O operation is executed. When the terminal input is received, storage is acquired again, and all Natural areas are read from the threads.

Natural for SQL/DS in z/VSE Batch Mode

An explicit connection to the database must be performed. The sample program `DEM2CONN` can be used for this purpose. `DEM2CONN` calls the `DB2SERV` module with function code `U` which in turn calls the database connect services.

Integration with Predict

Predict, Software AG's open, operational data dictionary for fourth-generation-language development with Natural, is a central repository of application metadata and provides documentation and cross-reference features. Predict lets you automatically generate code from definitions, enhancing development and maintenance productivity.

Since Predict supports SQL/DS, direct access to the SQL/DS catalog is possible via Predict, and information from the SQL/DS catalog can be transferred to the Predict dictionary to be integrated with data definitions for other environments.

SQL/DS databases, tables and views can be incorporated and compared, new SQL/DS tables and views can be generated and Natural DDMs can be generated and compared. All SQL/DS-specific data types and the referential integrity of SQL/DS are supported. See the relevant Predict documentation for details.

In addition, Predict active references support static SQL for SQL/DS.

Integration with Natural Security

When run in an environment that is controlled by Natural Security, the use of certain features of Natural for SQL/DS can be restricted by the security administrator, for example:

- **Static SQL**

  Static generation can be disallowed by

  - restricting access to the Natural system library `SYSSQL`,

- disallowing the module CMD,
- restricting access to the libraries that contain the relevant Natural objects,
- disallowing one of the Natural system commands `CATALOG` or `STOW` for a library that contains relevant Natural objects.

If a library is defined in Natural Security and the DBID and FNR of this library are different from the default specifications, the static generation procedure automatically switches to the DBID and FNR specifications defined in Natural Security.

For further information, ask your security administrator.

Messages Related to SQL/DS

The message number ranges of Natural system messages related to SQL/DS are 3700-3749 4750 - 4799, 6700 - 6799 and 7386-7395.

For a list of error messages that may be issued during static generation, see *Static Generation Messages and Codes Issued under NDB/NSQ* in the Natural *Messages and Codes* documentation.

Terms Used in this Documentation

Term	Explanation
DB2	DB2 refers to IBM's DB2 UDB for z/OS.
DBRM	Database request module
DDM	Data definition module.
DML	Data manipulation language (Natural).
NSQ	This is the product code of Natural for SQL/DS. In this documentation the product code is often used as prefix in the names of datasets, modules, etc.
SQL/DS	SQL/DS refers to IBM's DB2 Server for VSE and VM.

24 Installing Natural for SQL/DS

This section describes step by step how to install the Natural interface to SQL/DS.

This section covers the following topics:

Notation vrs or vr: If used in the following document, the notation `vrs` or `vr` stands for the relevant version, release, system maintenance level numbers. For further information on product versions, see Version in the *Glossary*.

Installation Jobs

The installation of Software AG products is performed by installation "jobs". These jobs are either created "manually" or generated by System Maintenance Aid (SMA).

For each step of the installation procedures described later in this section, the job number of a job performing the respective task is indicated. This job number refers to an installation job generated by SMA. If you are not using SMA, an example job of the same number is provided in the job library on the Natural for SQL/DS installation tape; you must adapt this example job to your requirements. That the job numbers on the tape are preceded by a product code (for example, `NSQI070`).

Using System Maintenance Aid

For information on using Software AG's System Maintenance Aid for the installation process, refer to the *System Maintenance Aid* documentation.

Prerequisites

- Base Natural must be installed first; you cannot install Natural and Natural for SQL/DS at the same time.
- The Software AG Editor must be installed (as described in the Natural *Installation* documentation).

Further product/version dependencies are specified under *Natural and Other Software AG Products* and *Operating/Teleprocessing Systems Required* in the current Natural *Release Notes*.

Installation under CMS

This section only applies to the installation of Natural for SQL/DS under CMS.

Installation Tape

The installation tape was created under z/OS; it has standard z/OS labels and headers. It contains the datasets listed in the table below. The sequence of the datasets is shown in the *Report of Tape Creation* which accompanies the installation tape.

Dataset Name	Contents
`NSQvrs.TAPE`	Natural for SQL/DS source modules, load modules and installation EXECs. This dataset is in TAPE DUMP format and must be loaded onto the installation minidisk.
`NSQvrs.INPL`	Natural for SQL/DS utility programs in `INPL` format.
`NSQvrs.ERRN`	Natural for SQL/DS error messages.

The notation *vrs* in dataset names represents the version number of the product.

Copying the Tape Contents to Disk

The tape file `NSQnnn.TAPE` was created with the CMS TAPE DUMP facility. Load the contents of the tape to your A-disk. The free space should be at least 450 4-KB blocks; for example, 3 cylinders on 3350 or 3380 disks.

Ask the system operator to attach a tape drive to your virtual machine at address `X'181'` and mount the Natural for SQL/DS installation tape.

To position the tape for the `TAPE LOAD` command, calculate the number of tape marks as follows: If the sequence number of `NSQnnn.TAPE` - as shown by the *Report of Tape Creation* - is *n*, you must position over 3*n*-2 tape marks; that is, FSF 1 for the first dataset, FSF 4 for the second, etc.

Position the tape by issuing the CMS command:

```
TAPE FSF fsfs
```

where *fsfs* is calculated as described above.

Load the Natural for SQL/DS installation material by issuing the CMS command:

```
TAPE LOAD * * A
```

You may wish to keep the tape drive attached to your virtual machine, because the tape is still needed in Step 7 of the installation procedure.

Preparing the Installation

Perform the following steps to prepare the installation of Natural for SQL/DS:

1. Ensure that the required SQL/DS database machine is activated in multiple- user mode and that the user machine for this installation is properly configured and initialized to access the SQL/DS database machine.
2. All precompilations as well as Natural for SQL/DS itself take advantage of the implicit CONNECT mechanism provided by VM. Therefore, ensure that the VM user ID is authorized for SQL/DS.
3. Ensure that your user machine has access to the following minidisks: the SQL/DS production minidisk, the Natural installation minidisk.
4. Ensure that the Adabas environment for your user machine is set up.

Concerning the following installation steps, also refer to the section *Installing Natural under VM/CMS* in the Natural *Installation* documentation.

Installation Procedure

Perform the following steps to install Natural for SQL/DS:

Step 1: Generate the NSQ I/O module NDBIOMO

Generate NDBIOMO by using the command:

```
GENIOMO SQL/DS n
```

GENIOMO generates the assembly source for NDBIOMO from the existing source NDBIOTM. It prompts you for the Natural/CMS batch module and invokes the Natural program NDBGENI, which is loaded with INPL during the base Natural installation.

GENIOMO is invoked with the following two parameters:

- the DB-environment parameter, which must be set to SQL/DS,
- the parameter *n* to specify the number of statements for dynamic access; the default value is 10.

NDBIOMO performs the dynamic access to SQL/DS and contains all necessary EXEC SQL statements. In addition, it contains some special SQL statements which cannot be executed in dynamic mode.

An output report is created by this job and should be checked for successful completion. In addition, a condition code of 0 indicates normal completion.

Step 2: Precompile and assemble NDBIOMO

Precompile and assemble NDBIOMO using the command:

```
NDBIOMO
```

Note: Since no precompiler options are specified, the default SQL/DS isolation level Repeatable Read may lead to locking problems, because all SQL/DS locks are held until the end of the transaction. Thus, depending on your application, it may be necessary to specify a different isolation level.

Step 3: Modify and assemble the NSQ parameter module NDBPARM

Assemble NDBPARM using the command:

```
NDBPARM
```

The Natural for SQL/DS parameter module contains the macro NDBPRM, which contains parameters specific to the Natural interface to SQL/DS.

You can generally use the default values for all parameters. Modify only the values of the parameters whose default values do not suit your requirements.

The individual parameters are described in the section *Parameter Module NDBPARM*.

Step 4: Modify NATPARM

Adapt your Natural parameter module NATPARM by adding parameters specific to Natural for SQL/DS as described in the section ***Natural Parameter Modification for SQL/DS***.

Step 5: Modify NAT$LOAD LOADLIST

Edit the member NAT$LOAD EXEC provided on the Natural/CMS installation tape and add the following line to the existing LOADLIST statements:

```
LOADLIST = LOADLIST 'NDBNUC NDBNSQ NDBPARM NDBIOMO ARIRVSTC'
```

Step 6: Generate a Natural module

Generate the Natural/CMS load module using the command:

```
NATBLDM
```

NATBLDM is provided on the Natural CMS installation tape and prompts you for the name of the Natural nucleus and generates the executable Natural module.

Step 7: Load Natural objects and error messages into system file

In this step, the Natural for SQL/DS system programs, maps and DDMs (dataset NSQ*vrs*.INPL) and the Natural for SQL/DS error messages file (dataset NSQ*vrs*.ERRN) are loaded into the Natural system file.

If the tape drive used when copying the contents of the installation tape to disk was detached from your virtual machine, ask the system operator to attach a tape drive to your virtual machine at address X'181' and mount the Natural installation tape.

Issue the following command:

```
NSQINPL
```

You are prompted for the name of the command to invoke Natural. Enter the name of the Natural module generated in the preceding step.

NSQINPL then positions the tape and loads the Natural objects and error messages.

The INPL job loads objects into the libraries SYSDDM, SYSTEM and SYSSQL.

The ERRLODUS job loads error messages into the library SYSERR.

The Natural for SQL/DS system programs and error messages *must* be loaded into the FNAT system file

Caution: Ensure that your newly created `SYSSQL` library contains all necessary Predict interface programs, which are loaded into `SYSSQL` when installing Predict (see the relevant Predict documentation).

Installation under z/VSE

Under z/VSE, Natural for SQL/DS basically consists of two parts:

1. An environment-independent nucleus, which can be linked to a shared Natural nucleus and loaded in the shared virtual area (SVA) of the operating system.
2. Environment-dependent components, which must be linked to the appropriate Natural environment-dependent interface.

This section covers the following topics:

Installation Tape

The installation tape contains the datasets listed in the table below. The sequence of the datasets is shown in the Report of Tape Creation which accompanies the installation tape.

Dataset Name	Contents
`NSQ`*`vrs`*`.LIBR`	LIBR backup file.
`NSQ`*`vrs`*`.INPL`	Natural for SQL/DS utility programs in `INPL` format.
`NSQ`*`vrs`*`.ERRN`	Natural for SQL/DS error messages.

The notation *`vrs`* in dataset names represents the version number of the product.

Copying the Tape Contents to a z/VSE Disk

If you are using SMA, refer to the *System Maintenance Aid* documentation (included in the current edition of the Natural documentation CD).

If you are *not* using SMA, follow the instructions below.

This section explains how to:

- Copy dataset `COPYTAPE.JOB` from tape to disk.
- Modify this dataset to confom with your local naming conventions.

The JCL in this member is then used to copy all datasets from tape to disk.

If the datasets for more than one product are delivered on the tape, the member `COPYTAPE.JOB` contains the JCL to unload the datasets for all delivered products from the tape to your disk, except the datasets that you can directly install from tape, for example, Natural `INPL` objects.

After that, you will have to perform the individual install procedure for each component.

- Step 1 - Copy Dataset COPYTAPE.JOB from Tape to Disk
- Step 2 - Modify COPYTAPE.JOB
- Step 3 - Submit COPYTAPE.JOB

Step 1 - Copy Dataset COPYTAPE.JOB from Tape to Disk

The dataset `COPYTAPE.JOB` contains the JCL to unload all other existing datasets from tape to disk. To unload `COPYTAPE.JOB`, use the following sample JCL:

```
* $$ JOB JNM=LIBRCAT,CLASS=0,                                        +
* $$ DISP=D,LDEST=(*,UID),SYSID=1
* $$ LST CLASS=A,DISP=D
// JOB LIBRCAT
* ****************************************
*     CATALOG COPYTAPE.JOB TO LIBRARY
* ****************************************
// ASSGN SYS004,nnn                                <------  tape address
// MTC REW,SYS004
// MTC FSF,SYS004,4
ASSGN SYSIPT,SYS004
// TLBL IJSYSIN,'COPYTAPE.JOB'
// EXEC LIBR,PARM='MSHP; ACC S=lib.sublib'         <------- for catalog
/*
// MTC REW,SYS004

ASSGN SYSIPT,FEC
/*
/&
* $$ EOJ
```

where:

nnn is the tape address
lib.sublib is the library and sublibrary of the catalog

Step 2 - Modify COPYTAPE.JOB

Modify COPYTAPE.JOB to conform to your local naming conventions and set the disk space parameters before submitting this job.

Step 3 - Submit COPYTAPE.JOB

Submit COPYTAPE.JOB to unload all other datasets from the tape to your disk.

Installation Procedure

The following steps describe the procedure for installing the components of Natural for SQL/DS.

Step 1: Generate the NSQ I/O Module NDBIOMO

Job I055, Step 1600

By executing a standard Natural batch job, this step generates the assembly source for NDBIOMO from the member NDBIOTM.

This batch job invokes the Natural program NDBGENI, which is loaded INPL during the base Natural installation. NDBGENI contains the following two parameters, which can be modified to meet your specific requirements:

- the DB-environment parameter, which must be set to SQL/DS,
- the parameter to specify the number of statements for dynamic access.

NDBIOMO performs the dynamic access to SQL/DS and contains all necessary EXEC SQL statements (see further information on NDBIOMO in the section *Internal Handling of Dynamic Statements*). In addition, it contains some special SQL statements which cannot be executed in dynamic mode.

An output report is created by this job and should be checked for successful completion. In addition, a condition code of 0 indicates normal completion.

Step 2: Precompile and Assemble NDBIOMO

Job I055, Steps 1610 and 1620

Precompile (using the SQL precompiler) and assemble NDBIOMO. Ensure that an appropriate SQL/DS user ID and password is specified for precompiling.

Note: Since no precompiler options are specified, the default SQL/DS isolation level Repeatable Read may lead to locking problems, because all SQL/DS locks are held until the end of the transaction. Thus, depending on your application, it may be necessary to specify a different isolation level.

Step 3: Modify and Assemble the NSQ Parameter Module NDBPARM - Job I055, Step 1640

The Natural for SQL/DS parameter module contains the macro `NDBPRM` with parameters specific to the Natural interface to SQL/DS.

You can generally use the default values for all parameters. Modify only the values of the parameters whose default values do not suit your requirements.

The individual parameters are described in the section ***Parameter Module NDBPARM***.

Step 4: Modify and Reassemble NATPARM

Adapt your Natural parameter module `NATPARM` by **adding parameters specific to Natural for SQL/DS** and reassemble `NATPARM`.

Step 5: Relink your Natural Nucleus

Modify the JCL used to link your Natural nucleus by adding the following `INCLUDE` cards and the corresponding DLBL statements:

`INCLUDE NDBNUC`	Environment-independent Natural for SQL/DS nucleus
`INCLUDE NDBNSQ`	Environment-independent SQL/DS interface
`INCLUDE NDBPARM`	Natural for SQL/DS parameter module created in Step 3
`INCLUDE NDBIOMO`	Natural for SQL/DS I/O module created in Step 1
`INCLUDE` *xxxxxxx*	Environment-dependent SQL/DS interface (see below)

Depending on your environment(s), `INCLUDE` the appropriate environment-specific language interface *xxxxxxxx* as shown in the following table:

Interface	Environment
`ARIPRDID`	In batch mode
`ARIRRTED`	Under CICS

Note: If you want to use Natural for SQL/DS in both environments, repeat this step for each of these environments.

Instead of link-editing your Natural nucleus in the way described above, you have the following alternatives:

1. If you use a shared Natural nucleus, only include `NDBNUC` and `NDBNSQ` in the link-edit of this nucleus. All other modules must be included in the link-edit of your Natural environment-dependent nucleus.

2. Remove NDBNUC and NDBNSQ from the link-edit of the Natural nucleus and link-edit them as a separate module with the mandatory *entry* name NATGWDB2. The *name* of the resulting phase is arbitrary. However, if you use a name different from NATGWDB2, this name must be specified as an alias name in an NTALIAS macro entry of the Natural parameter module. This way of link-editing only applies if the Natural Resolve CSTATIC Addresses feature (RCA) is used.
3. Include all modules in the link-edit job of a separate Natural parameter module with the mandatory *entry* name CMPRMTB. The *name* of the resulting phase is arbitrary. This way of link-editing only applies if an alternative parameter module (PARM profile parameter) is used.
4. If link-editing is done in this way, you can install Natural for SQL/DS without having to modify your Natural nucleus or driver.

If link-editing is done according to number 2. or 3., the following applies:

Under CICS: _ the resulting module must be defined via a PPT entry or RDO:

```
DFHPPT TYPE=ENTRY,PROGRAM=module-name,PGMLANG=ASSEMBLER
```

Step 6: Load Natural Objects Into System File

Job I061, Step 1600

In this step, the Natural for SQL/DS system programs, maps and DDMs are loaded into the Natural system files. The INPL job loads objects into the libraries SYSDDM, SYSTEM and SYSSQL.

The Natural for SQL/DS system programs *must* be loaded into the FNAT system file.

Caution: Ensure that your newly created SYSSQL library contains all necessary Predict interface programs, which are loaded into SYSSQL when installing Predict (see the relevant Predict documentation).

Step 7: Load Natural Error Messages into System File

Job I061, Step 1620

This step executes a batch Natural job that runs an error load program using the NSQ *nnn*.ERRN dataset as input. The ERRLODUS job loads error messages into the library SYSERR in the FNAT system file.

The Natural for SQL/DS error messages *must* be loaded into the Natural FNAT system file.

Installation Verification

This section covers the following topics:

- Prepare your SQL/DS Environment
- Online Verification Methods
- Sample Batch Verification Job - z/VSE only

Prepare your SQL/DS Environment

As all dynamic access to SQL/DS is performed by `NDBIOMO`, all Natural for SQL/DS users must have `RUN` privilege on `NDBIOMO`.

Online Verification Methods

To verify the installation of the Natural interface to SQL/DS online, you can use either of the following methods:

- SQL Services
- DEM2* Sample Programs

SQL Services

Perform the following steps to verify and check the installation of Natural for SQL/DS using the SQL Services of the Natural utility `SYSDDM`.

1. Invoke Natural.
2. Invoke `SYSDDM`.

   On the `SYSDDM` main menu enter function code `B` to invoke the SQL Services function.

   Enter function code `S` to select all SQL/DS tables.

   The communication between Natural and SQL/DS works if all existing SQL/DS tables are displayed.
3. For one of the tables, generate a Natural DDM as described in the section ***Generate DDM from an SQL Table***.

To enable SYSDDM to generate a DDM, the Natural administrator requires access to the following SQL/DS tables:

SYSTEM.SYSCATALOG
SYSTEM.SYSCOLUMNS
SYSTEM.SYSINDEXES
SYSTEM.SYSVIEWS
SYSTEM.SYSSYNONYMS
SYSTEM.SYSUSAGE

4. After you have generated a DDM, access the corresponding SQL/DS table with a simple Natural program:

   Example:

```
FIND view-name WITH field = value
  DISPLAY field
LOOP
END
```

5. If you receive the message SYSFUL 3700, enter the command SQLERR to display the corresponding SQL return code. See the description of the **SQLERR** command.

DEM2* Sample Programs

To verify and test your installation you can also use the sample programs DEM2* in the library SYSSQL provided on the installation tape.

Using these sample programs, you can create an SQL/DS table using DEM2CREA and create the corresponding DDM via SYSDDM. You can then store data in the created table using DEM2STOR and retrieve data from the table using DEM2FIND or DEM2SEL. You can also drop the table using program DEM2DROP.

Sample Batch Verification Job - z/VSE only

To verify the installation of the Natural interface to SQL/DS, a sample batch verification job (Job I065) is provided. This step contains sample JCL and sample programs to test Natural with Natural for SQL/DS in batch mode.

The sample program DEM2CONN performs the connection to the database, which is required before you can run a Natural program that accesses SQL/DS. DEM2CONN calls the DB2SERV module with function code U which in turn calls the database connect services.

Sample program DEM2JOIN performs a JOIN combining information from SQL/DS SYSTEM.SYSDBSPACE and SYSTEM.SYSCATALOG.

Natural Parameter Modification for SQL/DS

This section covers the following topics:

- DB2SIZE Parameter
- NTDB Macro
- Performance Considerations for the DB2SIZE Parameter

DB2SIZE Parameter

Add the following Natural profile parameter to your NATPARM module:

```
DB2SIZE=nn
```

The DB2SIZE parameter can also be specified dynamically. It indicates the size of the SQL/DS buffer area, which should be set to at least 6 KB.

The setting of DB2SIZE can be calculated according to the following formula:

```
((808 + n1 * 40 + n2 * 100) + 1023) / 1024 KB
```

The variables *n1* and *n2* correspond to:

n1	the number of statements for dynamic access as specified as the second parameter in job I055, step 1600 (under z/VSE).
n2	the maximum number of nested database loops as specified with the MAXLOOP parameter in NDBPARM.

Note: Ensure that you have also added the Natural parameters required for the Software AG Editor (see *Installing the Software AG Editor* in the Natural *Installation* documentation).

Since DB2SIZE applies to Natural for SQL/DS and Natural for DB2, it should be set to the maximum value if you run more than one of these environments.

NTDB Macro

Add an NTDB macro for database type SQL specifying the list of logical database numbers that relate to SQL/DS tables. All Natural DDMs that refer to an SQL/DS table must be cataloged with a DBID from this list.

DBIDs can be any number from 1 to 254; a maximum of 254 entries can be specified. For most user environments, one entry is sufficient.

Note: Ensure that all Natural for SQL/DS DDMs used when cataloging a given program have a valid SQL/DS DBID. Also ensure that the DBIDs selected in the NTDB macro for SQL/DS do not conflict with DBIDs selected for other database systems.

The DBID for SQL/DS used when cataloging a Natural program does not have to be in the NTDB list of DBIDs used when executing this program. Therefore, when executing existing Natural programs, DBID 250 is not mandatory.

Two sample NTDB macros follow:

```
NTDB SQL,250
```

```
NTDB SQL,(200,250,251)
```

Performance Considerations for the DB2SIZE Parameter

During execution of an SQL statement, storage is allocated dynamically to build the SQLDA for passing the host variables to SQL/DS.

In previous Natural for SQL/DS versions, this storage was always obtained from the TP monitor or operating system. For performance reasons, it is now first attempted to meet the storage requirements by free space in the Natural for SQL/DS buffer (DB2SIZE). Only if there is not enough space available in this buffer, the TP monitor or operating system is invoked.

To take advantage of this performance enhancement, you must specify your DB2SIZE larger than calculated according to the **formula**. The additional storage requirements (in bytes) can be calculated as follows:

- With sending fields:

  ```
  64 + n * 56
  ```

  where *n* is the number of sending fields in an SQL statement.

  The storage is freed immediately after the execution of the SQL statement.
- With receiving fields (that is, with variables of the `INTO` list of a `SELECT` statement):

  ```
  64 + n * 56 + 24 + n * 2
  ```

  where *n* is the number of receiving fields in an SQL statement.

  The storage remains allocated until the loop is terminated.

Example:

If you use the default value `10` for both variables (*n1* and *n2*), the calculated `DB2SIZE` will be 2200 bytes. However, if you specify a `DB2SIZE` of 20 KB, the available space for dynamically allocated storage will be 18272 bytes, which means enough space for up to either 325 sending fields or 313 receiving fields.

As space for receiving fields remains allocated until a database loop is terminated, the number of fields that can be used inside such a loop is reduced accordingly: for example, if you retrieve 200 fields, you can update about 110 fields inside the loop.

Note: When using `VARCHAR` fields (that is, fields with either an accompanying `L@` field in the Natural view or an explicit `LINDICATOR` clause), additional storage is allocated dynamically if the `L@` or `LINDICATOR` field is not specified directly in front of the corresponding base field. Therefore, always specify these fields in front of their base fields.

Parameter Module NDBPARM

The source module `NDBPARM` is used in several Natural add-on products. It contains parameter macros specific to an SQL environment:

- `NDBPRM`
- `NDBID`

These macros are described below.

Parameter Macro NDBPRM

The default values of the parameters contained in this macro can be modified to meet site-specific requirements (see the corresponding step of the *Installation Procedure*). The values of the parameters cannot be dynamically overwritten.

Complete List of Parameters Contained in NDBPRM

Below is a description of all parameters contained in the `NDBPRM` macro:

`BTIGN` | `CONVERS` | `CONVRS2` | `DDFSERV` | `DELIMID` | `EBPFSRV` | `EBPPRAL` | `EBPSEC` | `EBPMAX` | `ETIGN` | `FSERV` | `MAXLOOP` | `NNPSF` | `PSCIGN` | `REFRESH` | `RETRYPO` | `RWRDONL` | `STATDYN`

List of Parameters Applicable to Natural for SQL/DS

The following parameters in the `NDBPRM` parameter macro are relevant to Natural for SQL/DS. All other parameters contained in the module are ignored.

`BTIGN` | `CONVERS` | `CONVRS2` | `DELIMID` | `MAXLOOP` | `PSCIGN` | `REFRESH` | `RWRDONL` | `STATDYN`

BTIGN - Ignore BACKOUT TRANSACTION Error

`BTIGN` is used to ignore the error which results from a BACKOUT TRANSACTION statement that was issued too late for backing out the current transaction, because an implicit Syncpoint has previously been issued by the TP monitor.

Possible Values:

Value	Explanation
`ON`	The error after a late `BACKOUT TRANSACTION` is ignored. This is the default value.
`OFF`	The error after a late `BACKOUT TRANSACTION` is *not* ignored.

CONVERS - Conversational Mode under CICS

This parameter is used to allow conversational mode in CICS environments.

Possible Values:

Value	Explanation
ON	Conversational mode is allowed. This is the default value.
OFF	Conversational mode is *not* allowed.

If this parameter is set to OFF and no Natural file server is used, you cannot continue database loops across terminal I/Os; if so, the DB2 SQL codes -501, 504, 507, 514, or 518 may occur.

If you use SYSDDM SQL Services in a CICS environment, specify CONVERS=ON, otherwise the aforementioned errors could occur. See also the section ***SQL Services***.

CONVRS2 - Allow Conversational Mode 2 under CICS

This parameter is used to allow conversational mode 2 in CICS environments.

Possible Values:

Value	Explanation
ON	Conversational mode 2 is allowed.
OFF	Conversational mode 2 is *not* allowed. This is the default value.

This parameter is used to control conversational mode 2 in CICS environments. Conversational mode 2 means that update transactions are spawned across terminal I/Os until either an explicit COMMIT or explicit ROLLBACK has been issued (Caution: DB2 and CICS resources are kept across terminal I/Os!). This means CONVRS2=ON has the same effect as the Natural parameter PSEUDO=OFF, except that the conversational mode is entered after an DB2 update statement (UPDATE, DELETE, INSERT) and left again after a COMMIT or ROLLBACK, while PSEUDO=OFF causes conversational mode for the total Natural session.

See also CALLNAT subprogram NDBCONV, which allows setting or resetting conversational mode 2 dynamically.

DDFSERV - Alternate DD Name for Natural File Server

This parameter specifies a DD name for the Natural file server module other than CMFSERV.

Possible Values:

Value	Explanation
DD-name	Any valid DD name. There is no default value.

DELIMID - Escape Character for Delimited Identifiers

This parameter determines the escape character to be used for generating delimited SQL identifiers for the column names and table names in SQL statements. A delimited identifier is a sequence of one or more characters enclosed in escape characters. You must specify a delimited identifier if you use SQL-reserved words for column names and table names, as demonstrated in the *Example of DELIMID* below.

Possible Values:

Value	Explanation
"	Double quotation mark
'	Single quotation mark
None	No value: Delimited identifiers are not enabled. This is the default value.

To enable generation of delimited identifiers, `DELIMID` must be set to double quotation mark (") or single quotation mark (').

The escape character specified for `DELIMID` and the SQL `STRING DELIMITER` are mutually exclusive. This implies that the mark (double or single quotation) used to enclose alphanumeric strings in SQL statements must be different from the value specified for `DELIMID`. If you enable delimited identifiers, ensure that the value specified for `DELIMID` also complies with the SQL `STRING DELIMITER` value of your DB2 installation.

See also the `RWRDONL` parameter to determine which delimited identifiers are generated in the SQL string.

Example of DELIMID:

In the following example, a double quotation mark (") has been specified as the escape character for the delimited identifier:

Natural statement:

```
SELECT FUNCTION INTO #FUNCTION FROM XYZ-T1000
```

Generated SQL string:

```
SELECT "FUNCTION" FROM XYZ.T1000
```

EBPFSRV - Editor Buffer Pool for Natural File Server

Note: This parameter does not apply to Natural for SQL/DS and is ignored.

This parameter is used to determine whether the Natural file server uses the Software AG Editor buffer pool as the storage medium.

Possible Values:

Value	Explanation
ON	The Software AG buffer pool is to be used as the storage medium for the Natural file server. ON *must* be set if the file server is to be used in a Parallel Sysplex environment. In this case, your Natural session must use the auxiliary editor buffer pool (see also *Support of a z/OS Parallel Sysplex Environment* in the *Installation* documentation).
OFF	A VSAM file is to be used as the storage medium for the Natural file server. This is the default value.

EBPPRAL - Editor Buffer Pool Primary Allocation

Note: This parameter does not apply to Natural for SQL/DS and is ignored.

This parameter specifies the number of blocks to be allocated primarily to each user of the Natural file server, if the Software AG Editor buffer pool is used as the storage medium.

Possible Values:

Value	Explanation
0 - 32676	Number of blocks to be allocated primarily.
20	This is the default value.

If the EBPFSRV parameter is set to OFF, EBPPRAL is not used at runtime.

EBPSEC - Editor Buffer Pool Secondary Allocation

Note: This parameter does not apply to Natural for SQL/DS and is ignored.

This parameter specifies the number of blocks to be allocated secondarily to each user of the Natural file server if the Software AG Editor buffer pool is used as the storage medium. The secondary allocation is used to allocate buffer pool blocks to the user if the primary allocation amount is already exhausted.

Possible Values:

Value	Explanation
`0 - 32676`	Number of blocks to be allocated secondarily.
`10`	This is the default value.

If the `EBPFSRV` parameter is set to `OFF`, `EBPSEC` is not used at runtime.

EBPMAX - Editor Buffer Pool Maximum Allocation

Note: This parameter does not apply to Natural for SQL/DS and is ignored.

This parameter specifies the maximum number of blocks to be allocated to each user of the Natural file server if the Software AG Editor buffer pool is used as the storage medium. This parameter serves as upper limit for the allocation of buffer pool blocks to a single user.

Possible Values:

Value	Explanation
`0 - 32676`	Maximum number of blocks to be allocated.
`100`	This is the default value.

If the `EBPFSRV` parameter is set to `OFF`, `EBPMAX` is not used at runtime.

ETIGN - Ignore END TRANSACTION Error

Note: This parameter does not apply to Natural for SQL/DS and is ignored.

This parameter is relevant in IMS TM MPP and message-oriented BMP environments only.

It is used to handle `END TRANSACTION` statements in a message-driven IMS region (MPP or message-oriented BMP).

In such a region, an `END TRANSACTION` cannot be executed by the Natural/IMS interface and is therefore ignored without any notification. In such situations, the `ETIGN` parameter can be used to issue an error message instead.

Possible Values:

Value	Explanation
`ON`	The `END TRANSACTION` error is ignored and processing is continued. This is the default value.
`OFF`	The `END TRANSACTION` error is *not* ignored.

FSERV - Activate Natural File Server

Note: This parameter does not apply to Natural for SQL/DS and is ignored.

This parameter determines whether the Natural file server is to be used and whether it can be disabled in the case of an initialization error.

Possible Values:

Value	Explanation
`ON`	Natural file server is to be used.
`OFF`	Natural file server is not to be used. This is the default value.
`DIS`	Natural file server is to be used but is to be disabled if it cannot be initialized.

If `FSERV` is set to `ON` and the file server is not operational, the initialization of the Natural SQL Gateway is terminated with a corresponding Natural error message. The Natural SQL Gatewayis disabled and any SQL call is rejected with a corresponding error message.

MAXLOOP - Maximum Number of Nested Program Loops

This parameter specifies the maximum possible number of nested database loops accessing SQL databases.

Possible Values:

Value	Explanation
`1 - 99`	Maximum possible number of nested database loops.
`10`	This is the default value.

NNPSF - Set Natural Numerics' Positive Sign to F

Note: This parameter does not apply to Natural for SQL/DS and is ignored.

This parameter changes the sign character of positive Natural variables which have format N, if they are filled from the SQL database system. Usually these variables have the `C` as positive sign character. If the parameter `NNPSF` is set to `ON`, `F` is used as positive sign character.

Possible Values:

Value	Explanation
`ON`	Positive numbers put into Natural numeric variables by the SQL database system get the sign `F`.
`OFF`	Positive numbers put into Natural numeric variables by the SQL database system remain unchanged. This is the default value.

PSCIGN - Treat Positive Sqlcodes as Slqcode 0

This parameter influences the treatment of positive sqlcodes returned from the SQL database system. If the parameter `PSCIGN` is set to `OFF`, a NAT3700 error message is issued. If the parameter `PSCIGN` is set to `ON`, positive sqlcodes are treated as if they were zero, that is, no NAT3700 error message is issued.

Possible Values:

Value	Explanation
`ON`	Positive sqlcodes are treated as zero.
`OFF`	Positive sqlcodes cause a NAT3700 error message. This is the default value.

REFRESH - Refresh Setting of DB2 Server

This parameter is used to automatically set the DB2 server to the value that applied when the last transaction was executed.

Server is refreshed by using the `CONNECT` *`user`* `IDENTIFIED BY` *`password`* `TO` *`server-name`* SQL statement of DB2.

Possible Values:

Value	Explanation
ON	An automatic refresh is performed every time before a database transaction starts.
OFF	No automatic refresh is performed. This is the default value.

RETRYPO - Number of Positioning Retries

Note: This parameter does not apply to Natural for SQL/DS and is ignored.

This parameter delimits the number of retries in order to reposition a dynamic scrollable cursor in a pseudo-conversational environment (IMS MPP or CICS).

Possible Values:

Value	Explanation
0 - 2147483648	Number of retries.
10	This is the default value.

This parameter applies only for dynamic scrollable cursors.

In pseudo-conversational environments, cursors are closed at terminal I/O. For dynamic scrollable cursors the current absolute position number and the current key column values are saved. After terminal I/O the dynamic scrollable cursor is opened again and positioned absolutely to the position of the saved absolute position. The contents of the key columns are compared with the saved values. If they match, processing continues with the next requested database operation.

If the contents of the key columns do not match the saved values, the next rows are fetched and compared with the saved values until either the values match or no row is found or the RETRYPO count is exhausted. In the latter cases the cursor is repositioned to the saved position and the prior rows are fetched and compared until either the values match or no row is found or the RETRYPO count is exhausted. In the latter cases a NAT3703 error message is issued. If a row is fetched whose key columns matches the saved values, processing continues with the next database instruction.

RETRYPO delimits the retries in each direction (*next* or *prior*).

If RETRYPO is zero no repositioning takes place.

RWRDONL - Generate Delimited Identifiers for Reserved Words Only

This parameter determines which identifiers are generated as delimited identifier in an SQL string. `RWRDONL` only takes effect if the setting of the `DELIMID` parameter allows delimited identifiers.

Possible Values:

Value	Explanation
`ON`	Only identifiers that are reserved words are generated as delimited identifiers. The list of reserved words is contained in the `NDBPARM` macro. This list has been merged from the lists of reserved words for DB2 for z/OS, DB2 for VSE/VM, DB2 for LINUX, OS/2, Windows and UNIX, and ISO/ANSI SQL99. This is the default value.
`OFF`	All identifiers are generated as delimited identifiers.

STATDYN - Allow Static to Dynamic Switch

This parameter is used to allow dynamic execution of statically generated SQL statements if the static execution returns an error.

Possible Values:

Value	Explanation
`NEVER`	Dynamic execution is never allowed. This is the default value.
`ALWAYS`	Dynamic execution is always allowed after an error.
`SPECIAL`	Dynamic execution is allowed after special errors only. These special errors are: ■ NAT3706: Load module not found ■ SQL -805: DBRM (database request module) does not exist in plan ■ SQL -818: Mismatch of timestamps

Parameter Macro NDBID

The parameter macro `NDBID` determines the database type of an SQL DBID.

The `NDBID` macro is specified as follows:

1. Default Database Definition

   The default database type is specified as follows. It applies to all database IDs not explicitly specified by `NDBID`.

   ```
   NDBID=database-type
   ```

2. Single Database Definition

   A single database ID and its type is specified as follows:

   ```
   NDBID=database-type,database-id
   ```

3. Multiple Database Definition

   Multiple database IDs of the same database type can be specified together, enclosed in parentheses:

   ```
   NDBID=(database-type,database-id1,database-id2,...)
   ```

database-type

Possible Values	Explanation
DB2	Databases are accessed via NDB. This is the default value.

database-id

Possible Values	
1-254	

25 Accessing an SQL/DS Table

To be able to access an SQL/DS table with a Natural program

1 Use the `SYSSQL` utility to define an SQL/DS table.

2 Use Predict or the **SQL Services** function of the Natural `SYSDDM` utility to create a Natural data definition module (DDM) of the defined SQL/DS table.

3 Once you have defined a DDM for an SQL/DS table, you can access the data stored in this table by using a Natural program.

The Natural interface to SQL/DS translates the statements of a Natural program into SQL statements.

Natural automatically provides for the preparation and execution of each statement. In dynamic mode, a statement is only prepared once (if possible) and can then be executed several times. For this purpose, Natural internally maintains a **table of all prepared statements**.

Almost the full range of possibilities offered by the Natural programming language can be used for the development of Natural applications which access SQL/DS tables. For a number of Natural native DML statements, however, there are certain restrictions and differences as far as their use with SQL/DS is concerned; see ***Using Natural Native DML Statements***. In the section *SQL Statements* in the Natural *Statements* documentation, you can find notes on Natural usage with SQL/DS in the descriptions of the statements concerned.

As there is no SQL/DS equivalent to Adabas internal sequence numbers (ISNs), any Natural features which use ISNs are not available when accessing SQL/DS tables with Natural.

For SQL databases, in addition to the Natural native DML statements, Natural provides SQL statements; see ***Using Natural SQL Statements***. In the section *SQL Statements* in the Natural *Statements* documentation you can find a detailed description of these statements.

26 Database Management

This section covers the following topics:

SYSSQL Utility

The Natural interactive catalog utility SYSSQL allows you to do SQL/DS database management without leaving your development environment.

With SYSSQL you can maintain SQL/DS tables and other SQL/DS objects.

The SYSSQL utility incorporates an SQL generator that automatically generates from your input the SQL code required to maintain the desired SQL/DS object. You can display, modify, save and retrieve the generated SQL code.

The DDL/DCL definitions are stored in the library SYSSQL on the Natural system file FDIC.

The SYSSQL utility offers two modes of operation: Fixed Mode and Free Mode. To switch between the two modes, you press PF4.

- Fixed Mode
- Free Mode

Fixed Mode

In fixed mode, input screens with syntax graphs help you to specify correct SQL code. You simply enter the required data on input screens, and the data are automatically checked to ensure that they comply with the SQL syntax of SQL/DS. Then, SQL members are generated from the entered data. The members can be executed directly by pressing PF5 (Exec). But you can also switch to free mode, where the generated SQL code can be modified.

For each field where a window can be invoked, you can specify an S. When you press Enter, the window appears and you can select or enter the necessary information. If such a selection is required, an S is already preset when the corresponding screen is invoked.

When you press Enter again, the window closes and if data have been entered, the field is marked with X instead of S. If not, the field is left blank or marked with S again.

This continues each time you press Enter until no S remains. To redisplay a window where data have been entered, you change its X mark back to S.

If another letter or character is used, an appropriate error message appears on the screen. The wrong character is automatically replaced by an S and if you press Enter again, the corresponding window appears.

In fields where keywords are to be entered, you have to enter one of the keywords displayed beneath the field. Default keywords are highlighted.

Creating an SQL/DS Table

The following example illustrates how to use the SYSSQL utility to create an SQL/DS table in fixed mode.

To create an SQL/DS table in fixed mode

1 Log on to library SYSSQL and issue the command MENU.

The SYSSQL **Main Menu** appears:

```
14:41:38                  **** SYSSQL Utility ****                2006-05-25
                                - Main Menu -


   +---------- Maintenance ---------+   +--------- Authorizations -------+

   !   x CREATE                     !   !   _ GRANT                      !

   !   _ ACQUIRE DBSPACE            !   !   _ REVOKE                     !

   !   _ ALTER                      !   !   _ LOCK TABLE                 !

   !   _ DROP                       !   !   _ CONNECT                    !

   !   _ UPDATE STATISTICS          !   !                                !

   +------------------------------+   +------------------------------+

                     +-------- Descriptions ----------+

                     !   _ EXPLAIN                   !

                     !   _ COMMENT ON                !

                     +-------------------------------+


   +---------------------------- Comments -------------------------------+

   !  Enter ? for HELP or press PF1                                      !

   !  Enter . to QUIT or press PF12                                      !

   !  Press PF4 to enter Free-Mode                                       !

   +-----------------------------------------------------------------------+
```

```
Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help              Free                                            Exit

 SYSSQL4776 Please mark your choice.
```

2 Mark the **CREATE** function with an `X`.

Awindow is invoked which shows you a list of all available objects, and you are prompted for the type of object to be created::

```
14:41:39                  **** SYSSQL Utility ****                2006-05-25
                                - Main Menu -



    +---------- M +------------------+   +--------- Authorizations -------+

    !   x CREATE  !    _ INDEX       !   !   _ GRANT                      !

    !   _ ACQUIRE !    _ SYNONYM     !   !   _ REVOKE                     !

    !   _ ALTER   !    x TABLE       !   !   _ LOCK TABLE                 !

    !   _ DROP    !    _ VIEW        !   !   _ CONNECT                    !

    !   _ UPDATE  !                  !   !                                !

    +------------ +------------------+   +--------------------------------+

                      +-------- Descriptions ----------+

                      !   _ EXPLAIN                    !

                      !   _ COMMENT ON                 !

                      +--------------------------------+



    +---------------------------- Comments -------------------------------+

    !  Enter ? for HELP or press PF1                                       !

    !  Enter . to QUIT or press PF12                                       !

    !  Press PF4 to enter Free-Mode                                        !
```

```
    +-----------------------------------------------------------------------+



Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help             Free                                          Exit

SYSSQL4776 Please mark your choice.
```

3 Mark the **TABLE** keyword with an `X` and press Enter.

The first **Create Table** syntax input screen is displayed:

```
14:44:52                 **** SYSSQL/DS Utility ****              2006-05-25
                              - Create Table -                    Page: 01



>>---- CREATE TABLE ----- SAG_____ . PERSONNEL_________ ---------------------->
                             <creator.>table-name



>- PERS-NO___________  DECIMAL________ ( 8____ ) NN -- _ -- _ -- _ -( S_ - A +
+- NAME_______________  CHAR___________ ( 25___ ) NN -- _ -- _ -- _ -- __ - _ +
+- FIRST-NAME________  CHAR___________ ( 25___ ) NN -- _ -- _ -- _ -- __ - _ +
+- AGE________________  DECIMAL________ ( 2____ ) NN -- _ -- _ -- _ -- __ - _ +
+- SALARY_____________  DECIMAL________ ( 5,2__ ) __ -- _ -- _ -- _ -- __ - _ +
+- FUNCTION___________  INTEGER________ ( _____ ) __ -- _ -- _ -- _ -- __ - _ +
+- EMPL_SINCE_________  DATE___________ ( _____ ) NN -- _ -- _ -- _ -- __ - _ +
+- ___________________  _______________ ( _____ ) __ -- _ -- _ -- _ -- __ - _ )
       column-name         format        length  NN    S  field CCS  PRIMARY !
                                                 NU    M  proc  ID   KEY A/D !
                                                 NP    B     +---------------+
                                                                +- PCTFREE=  __ ->
                                                                              0-99




Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help  Next         Free  Exec  Top   Bwd   Fwd   Bot         Error Menu
```

You can enter the creator and table names on this screen, as well as the individual column names, formats and lengths, as shown below:

Note: Since the specification of any special characters as part of a Natural field or DDM name does not comply with Natural naming conventions, any special characters allowed

within SQL/DS should be avoided. The same applies to SQL/DS delimited identifiers, which are not supported by Natural.

In addition, various attributes can be specified for each column.

- In the **NN/NU/NP** field you can specify:
  - `NN (NOT NULL)` if the column may not contain null values,
  - `NP (NOT NULL PRIMARY KEY)` if the column is the primary key
  - `NU (NOT NULL UNIQUE)` if the column is a unique key

- In the **S/M/B** field you can specify the following for character columns:
  - `S (FOR SBCS DATA)`
  - `B (FOR BIT DATA)`
  - `M (FOR MIXED DATA)`

- You can mark the field **fieldproc** to display a window where you can specify a field procedure which has to be executed for that column.
- For character and graphic columns you can mark the CCSID to display a window where you can specify a CCSID to be used for that column.

You can also specify which columns are to be part of a primary key if the primary key is comprised of multiple columns. To do so enter an "S" or the positional number in the first column of the field **PRIMARY KEY**.

A primary key is a set of column values that enforce referential integrity. Only one primary key definition is allowed per table. Primary key values must be unique and must be defined as `NOT NULL`.

If a column is to be part of a primary key, you also have to specify whether the values from this column are to be arranged in ascending (`A`) or descending order (`D`), where `A` (Asc) is the default value. In addition, you can specify the percentage of space within each index page for later insertions and updates of the primary key (the default value is 10%).

If a letter or character other than those mentioned above is used, an appropriate error message appears on the screen and the wrong character is automatically replaced by the appropriate one.

4 If you need help for field input, enter the help character, that is, a question mark (?), in the appropriate field on the screen.

Windows like the one below may help you in making a valid selection:

```
 14:50:09                  **** SYSSQL Utility ****                2006-05-25
                                - Create Table -                     Page:
01


   >>--- CREATE TABLE ----- SAG_____ . PERSONNEL_________ -------------------->
                            <creator.>table-na +-----------------------------+
                                                ! Please mark your choice:
 !
   >-( PERS-NO___________ - DECIMAL________ ( 8_ !  _ INTEGER
 !
   >-- NAME______________ - CHAR___________ ( 25 !  _ SMALLINT
 !
   >-- FIRST-NAME________ - CHAR___________ ( 25 !  _ FLOAT(integer,integer)
 !
  >-- AGE_________________ - DECIMAL________ ( 25 !  _ DECIMAL(integer,integer) !
   >-- SALARY_____________ - DECIMAL________ ( 2_ !  _ CHAR(integer)
 !
   >-- FUNCTION__________ - INTEGER________ ( 5, !  _ VARCHAR(integer)
 !
   >-- EMPL-SINCE________ - DATE___________ ( __ !  _ LONG VARCHAR
 !
   >-- ___________________ - ?______________ ( __ !  _ GRAPHIC(integer)
 !
         column-name           format       ( __ !  _ VARGRAPHIC(integer)
 !
                                            ( __ !  _ LONG VARGRAPHIC
 !
                                                 !  _ DATE
 !
                                                 !  _ TIME
 !
                                                 !  _ TIMESTAMP
 !
                                                 ! Valid abbreviations:
 !
                                                 ! I,S,F,DE,C,VARC,L VARC,G,
 !
   Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7 ! VARG,L VARG,DA,TIME,TIMES
 !
         Help  Next        Free  Exec  Top   Bwd !
 !
                                               +-----------------------------+
```

As you can see on the above screen, the beginning of the syntax specification for an SQL statement is always indicated by >>.

Press Enter to close the window again.

5 In the case of complex SQL statements, more than one input screen may be required. If so, you can switch to the following screen by pressing PF2 (Next).

If you press PF2 (Next), the next **Create Table** input screen screen is displayed, where you can specify up to 16 foreign keys for the current table together with their corresponding parent table and up to 16 unique keys.

```
 14:52:52                 **** SYSSQL/DS Utility ****              2006-05-25
                                 - Create Table -                    Page:
01


 >-+-+-------------------------------------------------------------------+-+-)->
    ! +- , - FOREIGN KEY --- AUTO-NAME_________ --- ( --- X --- ) ---->   ! !

    !                       <constraint-name>       column-names         ! !

    !                                                                    ! !

    !  >---- REFERENCES ---->                                            ! !

    !  >--- SAG_____ . AUTOMOBILES_______ - ON DELETE -+- _ - RESTRICT -+-+ !

    !       <creator>     table-name                  +- _ - CASCADE --+   !

    !                                                 +- S - SET NULL -+   !

   +-----------------------------------<-----------------------------------+



 >-+-+-------------------------------------------------------------------+-+-)->
    ! !                                                                    !

    ! +- , - UNIQUE -------- ___________________ --- ( --- _ --- ) ---->    !

    !                      <constraint-name>        column-names          !

    !  >---- PCTFREE= ------ __                                           !

    !                       0-99                                         !

   +-----------------------------------<-----------------------------------+

 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Next  Prev  Free  Exec  Top   Bwd   Fwd   Bot         Error Menu
```

On this screen, you can specify a referential constraint to another table. To do so, enter an S in the first **column-names** field and press Enter.

A list of all columns available in the current table (dependent table) is displayed, where you can select the column(s) to comprise the foreign key related to another table (parent table). You can also specify a name for the constraint. If not, the constraint name is derived from the first column of the foreign key.

A foreign key consists of one or more columns in a dependent table that together must take on a value that exists in the primary key of the related parent table.

In the **REFERENCES** part, you must specify the table name (with an optional creator name) of the parent table which is to be affected by the specified constraint. In addition, you must specify the action to be taken when a row in the referenced parent table is deleted. You have three options available:

- **RESTRICT** prevents the deletion of the parent row until all dependent rows are deleted (this is the default value).
- **CASCADE** deletes all dependent rows, too.
- **SET NULL** sets to null all columns of the foreign key in each dependent row that can contain null values.

You can also specify a unique key for that table. To do so, enter an `S` in the second **column-names** field and press Enter.

A list of all columns available in the current table is displayed, where you can select the column(s) to comprise the key. All selected columns must have been defined with the `NOT NULL` attribute. If this is not the case, a window is displayed where you can set `NOT NULL` for this column. You can also specify a name for the constraint. If you do not, the constraint name is derived from the first column of the unique key.

You can specify up to 16 constraint blocks. In each block you can define a foreign key and a unique key. In the top right-hand corner of the screen, the index of the currently displayed referential constraint block (1) is displayed. You can page forward and backward through the contraint blocks by pressing PF7 (-) and PF8 (+).

6 When you have entered all information, you can press either PF3 (Prev) to return to the previous screen, or PF2 (Next) to go to the last screen as shown below:

```
 15:05:38                 **** SYSSQL/DS Utility ****              2006-05-25
                                 - Create Table -                    Page:
01
```

```
>------------+-------------------------------------------------------+-------><
             !                                                       !

             +-------- IN -- SAG_____ . DEMO_______________ ---------+

                                 <owner.>dbspace-name

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Prev  Free  Exec                                Error Menu
```

On this screen, you can specify the dbspace where the table is to be created.

As you can see on the above screen, the end of the syntax specification for an SQL statement is always indicated by `><`.

If you press `PF2` (Prev) on this screen, you return to the previous screen.

7 When all information has been entered, you can either switch to **free mode** by pressing `PF4` (Free) or submit the created member directly to SQL/DS for execution by pressing `PF5` (Exec).

If execution is successful, you receive the message:

```
Statement(s) successful, SQLCODE = 0
```

If not, an error code is returned.

Once a table has been created, the data type of its columns cannot be changed and columns cannot be deleted. However, new columns can be added using the **ALTER TABLE** function as described in the following section.

Altering an SQL/DS Table

With the **ALTER TABLE** function you can add single columns to an existing table. You can also add, drop, activate or deactivate primary and foreign keys. The following example illustrates how to use the `SYSSQL` utility to alter an SQL/DS table in fixed mode.

To alter an SQL/DS table

1 On the `SYSSQL` **Main Menu**, mark the **ALTER** function with an `X` and press Enter.

A window appears and prompts you for the type of object to be altered:

```
15:07:33                  **** SYSSQL Utility ****                2006-05-25
                                - Main Menu -


   +---------- Maintenance ---------+   +--------- Authorizations -------+

   !   _ CREATE                     !   !   _ GRANT                      !

   !   _ ACQUIRE +------------------+   !   _ REVOKE                     !

   !   x ALTER   !    _ DBSPACE     !   !   _ LOCK TABLE                 !

   !   _ DROP    !    x TABLE       !   !   _ CONNECT                    !

   !   _ UPDATE  !                  !   !                                !

   +------------ +-----------------++   +--------------------------------+

                     +-------- Descriptions ----------+

                     !   _ EXPLAIN                   !

                     !   _ COMMENT ON                !

                     +-------------------------------+
```

```
    +---------------------------- Comments -------------------------------+

     !  Enter ? for HELP or press PF1                                      !

     !  Enter . to QUIT or press PF12                                      !

     !  Press PF4 to enter Free-Mode                                       !

    +--------------------------------------------------------------------+



 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help             Free                                            Exit

 SYSSQL4776 Please mark your choice.
```

2 Mark the **TABLE** keyword with an `X` and press Enter.

When you press Enter again, the first **Alter Table** input screen is displayed:

```
 15:07:04                  **** SYSSQL/DS Utility *                 2006-05-25
                                - Alter Table -



   >>--- ALTER TABLE ---------- ________ . ___________________ ----------------->
                                  <creator.>table-name



   >-+-- ADD -- ___________________  ________________ ( _____ ) -- _ -- _ -- _-+->
     !             column-name          format       length     S  field CCS !
     !                                                          M  proc  ID
!
     !                                                          B
!
     !
!
    +--+-------+-- PRIMARY KEY --- ( --- _ --- ) ---- PCTFREE= --  __   -----+
     !  +- ADD -+                    column-names                  0-99
!
     !
!
    +-- DROP --+-- PRIMARY KEY --- _ ----------------------------------------+
               !
!
              +-- FOREIGN KEY --- ___________________ -----------------------+
               !                    constraint-name
```

```
!
              +-- UNIQUE KEY  --- ___________________ -----------------------+
                                    constraint-name



 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Next        Free  Exec                                Error Menu
```

You can enter the creator and table names on this screen, as well as the name, format and length of an additional column.

In addition, you can define a primary key as described in the section ***Creating an SQL/DS Table***. You can also drop an already existing primary key, thereby removing all referential constraints in which the current table is a parent table.

You can also drop any already existing foreign key or unique key by specifying its constraint name. If a foreign key is dropped the corresponding referential constraint is removed.

3 Once you have entered all necessary information, press PF2 (Next) to display the next **Alter Table** input screen, where you can add or drop foreign keys and unique keys.

```
 15:09:56                  **** SYSSQL/DS Utility *                2006-05-25
                                - Alter Table -





 +>>----+-------+- FOREIGN KEY --- ___________________ --- ( --- _ --- ) ---+->
        +- ADD -+                    constraint-name       column-names



      >---- REFERENCES ---------- ________ . ___________________ ------------>
                                   <creator.> table-name

      >---- ON DELETE -+- S - RESTRICT -+-+-------------------------------><
                       +- _ - CASCADE --+

                       +- _ - SET NULL -+





 +>>----+-------+- UNIQUE KEY ---- ___________________ --- ( --- _ --- ) ----->
        +- ADD -+                  constraint-name         column-names
```

```
      >---------- PCTFREE= ------ __ ---------------------------------------><
                                  0-99



 Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
       Help  Next  Prev  Free  Exec                                Error Menu
```

A foreign key or unique key is added as described in the section *Creating an SQL/DS Table*.

4 When you have entered all information you can press either PF3 (Prev) to return to the previous screen, or PF2 (Next) to go to the last screen as shown below:

```
 15:12:40                  **** SYSSQL/DS Utility ****             2006-05-25
                                 - Alter Table -



  >--- ACTIVATE ---+---- _ --- ALL ----------------------------------------+-><
                   !                                                       !

                   +---- _ --- PRIMARY KEY --------------------------------+

                   !                                                       !

                   +---------- FOREIGN KEY -- __________________ ----------+

                   !                            constraint-name            !

                   +---------- UNIQUE kEY --- __________________ ----------+

                                                constraint-name



  >--- DEACTIVATE -+---- _ --- ALL ----------------------------------------+-><
                   !                                                       !

                  +---- _ --- PRIMARY KEY---------------------------------+

                   !                                                       !

                  +---------  FOREIGN KEY -- __________________ -----------+

                   !                           constraint-name            !

                  +---------  UNIQUE KEY --- __________________ -----------+
```

```
                                                  constraint-name



Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Prev  Free  Exec                                Error Menu
```

In the **ACTIVATE** part you have three options available. You can activate:

- **ALL**, which automatically enforces all the referential constraints defined for a primary key.
- **PRIMARY KEY**, which automatically enforces the primary key.
- **FOREIGN KEY constraint-name**, which automatically enforces the specified referential constraint.

In the **DEACTIVATE** part you have three options available. You can deactivate:

- **ALL**, which deactivates the primary key and all active foreign keys in the table.
- **PRIMARY KEY**, which drops the primary key index from the table and implicitly deactivates all active dependent foreign keys.
- **FOREIGN KEY constraint-name**, which deactivates the specified referential constraint.

By specifying any of these options, the restrictions imposed by the referential constraints are suspended and the parent and dependent tables involved in a referential constraint are made unavailable to users other than the DBA and the owner of the table.

Press PF2 (Prev) to return to the previous screen.

Free Mode

When free mode is invoked from fixed mode, the data that were entered in fixed mode are shown as generated SQL code, which can be saved for later use or modification. The editor provided is an adapted version of the Natural program editor.

If you modify an SQL member in free mode, this has no effect on the fixed-mode version of the member. You can save your modified code in free mode, but when you return to fixed mode, the original data appear again. Thus, both original and modified data are available.

In free mode you can execute the member currently in the source area by pressing PF5 (Exec) (as in fixed mode).

If you switch to free mode after you have created an SQL/DS table in fixed mode as described in the section ***Creating an SQL/DS Table***, the free-mode editor displays the generated SQL code as in the following sample screen:

```
15:15:39                  **** SYSSQL Utility ****                 2006-05-25
                                - Free Mode -            Member:

   Command:
   +-----------------------------------------------------------------------+
   ! CREATE TABLE SAG.PERSONNEL                                            !
   !   (PERS-NO              DECIMAL(8)             NOT NULL,              !
   !    NAME                 CHAR(25)               NOT NULL,              !
   !    FIRST-NAME           CHAR(25)               NOT NULL,              !
   !    AGE                  DECIMAL(2)             NOT NULL,              !
   !    SALARY               DECIMAL(5,2),                                 !
   !    FUNCTION             INTEGER,                                      !
   !    EMPL-SINCE           DATE                   NOT NULL,              !
   !   PRIMARY KEY (PERS-NO),                                              !
   !   FOREIGN KEY  AUTO-NAME (NAME)                                       !
   !     REFERENCES SAG.AUTOMOBILES                                        !
   !     ON DELETE SET NULL                                                !
   !   )                                                                   !
   !   IN SAG.DEMO                                                         !
   +-----------------------------------------------------------------------+

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help              Fix   Exec  Top   Bwd   Fwd   Bot         Error Menu
```

Free-Mode Editor

The free-mode editor available is almost identical to the Natural program editor and allows you to edit the generated SQL code. All program editor line commands and the following editor commands are available:

Command	Function
`ADD dnf`	Adds *n* empty lines.

Command	Function
CHANGE	Scans for the value entered as *scandata* and replaces each such value found with the value entered as *replacedata*. The syntax for this command is: CHANGE '*scandata*' '*replacedata*'
CLEAR	Clears the editor source area (including the line markers X and Y).
DX, DY, DX-Y	Deletes the X-marked line or the Y-marked line or the block of lines delimited by X and Y.
EX, EY, EX-Y	Deletes source lines from the top of the source area to - but not including - the X-marked line, or from the source line following the Y-marked line to the bottom of the source area, or all source lines in the source area excluding the block of lines delimited by X and Y.
LET	Undoes all modifications made to the current screen since the last time Enter was pressed, including all line commands already entered but not yet executed.
POINT	Positions the line in which the line command .N was entered to the top of the current screen.
RESET	Deletes the current X and/or Y line markers and any marker previously set with the line command .N.
SCAN ['*scan-value*']	Scans for the string *scan-value* in the source area.
SCAN = [+|-]	Scans forwards (+) or backwards (-) for the next occurrence of the scan value.
SHIFT [-|+ *nn*]	Shifts the block of source lines delimited by the X and Y markers to the left (-) or right (+). *nn* represents the number of characters the source line is to be shifted.

For further details, refer to *Program Editor* in the Natural *Editors* documentation.

In addition, the following SQL code maintenance commands are available:

Command	Function
INSERT *member-name*	Saves the code in the source area as a member. If you press PF5 (Exec), the code in the source area can also be executed as in fixed mode.
SELECT *member-name*	Reads the specified member into the source area.
DELETE *member-name*	Deletes the specified member.
LIST QUERY *member-name*	Displays a list of members on the screen using asterisk notation (*). For example, L Q A* would display a list of all SQL code members beginning with A.

Member names must correspond to the naming conventions for Natural objects, which means they can be up to eight characters long and must start with a letter.

You can also always refer to the SYSSQL help system, which is invoked via PF1 (Help).

Natural System Commands for SQL/DS

The following Natural system commands have been incorporated into the **Natural Tools for DB2**:

Natural System Command	Explanation
`LISTSQL`	Lists Natural DML statements and their corresponding SQL statements.
`SQLERR`	Provides diagnostic information about an SQL/DS error
`LISTDBRM`	Displays either a list of packages for a particular Natural program or a list of Natural programs that reference a particular package.

For a description of these commands, follow the links leading to the Natural *System Commands* documentation.

27 Generating Natural Data Definition Modules (DDMs)

To enable Natural to access an SQL/DS table, a Natural DDM of the table must be generated. This is done either with Predict (see the relevant Predict documentation for details) or with the Natural utility `SYSDDM`; see also *SYSDDM Utility* in the Natural *Editors* documentation.

If you do not have Predict installed, use the `SYSDDM` function **SQL Services** to generate Natural DDMs from SQL/DS tables. This function is invoked from the main menu of `SYSDDM` and is described on the following pages.

For further information on Natural DDMs, see *Data Definition Modules - DDMs* in the Natural *Programming Guide*.

This section covers the following topics:

SQL Services

The **SQL Services** function of the Natural `SYSDDM` utility (see *Using SYSDDM Maintenance and Service Functions* in the Natural *Editors* documentation) is used to access SQL/DS tables. You access the catalog of the SQL/DS server to which you are connected, for example, by using the `CONNECT` command of the ***SYSSQL Utility*** (see the section ***Database Management***), or by entering the name of a server in the **Server Name** field on the **SQL Services Menu**. The name of the SQL/DS server to which you are connected is then displayed in the top left-hand corner of the screen `SQL Services Menu`. You can access any SQL/DS server that is located on either a mainframe (z/OS or z/VSE) or a UNIX platform if the servers have been connected via DRDA (Distributed Relational Database Architecture). For further details on connecting SQL/DS servers and for information on binding the application package (`SYSDDM` uses I/O module `NDBIOMO`) to access data on remote servers, refer to the relevant IBM literature.

The SQL Services function determines whether you are connected to a mainframe DB2 (z/OS or z/VSE) or a UNIX DB2, access the appropriate DB2 catalog and performs the functions listed below.

Note: If you use `SYSDDM` **SQL Services** in a CICS environment without file server, specify `CONVERS=ON` in the `NDBPARM` module (see the relevant section in Installing Natural for SQL/DS); otherwise you might get SQL code `-518`.

- Using SQL Services
- Select SQL Table from a List
- Generate DDM from an SQL Table
- List Columns of an SQL Table

The individual functions are described below.

Using SQL Services

To invoke the SQL Services function

1 In the command line, enter the Natural system command `SYSDDM` and press Enter.

Or:

1. From the Natural main menu, choose **Maintenance and Transfer Utilities** to display the **Maintenance and Transfer Utilities** menu.
2. From the **Maintenance and Transfer Utilities** menu, choose **Maintain DDMs**.

The menu of the `SYSDDM` utility is displayed. The fields and functions provided on the `SYSDDM` utility menu are explained in the section *Using SYSDDM Maintenance and Service Functions*.

2 In the **Code** field of the Natural `SYSDDM` utility **Menu**, enter code `B` and press Enter.

The **SQL Services Menu** is displayed.

```
14:43:41              ***** NATURAL SYSDDM UTILITY *****              2009-12-04
 Server DAVNDB2              - SQL Services: Menu -




                   Code  Function

                     S   Select SQL Table from a List
                     G   Generate DDM from an SQL Table
                     L   List Columns of an SQL Table
                     ?   Help
                     .   Exit

            Code ... _
      Table name ... ________________________________
      Creator ...... ________________________________
      Replace ...... N (Y,N)          DDM Name with Creator .. Y (Y/N)
      Server name .. DAVNDB2___________



Command ===>

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
      Help        Exit                                                  Canc
```

The functions available on this screen are described in the corresponding sections.

Select SQL Table from a List

This function is used to select an SQL/DS table from a list for further processing.

To invoke the Select SQL Table from a List function

- On the **SQL Services Menu**, enter Function Code `S`.
  - If you enter the function code only, you obtain a list of all tables defined to the SQL/DS catalog.
  - If you do not want a list of all tables but would like only a certain range of tables to be listed, you can, in addition to the function code, specify a start value in the **Table Name** and/or **Creator** fields. You can also use asterisk notation (*) for the start value.

  Press Enter.

  The **Select SQL Table From A List** screen is invoked displaying a list of all SQL/DS tables requested. On the list, you can mark an SQL/DS table with a function code:

Code	Function	Description
G	**Generate DDM from an SQL Table**	This function can be used to generate a Natural DDM from an SQL/DS table, based on the definitions in the SQL/DS catalog.
L	**List Columns of an SQL Table**	This function lists all columns of a specific SQL/DS table.

Generate DDM from an SQL Table

This function is used to generate a Natural DDM from an SQL/DS table, based on the definitions in the SQL/DS catalog.

The following topics are covered below:

- Invoking the Generate DDM from an SQL Table function
- DBID/FNR Assignment
- Long Field Redefinition
- Length Indicator for Variable Length Fields: VARCHAR, LONG VARCHAR, VARGRAPHIC, LONG VARGRAPHIC

- Null Values

Invoking the Generate DDM from an SQL Table function

To invoke the function

- On the **SQL Services Menu**, enter function code `G` along with the name and creator of the table for which you wish a DDM to be generated.
  - If you do not know the table name/creator, you can use the function **Select SQL Table from a List** to choose the table you want.
  - If you do not want the creator of the table to be part of the DDM name, enter an `N` (No) in the field **DDM Name with Creator** when you invoke the Generate function. The default setting is is `Y` (Yes).

    Important: Since the specification of any special characters as part of a field or DDM name does not comply with Natural naming conventions, any special characters allowed within SQL/DS must be avoided. SQL/DS delimited identifiers must be avoided, too.

  - If you wish to generate a DDM for a table for which a DDM already exists and you want the existing one to be replaced by the newly generated one, enter a `Y` (Yes) in the **Replace** field when you invoke the Generate function.
  - By default, **Replace** is set to `N` (No) to prevent an existing DDM from being replaced accidentally. If **Replace** is `N`, you cannot generate another DDM for a table for which a DDM has already been generated.

DBID/FNR Assignment

When the **Generate DDM from an SQL Table** function is invoked for a table for which a DDM is to be generated for the first time, the **DBID/FNR Assignment** screen is displayed. If a DDM is to be generated for a table for which a DDM already exists, the existing DBID and FNR are used and the **DBID/FNR Assignment** screen is suppressed.

On the **DBID/FNR Assignment** screen, enter one of the database IDs (DBIDs) chosen at Natural installation time, and the file number (FNR) to be assigned to the SQL/DS table. Natural requires these specifications for identification purposes only.

The range of DBIDs which is reserved for SQL/DS tables is specified in the `NTDB` macro of the Natural parameter module (see the Natural *Parameter Reference* documentation) in combination with the `NDBID` macro of the parameter module `NDBPARM`. Any DBID not within this range is not accepted. The FNR can be any valid file number within the database (between 1 and 255).

After a valid DBID and FNR have been assigned, a DDM is automatically generated from the specified table.

Long Field Redefinition

The maximum field length supported by Natural is 1 GB-1 (1073741823 bytes). If an SQL/DS table contains a column which is longer than 253 bytes, the pop-up window **Long Field Generation** will be displayed automatically.

A field which is longer than 253 bytes may be defined as a simple Natural field with a maximum length of 32KB-1, or as an array. In the DDM, such an array is represented as a multiple-value variable.

On the **Long Field Generation** screen you specify the element length of the array, which means the length of the occurrences. The number of occurrences depends on the length you specify.

If, for example, an SQL/DS column has a length of 2000 bytes, you can specify an array element length of 200 bytes, and you receive a multiple-value field with 10 occurrences, each occurrence with a length of 200 bytes.

Since redefined long fields are no multiple-value fields in the sense of Natural, the Natural C* notation cannot be applied to those fields.

When such a redefined long field is defined in a Natural view for being referenced by Natural SQL statements (that is, by host variables which represent multiple-value fields), both when defined and when referenced, the specified range of occurrences (index range) must always start with occurrence 1. If not, a Natural syntax error is returned.

Example:

```
UPDATE table SET varchar = #arr(*)
SELECT ... INTO #arr(1:5)
```

Note: When such a redefined long field is updated with the Natural native DML `UPDATE` statement, care must be taken to update each occurrence appropriately.

Length Indicator for Variable Length Fields: VARCHAR, LONG VARCHAR, VARGRAPHIC, LONG VARGRAPHIC

For each variable length column, an additional length indicator field (format/length I2) is generated in the DDM. The length is always measured in number of characters, not in bytes. To obtain the number of bytes of a `VARGRAPHIC` or `LONG VARGRAPHIC` field, the length must be multiplied by 2.

The name of a length indicator field begins with “L@” followed by the name of the corresponding field. The value of the length indicator field can be checked or updated by a Natural program.

If the length indicator field is not part of the Natural view and if the corresponding field is a redefined long field, the length of this field with `UPDATE` and `STORE` operations is calculated without trailing blanks.

Null Values

With Natural, it is possible to distinguish between a null value and the actual value zero (0) or blank in an SQL/DS column.

When a Natural DDM is generated from the SQL/DS catalog, an additional `NULL` indicator field is generated for each column which can be `NULL`; that is, which has neither `NOT NULL` nor `NOT NULL WITH DEFAULT` specified.

The name of the `NULL` indicator field begins with `N@` followed by the name of the corresponding field.

When the column is read from the database, the corresponding indicator field contains either zero (`0`) (if the column contains a value, including the value `0` or blank) or `-1` (if the column contains no value).

Example:

The column `NULLCOL CHAR(6)` in an SQL/DS table definition would result in the following view fields:

```
NULLCOL          A 6.0
N@NULLCOL    I 2.0
```

When the field `NULLCOL` is read from the database, the additional field `N@NULLCOL` contains:

- `0` (zero) if `NULLCOL` contains a value (including the value `0` or blank),
- `-1` (minus one) if `NULLCOL` contains no value.

A null value can be stored in a database field by entering `-1` as input for the corresponding `NULL` indicator field.

Note: If a column is `NULL`, an implicit `RESET` is performed on the corresponding Natural field.

List Columns of an SQL Table

This function lists all columns of a specific SQL/DS table.

To invoke the List Columns function

- On the **SQL Services Menu**, enter function code `L` along with the name and creator of the table whose columns you wish to be listed, and press Enter.

The **List Columns** screen for this table is invoked, which lists all columns of the specified table and displays the following information for each column:

Variable	Content	
Name	The SQL/DS name of the column.	
Type	The column type.	
Length	The length (or precision if type is DECIMAL) of the column as defined in the SQL/DS catalog.	
Scale	The decimal scale of the column (only applicable if type is DECIMAL).	
Update	Y	The column can be updated.
	N	The column cannot be updated.
Nulls	Y	The column can contain null values.
	N	The column cannot contain null values.
Not	A column which is of a scale length or type not supported by Natural is marked with an asterisk (*). For such a column, a view field cannot be generated. The maximum scale length supported is 7 bytes. Types supported are: CHAR, VARCHAR, LONG VARCHAR, GRAPHIC, VARGRAPHIC, LONG VARGRAPHIC, DECIMAL, INTEGER, SMALLINT, DATE, TIME, TIMESTAMP, and FLOAT.	

The data types DATE, TIME, TIMESTAMP, and FLOAT are converted into numeric or alphanumeric fields of various lengths: DATE is converted into A10, TIME into A8, TIMESTAMP into A26, and FLOAT into F8.

For SQL/DS, Natural provides an SQL/DS TIMESTAMP column as an alphanumeric field (A26) in the format *YYYY-MM-DD-HH.SS.MMMMMM*.

28 Dynamic and Static SQL Support

This section describes the dynamic and static SQL support provided by Natural.

Related Documentation

For a list of error messages that may be issued during static generation, see *Static Generation Messages and Codes Issued under NDB/NSQ* in the Natural *Messages and Codes* documentation.

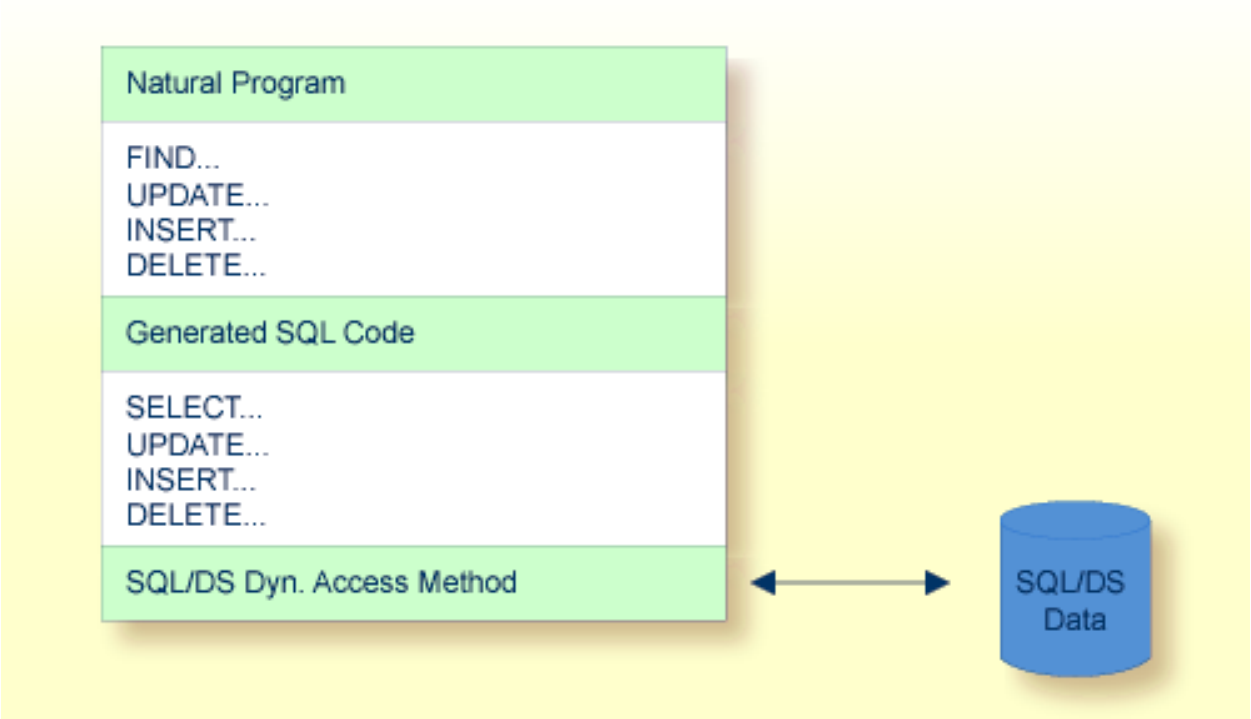
SQL Support - General Information

The SQL support of Natural combines the flexibility of dynamic SQL support with the high performance of static SQL support.

In contrast to static SQL support, the Natural dynamic SQL support does not require any special consideration with regard to the operation of the SQL interface. All SQL statements required to execute an application request are generated automatically and can be executed immediately with the Natural `RUN` command. Before executing a program, you can look at the generated SQL code, using the `LISTSQL` command.

Access to SQL/DS through Natural has the same form whether dynamic or static SQL support is used. Thus, with static SQL support, the same SQL statements in a Natural program can be executed in either dynamic or static mode. An SQL statement can be coded within a Natural program and, for testing purposes, it can be executed using dynamic SQL. If the test is successful, the SQL statement remains unchanged and static SQL for this program can be generated.

Thus, during application development, the programmer works in dynamic mode and all SQL statements are executed dynamically, whereas static SQL is only created for applications that have been transferred to production status.



Internal Handling of Dynamic Statements

Natural automatically provides for the preparation and execution of each SQL statement and handles the opening and closing of cursors used for scanning a table.

The following topics are covered:

- I/O Module NDBIOMO for Dynamic SQL Statement Execution
- Statement Table
- Processing of SQL Statements Issued by Natural

I/O Module NDBIOMO for Dynamic SQL Statement Execution

As each dynamic execution of an SQL statement requires a statically defined `DECLARE STATEMENT` and `DECLARE CURSOR` statement, a special I/O module named `NDBIOMO` is provided which contains a fixed number of these statements and cursors. This number is specified during the generation of the `NDBIOMO` module in the course of the Natural for DB2 installation process.

Statement Table

If possible, an SQL statement is only prepared once and can then be executed several times if required. For this purpose, Natural internally maintains a table of all SQL statements that have been prepared and assigns each of these statements to a `DECLAREd STATEMENT` in the module `NDBIOMO`. In addition, this table maintains the cursors used by the SQL statements `SELECT`, `FETCH`, `UPDATE` (positioned), and `DELETE` (positioned).

Each SQL statement is uniquely identified by:

- the name of the Natural program that contains this SQL statement,
- the line number of the SQL statement in this program,
- the name of the Natural library into which this program was stowed,
- the time stamp when this program was stowed.

Once a statement has been prepared, it can be executed several times with different variable values, using the dynamic SQL statement `EXECUTE USING DESCRIPTOR` or `OPEN CURSOR USING DESCRIPTOR`.

When the full capacity of the statement table is reached, the entry for the next prepared statement overwrites the entry for a free statement whose latest execution is the least recent one.

When a new `SELECT` statement is requested, a free entry in the statement table with the corresponding cursor is assigned to it and all subsequent `FETCH`, `UPDATE`, and `DELETE` statements referring to this `SELECT` statement will use this cursor. Upon completion of the sequential scanning of the table, the cursor is released and free for another assignment. While the cursor is open, the entry in the statement table is marked as used and cannot be reused by another statement.

If the number of nested `FIND` (`SELECT`) statements reaches the number of entries available in the statement table, any further SQL statement is rejected at execution time and a Natural error message is returned.

The size of the statement table depends on the size specified for the module `NDBIOMO`. Since the statement table is contained in the SQL/DS buffer area, the setting of Natural profile parameter `DB2SIZE` (see also ***Natural Parameter Modification for SQL/DS***) may not be sufficient and may need to be increased.

Processing of SQL Statements Issued by Natural

The embedded SQL uses cursor logic to handle `SELECT` statements. The preparation and execution of a `SELECT` statement is done as follows:

1. The typical `SELECT` statement is prepared by a program flow which contains the following embedded SQL statements (note that *X* and *SQLOBJ* are SQL variables, not program labels):

   ```
   DECLARE SQLOBJ STATEMENT
   DECLARE X CURSOR FOR SQLOBJ
   INCLUDE SQLDA (copy SQL control block)
   ```

   Then, the following statement is moved into `SQLSOURCE`:

   ```
   SELECT PERSONNEL_ID, NAME, AGE
    FROM EMPLOYEES
    WHERE NAME IN (?, ?)
       AND AGE BETWEEN ? AND ?
   ```

   Note: The question marks (?) above are parameter markers which indicate where values are to be inserted at execution time.

   ```
   PREPARE SQLOBJ FROM SQLSOURCE
   ```

2. Then, the `SELECT` statement is executed as follows:

   ```
   OPEN X USING DESCRIPTOR SQLDA
   FETCH X USING DESCRIPTOR SQLDA
   ```

   The descriptor `SQLDA` is used to indicate a variable list of program areas. When the `OPEN` statement is executed, it contains the address, length, and type of each value which replaces a parameter marker in the `WHERE` clause of the `SELECT` statement. When the `FETCH` statement is executed, it contains the address, length, and type of all program areas which receive fields read from the table.

   When the `FETCH` statement is executed for the first time, it sets the Natural system variable `*NUMBER` to a non-zero value if at least one record is found that meets the search criteria. Then, all records satisfying the search criteria are read by repeated execution of the `FETCH` statement.

3. Once all records have been read, the cursor is released by executing the following statement:

```
CLOSE X
```

Preparing Programs for Static Execution

This section describes how to prepare Natural programs for static execution.

The following topics are covered:

- Basic Principles
- Generation Procedure: CMD CREATE Command
- Modification Procedure: CMD MODIFY Command

For an explanation of the symbols used in this section to describe the syntax of Natural statements, see *Syntax Symbols* in the Natural *Statements* documentation.

Basic Principles

Static SQL is generated in Natural batch mode for one or more Natural applications which can consist of one or more Natural object programs. The number of programs that can be modified for static execution in one run of the generation procedure is limited to 999.

During the generation procedure, the database access statements contained in the specified Natural objects are extracted, written to work files, and transformed into a temporary Assembler program. If no Natural program is found that contains SQL access or if any error occurs during static SQL generation, batch Natural terminates and condition code 40 is returned, which means that all further JCL steps must no longer be executed.

The temporary Assembler program is written to a temporary file (the Natural work file `CMWKF06`) and precompiled. The size of the workfile is proportional to the maximum number of programs, the number of SQL statements and the number of variables used in the SQL statements. During the precompilation step, a static SQL/DS module (access module) is created, and after the precompilation step, the precompiler output is extracted from the Assembler program and written to the corresponding Natural objects, which means that the Natural objects are modified (prepared) for static execution. The temporary Assembler program is no longer used and deleted.

Note: Since the Assembler precompiler of SQL/DS does not support `GRAPHIC` field types, you cannot generate a static Assembler program if your Natural program(s) contain any references to `GRAPHIC`-type columns.

The Natural subprogram `NDBDBRM` can be used to check whether a Natural program contains an SQL access and whether it has been modified for static execution.

Generation Procedure: CMD CREATE Command

The following topics are covered:

- Generating Static SQL for Natural Programs
- Static Name
- USING-Clause

Generating Static SQL for Natural Programs

To generate static SQL for Natural programs

1 Logon to the Natural system library `SYSSQL`.

Since a new `SYSSQL` library has been created when installing Natural for SQL/DS, ensure that it contains all Predict interface programs necessary to run the static SQL generation. These programs are loaded into `SYSSQL` at Predict installation time (see the relevant *Predict* product documentation).

2 Specify the `CMD CREATE` command and the Natural input necessary for the static SQL generation process; the `CMD CREATE` command has the following syntax:

```
CMD CREATE DBRM static-name USING using-clause
{application-name,object-name,excluded-object}
:
:
```

The generation procedure reads but does not modify the specified Natural objects. If one of the specified programs was not found or had no SQL access, return code 4 is returned at the end of the generation step.

Static Name

If the `PREDICT DOCUMENTATION` option is to be used, a corresponding Predict static SQL entry must be available and the *`static-name`* must correspond to the name of this entry. In addition, the *`static-name`* must correspond to the name of the static SQL/DS package to be created during precompilation. The *`static-name`* can be up to 8 characters long and must conform to Assembler naming conventions.

USING-Clause

The *using-clause* specifies the Natural objects to be contained in the the static SQL/DS package. These objects can either be specified explicitly as INPUT DATA in the JCL or obtained as PREDICT DOCUMENTATION from Predict.

```
{ INPUT DATA                 } [ WITH XREF { YES   } ] [LIB lib-name]
{ PREDICT DOCUMENTATION      }             { NO    }
                                           { FORCE }
```

If the parameters to be specified do not fit in one line, specify the command identifier (CMD) and the various parameters in separate lines and use both the input delimiter (as specified with the Natural profile/session parameter ID - default is a comma (,) - and the continuation character indicator - as specified with the Natural profile/session parameter CF; default is a percent (%) - as shown in the following example:

Example:

```
CMD
CREATE,DBRM,static,USING,PREDICT,DOCUMENTATION,WITH,XREF,NO,%
LIB,library
```

Alternatively, you can also use abbreviations as shown in the following example:

Example:

```
CMD CRE DBRM static US IN DA W XR Y LIB library
```

The sequence of the parameters USING, WITH, and LIB is optional.

INPUT DATA

As input data, the applications and names of the Natural objects to be included in the static SQL/DS package must be specified in the subsequent lines of the job stream (*application-name*,*object-name*). A subset of these objects can also be excluded again (*excluded-objects*). Objects in libraries whose names begin with SYS can be used for static generation, too.

The applications and names of Natural objects must be separated by the input delimiter - as specified with the Natural profile parameter ID; default is a comma (,). If you wish to specify all objects whose names begin with a specific string of characters, use an *object-name* or *excluded-objects* name that ends with asterisk notation (*). To specify all objects in an application, use asterisk notation only.

Example:

```
LIB1,ABC*
LIB2,A*,AB*
LIB2,*
:
.
```

The specification of applications/objects must be terminated by a line that contains a period (.) only.

PREDICT DOCUMENTATION

Since Predict supports static SQL for SQL/DS, you can also have Predict supply the input data for creating static SQL by using already existing `PREDICT DOCUMENTATION`.

WITH XREF Option

Since Predict Active References supports static SQL for SQL/DS, the generated static SQL/DS package can be documented in Predict, and the documentation can be used and updated with Natural.

`WITH XREF` is the option which enables you to store cross-reference data for a static SQL entry in Predict each time a static SQL/DS package is created (`YES`). You can instead specify that no cross-reference data are stored (`NO`) or that a check is made to determine whether a Predict static SQL entry for this static DBRM already exists (`FORCE`). If so, cross-reference data are stored; if not, the creation of the static DBRM is not allowed. For more detailed information on Predict Active References, refer to the relevant Predict documentation.

When `WITH XREF (YES/FORCE)` is specified, `XREF` data are written for both the Predict static SQL entry (if defined in Predict) and each generated static Natural program. However, static generation with `WITH XREF (YES/FORCE)` is possible only if the corresponding Natural programs have been cataloged with `XREF ON`.

`WITH XREF FORCE` only applies to the `USING INPUT DATA` option.

Note: If you do not use Predict, the `XREF` option must be omitted or set to `NO` and the module `NATXRF2` need not be linked to the Natural nucleus.

LIB Option

With the `LIB` (library) option, a Predict library other than the default library (`*SYSSTA*`) can be specified to contain the Predict static SQL entry and `XREF` data. The name of the library can be up to eight characters long.

Modification Procedure: CMD MODIFY Command

The modification procedure modifies the Natural objects involved by writing precompiler information into the object and by marking the object header with the *static-name* as specified with the CMD CREATE command.

In addition, any existing copies of these objects in the Natural global buffer pool (if available) are deleted and XREF data are written to Predict (if specified during the generation procedure).

To perform the modification procedure

1 Logon to the Natural system library SYSSQL.

2 Specify the CMD MODIFY command which has the following syntax:

```
CMD MODIFY [ XREF ]
```

The input for the modify step is the precompiler output which must reside on a dataset defined as the Natural work file CMWKF01.

The output consists of precompiler information which is written to the corresponding Natural objects. In addition, a message is returned telling you whether it was the first time an object was modified for static execution (modified) or whether it had been modified before (re-modified).

If the XREF option is specified, the Natural work file CMWKF02 must be defined to contain the resulting list of cross-reference information concerning the statically generated SQL statements (see also *Assembler/Natural Cross-References*).

Assembler/Natural Cross-References

If you specify the XREF option of the MODIFY command, an output listing is created on the work file CMWKF02, which contains the static SQL/DS package name and the Assembler statement number of each statically generated SQL statement together with the corresponding Natural source code line number, program name, library name, database ID and file number.

Example:

```
-----------------------------------------------------------------------
DBRMNAME STMTNO      LINE NATPROG  NATLIB   DB    FNR   COMMENT
-----------------------------------------------------------------------
DEM2S    000087      0170 DEM2SUPD HGK      00010 00032 SELECT
         000111      0230                              UPD/DEL
DEM2S    000121      0370 DEM2SINS HGK      00010 00032 INSERT
DEM2S    000131      0150 DEM2SDEL HGK      00010 00032 SELECT
         000155      0170                              UPD/DEL
DEM2S    000165      0040 DEM2SDL2 HGK      00010 00032 UPD/DEL
```

Column	Explanation
DBRMNAME	Name of the static SQL/DS package which contains the static SQL statement.
STMTNO	Assembler statement number of the static SQL statement.
LINE	Corresponding Natural source code line number.
NATPROG	Name of the Natural program that contains the static SQL statement.
NATLIB	Name of the Natural library that contains the Natural program.
DB / FNR	Natural database ID and file number.
COMMENT	Type of SQL statement.

Execution of Natural in Static Mode

To be able to execute Natural in static mode, all users of Natural must have the SQL/DS EXECUTE PLAN/PACKAGE privilege for the plan created in the precompilation step.

To execute static SQL, start Natural and execute the corresponding Natural program. Internally, the Natural runtime interface evaluates the precompiler data written to the Natural object and then performs the static accesses.

To the user there is no difference between dynamic and static execution.

Mixed Dynamic/Static Mode

It is possible to operate Natural in a mixed static and dynamic mode where for some programs static SQL is generated and for some not.

The mode in which a program is run is determined by the Natural object program itself. If a static SQL/DS package is referenced in the executing program, all statements in this program are executed in static mode.

Note: Natural programs which return a runtime error do not automatically execute in dynamic mode. Instead, either the error must be corrected or, as a temporary solution, the Natural program must be recataloged to be able to execute in dynamic mode.

Within the same Natural session, static and dynamic programs can be mixed without any further specifications. The decision which mode to use is made by each individual Natural program.

Messages and Codes

For a list of error messages that may be issued during static generation, refer to *Static Generation Messages and Codes Issued under NDB/NSQ* in the Natural *Messages and Codes* documentation.

29 Using Natural Statements and System Variables

This section contains special considerations concerning Natural data manipulation language (DML) statements (that is, Natural native DML statements and Natural SQL DML statements), and Natural system variables when used with SQL/DS

It mainly consists of information also contained in the Natural basic documentation set where each Natural statement and variable is described in detail.

For an explanation of the symbols used in this section to describe the syntax of Natural statements, see *Syntax Symbols* in the Natural *Statements* documentation.

For information on logging SQL statements contained in a Natural program, refer to *DBLOG Trace Screen for SQL Statements* in the *DBLOG Utility* documentation.

Using Natural Native DML Statements

This section summarizes particular points you have to consider when using Natural native data manipulation language (DML) statements with SQL/DS. Any Natural statement not mentioned in this section can be used with SQL/DS without restriction.

Below is information on the following Natural DML statements:

- BACKOUT TRANSACTION
- DELETE
- END TRANSACTION
- FIND
- GET
- HISTOGRAM
- READ
- STORE
- UPDATE

BACKOUT TRANSACTION

The Natural native DML statement `BACKOUT TRANSACTION` undoes all database modifications made since the beginning of the last logical transaction. Logical transactions can start either after the beginning of a session or after the last `SYNCPOINT`, `END TRANSACTION`, or `BACKOUT TRANSACTION` statement.

How the statement is translated and which command is actually issued depends on the environment:

Under CICS, the `BACKOUT TRANSACTION` statement is translated into an `EXEC CICS ROLLBACK` command. However, in pseudo-conversational mode, only changes made to the database since the last terminal I/O are undone. This is due to CICS-specific transaction processing, see ***Natural for DB2 under CICS***.

In batch mode, the `BACKOUT TRANSACTION` statement is translated into an SQL `ROLLBACK` command.

Note: Be aware that with terminal input in SQL/DS database loops, Natural switches to conversational mode if no file server is used.

As all cursors are closed when a logical unit of work ends, a `BACKOUT TRANSACTION` statement must not be placed within a database loop; instead, it has to be placed outside such a loop or after the outermost loop of nested loops.

If an external program written in another standard programming language is called from a Natural program, this external program must not contain its own ROLLBACK command if the Natural program issues database calls, too. The calling Natural program must issue the `BACKOUT TRANSACTION` statement for the external program.

DELETE

The Natural native DML statement `DELETE` is used to delete a row from a DB2 table which has been read with a preceding `FIND`, `READ`, or `SELECT` statement. It corresponds to the SQL statement `DELETE WHERE CURRENT OF` *`cursor-name`*, which means that only the row which was read last can be deleted.

Example:

```
FIND EMPLOYEES WITH NAME = 'SMITH'
     AND FIRST_NAME = 'ROGER'
DELETE
```

Natural would translate the above Natural statements into SQL and assign a cursor name (for example, `CURSOR1`) as follows:

```
DECLARE CURSOR1 CURSOR FOR
SELECT FROM EMPLOYEES
 WHERE NAME = 'SMITH' AND FIRST_NAME = 'ROGER'
DELETE FROM EMPLOYEES
 WHERE CURRENT OF CURSOR1
```

Both the `SELECT` and the `DELETE` statement refer to the same cursor.

Natural translates a Natural native DML `DELETE` statement into a Natural SQL `DELETE` statement in the same way it translates a Natural native DML `FIND` statement into a Natural SQL `SELECT` statement.

A row read with a `FIND SORTED BY` cannot be deleted due to DB2 restrictions explained with the `FIND` statement. A row read with a `READ LOGICAL` cannot be deleted either.

END TRANSACTION

The Natural native DML statement `END TRANSACTION` indicates the end of a logical transaction and releases all DB2 data locked during the transaction. All data modifications are committed and made permanent.

How the statement is translated and which command is actually issued depends on the environment:

Under CICS, the `END TRANSACTION` statement is translated into an `EXEC CICS SYNCPOINT` command.

In batch mode, the `END TRANSACTION` statement is translated into an SQL `COMMIT WORK` command.

As all cursors are closed when a logical unit of work ends, the END TRANSACTION statement must not be placed within a database loop; instead, it has to be placed outside such a loop or after the outermost loop of nested loops.

If an external program written in another standard programming language is called from a Natural program, this external program must not contain its own `COMMIT` command if the Natural program issues database calls, too. The calling Natural program must issue the `END TRANSACTION` statement on behalf of the external program.

Note: With SQL/DS, the `END TRANSACTION` statement cannot be used to store transaction data.

FIND

The Natural native DML statement `FIND` corresponds to the Natural SQL statement `SELECT`.

Example:

Natural native DML statements:

```
FIND EMPLOYEES WITH NAME = 'BLACKMORE'
   AND AGE EQ 20 THRU 40
OBTAIN PERSONNEL_ID NAME AGE
```

Equivalent Natural SQL statement:

```
SELECT PERSONNEL_ID, NAME, AGE
  FROM EMPLOYEES
    WHERE NAME = 'BLACKMORE'
      AND AGE BETWEEN 20 AND 40
```

Natural internally translates a FIND statement into an SQL SELECT statement as described in ***Processing of SQL Statements Issued by Natural*** in the section ***Internal Handling of Dynamic Statements***. The SELECT statement is executed by an OPEN CURSOR statement followed by a FETCH command. The FETCH command is executed repeatedly until either all records have been read or the program flow exits the FIND processing loop. A CLOSE CURSOR command ends the SELECT processing.

The WITH clause of a FIND statement is converted to the WHERE clause of the SELECT statement. The basic search criterion for an SQL/DS table can be specified in the same way as for an Adabas file. This implies that only database fields which are defined as descriptors can be used to construct basic search criteria and that descriptors cannot be compared with other fields of the Natural view (that is, database fields) but only with program variables or constants.

Note: As each database field (column) of a SQL/DS table can be used for searching, any database field can be defined as a descriptor in a Natural DDM.

The WHERE clause of the FIND statement is evaluated by Natural *after* the rows have been selected via the WITH clause. Within the WHERE clause, non-descriptors can be used and database fields can be compared with other database fields.

Note: SQL/DS does not have sub-, super-, or phonetic descriptors.

A FIND NUMBER statement is translated into a SELECT statement containing a COUNT(*) clause. The number of rows found is returned in the Natural system variable *NUMBER as described in the Natural *System Variables* documentation.

The FIND UNIQUE statement can be used to ensure that only one record is selected for processing. If the FIND UNIQUE statement is referenced by an UPDATE statement, a non-cursor (Searched) UPDATE operation is generated instead of a cursor-oriented (Positioned) UPDATE operation. Therefore, it can be used if you want to update an SQL/DS primary key. It is, however, recommended to use the Natural SQL Searched UPDATE statement to update a primary key.

In static mode, the FIND NUMBER and FIND UNIQUE statements are translated into a SELECT SINGLE statement as described in the section ***Using Natural SQL Statements***.

The FIND FIRST statement cannot be used. The PASSWORD, CIPHER, COUPLED and RETAIN clauses cannot be used either.

The SORTED BY clause of a FIND statement is translated into the SQL SELECT ... ORDER BY clause, which follows the search criterion. Because this produces a read-only result table, a row read with a FIND statement that contains a SORTED BY clause cannot be updated or deleted.

A limit on the depth of nested database loops can be specified at installation time. If this limit is exceeded, a Natural error message is returned.

GET

The Natural native DML statement `GET` is based on Adabas internal sequence numbers (ISNs) and therefore cannot be used with SQL/DS tables.

HISTOGRAM

The Natural native DML statement `HISTOGRAM` returns the number of rows in a table which have the same value in a specific column. The number of rows is returned in the Natural system variable `*NUMBER` as described in the Natural *System Variables* documentation.

Example:

Natural native DML statements:

```
HISTOGRAM EMPLOYEES FOR AGE
OBTAIN AGE
```

Equivalent Natural SQL statement:

```
SELECT COUNT(*), AGE FROM EMPLOYEES
  WHERE AGE > -999
  GROUP BY AGE
  ORDER BY AGE
```

Natural translates the `HISTOGRAM` statement into an SQL `SELECT` statement, which means that the control flow is similar to the flow explained for the `FIND` statement.

READ

The Natural native DML statement `READ` can also be used to access SQL/DS tables. Natural translates a `READ` statement into a Natural SQL `SELECT` statement.

`READ PHYSICAL` and `READ LOGICAL` can be used; `READ BY ISN`, however, cannot be used, as there is no DB2 equivalent to Adabas ISNs. The `PASSWORD` and `CIPHER` clauses cannot be used either.

Since a `READ LOGICAL` statement is translated into a `SELECT ... ORDER BY` statement, which produces a read-only table, a row read with a `READ LOGICAL` statement cannot be updated or deleted (see Example 1). The start value can only be a constant or a program variable; any other field of the Natural view (that is, any database field) cannot be used.

A `READ PHYSICAL` statement is translated into a `SELECT` statement without an `ORDER BY` clause and can therefore be updated or deleted (see Example 2).

Example 1:

The Natural native DML statements:

```
READ PERSONNEL BY NAME
OBTAIN NAME FIRSTNAME DATEOFBIRTH
```

Equivalent Natural SQL statement:

```
SELECT NAME, FIRSTNAME, DATEOFBIRTH FROM PERSONNEL
  WHERE NAME >= ' '
    ORDER BY NAME
```

Example 2:

The Natural native DML statements:

```
READ PERSONNEL PHYSICAL
OBTAIN NAME
```

Equivalent Natural SQL statement:

```
SELECT NAME FROM PERSONNEL
```

If the `READ` statement contains a `WHERE` clause, this clause is evaluated by the Natural processor *after* the rows have been selected according to the descriptor value(s) specified in the search criterion.

STORE

The Natural native DML statement `STORE` is used to add a row to an SQL/DS table. The `STORE` statement corresponds to the SQL statement `INSERT`.

Example:

The Natural native DML statement:

```
STORE RECORD IN EMPLOYEES
  WITH PERSONNEL_ID = '2112'
       NAME         = 'LIFESON'
       FIRST_NAME   = 'ALEX'
```

Equivalent Natural SQL statement:

```
INSERT INTO EMPLOYEES (PERSONNEL_ID, NAME, FIRST_NAME)
  VALUES ('2112', 'LIFESON', 'ALEX')
```

The PASSWORD, CIPHER and USING/GIVING NUMBER clauses of the STORE statement cannot be used.

UPDATE

The Natural native DML statement UPDATE updates a row in an SQL/DS table which has been read with a preceding FIND, READ, or SELECT statement. It corresponds to the SQL statement UPDATE WHERE CURRENT OF *cursor-name* (Positioned UPDATE), which means that only the row which was read last can be updated.

UPDATE with FIND/READ

As explained with the Natural native DML statement FIND, Natural translates a FIND statement into an SQL SELECT statement. When a Natural program contains a DML UPDATE statement, this statement is translated into an SQL UPDATE statement and a FOR UPDATE OF clause is added to the SELECT statement.

Example:

```
FIND EMPLOYEES WITH SALARY < 5000
  ASSIGN SALARY = 6000
  UPDATE
```

Natural would translate the above Natural statements into SQL and assign a cursor name (for example, CURSOR1) as follows:

```
DECLARE CURSOR1 CURSOR FOR
SELECT SALARY FROM EMPLOYEES WHERE SALARY < 5000
  FOR UPDATE OF SALARY
UPDATE EMPLOYEES SET SALARY = 6000
  WHERE CURRENT OF CURSOR1
```

Both the SELECT and the UPDATE statement refer to the same cursor.

Due to DB2 logic, a column (field) can only be updated if it is contained in the FOR UPDATE OF clause; otherwise updating this column (field) is rejected. Natural includes automatically all columns (fields) into the FOR UPDATE OF clause which have been modified anywhere in the Natural program or which are input fields as part of a Natural map.

However, a DB2 column is not updated if the column (field) is marked as “not updateable” in the Natural DDM. Such columns (fields) are removed from the FOR UPDATE OF list without any

warning or error message. The columns (fields) contained in the `FOR UPDATE OF` list can be checked with the `LISTSQL` command.

The Adabas short name in the Natural DDM determines whether a column (field) can be updated.

The following table shows the ranges that apply:

Short-Name Range	Type of Field
AA - N9	non-key field that can be updated
Aa - Nz	non-key field that can be updated
OA - O9	primary key field
PA - P9	ascending key field that can be updated
QA - Q9	descending key field that can be updated
RA - X9	non-key field that cannot be updated
Ra - Xz	non-key field that cannot be updated
YA - Y9	ascending key field that cannot be updated
ZA - Z9	descending key field that cannot be updated
1A - 9Z	non-key field that cannot be updated
1a - 9z	non-key field that cannot be updated

Be aware that a primary key field is never part of a `FOR UPDATE OF` list. A primary key field can only be updated by using a non-cursor `UPDATE` operation (see also Natural SQL `UPDATE` statement in the section *Using Natural SQL Statements*).

A row read with a `FIND` statement that contains a `SORTED BY` clause cannot be updated (due to SQL/DS limitations as explained with the `FIND` statement). A row read with a `READ LOGICAL` statement cannot be updated either (as explained with the `READ` statement).

If a column is to be updated which is redefined as an array, it is strongly recommended to update the whole column and not individual occurrences; otherwise, results are not predictable. To do so, in reporting mode you can use the `OBTAIN` statement, which must be applied to all field occurrences in the column to be updated. In structured mode, however, all these occurrences must be defined in the corresponding Natural view.

The data locked by an `UPDATE` statement are released when an `END TRANSACTION` (`COMMIT WORK`) or `BACKOUT TRANSACTION` (`ROLLBACK WORK`) statement is executed by the program.

Note: If a length indicator field or `NULL` indicator field is updated in a Natural program without updating the field (column) it refers to, the update of the column is not generated for SQL/DS and thus no updating takes place.

UPDATE with SELECT

In general, the Natural native DML statement `UPDATE` can be used in both structured and reporting mode. However, after a `SELECT` statement, only the syntax defined for Natural structured mode is allowed:

```
UPDATE [RECORD] [IN] [STATEMENT] [(r)]
```

This is due to the fact that in combination with the `SELECT` statement, the Natural native DML `UPDATE` statement is only allowed in the special case of:

```
...
SELECT ...
   INTO VIEW view-name
   ...
```

Thus, only a whole Natural view can be updated; individual columns (fields) cannot.

Example:

```
DEFINE DATA LOCAL
01 PERS VIEW OF SQL-PERSONNEL
  02 NAME
  02 AGE
END-DEFINE

SELECT *
  INTO VIEW PERS
  FROM SQL-PERSONNEL
  WHERE NAME LIKE 'S%'

    IF NAME = 'SMITH'
      ADD 1 TO AGE
    UPDATE
    END-IF

END-SELECT
    ...
```

In combination with the Natural native DML `UPDATE` statement, any other form of the `SELECT` statement is rejected and an error message is returned.

In all other respects, the Natural native DML `UPDATE` statement can be used with the `SELECT` statement in the same way as with the Natural `FIND` statement.

Using Natural SQL Statements

This section covers points you have to consider when using Natural SQL statements with SQL/DS. These SQL/DS-specific points partly consist in syntax enhancements which belong to the Extended Set of Natural SQL syntax. The Extended Set is provided in addition to the Common Set to support database-specific features; see *Common Set and Extended Set* in the section *SQL Statements* in the Natural *Statements* documentation. It also includes features not supported by SQL/DS.

For information on logging SQL statements contained in a Natural program, refer to *DBLOG Trace Screen for SQL Statements* in the *DBLOG Utility* documentation.

Below is information on the following Natural SQL statements and on common syntactical items:

- Syntactical Items Common to Natural SQL Statements
- COMMIT - SQL
- DELETE - SQL
- INSERT - SQL
- PROCESS SQL
- ROLLBACK - SQL
- SELECT - SQL
- UPDATE - SQL

Syntactical Items Common to Natural SQL Statements

The following common syntactical items are either SQL/DS-specific and do not conform to the standard SQL syntax definitions (that is, to the Common Set of Natural SQL syntax) or impose restrictions when used with SQL/DS (see also *SQL Statements* in the Natural *Statements* documentation).

Below is information on the following common syntactical items:

- atom
- comparison
- factor
- scalar-function
- scalar-operator
- special-register

- units

atom

An atom can be either a parameter (that is, a Natural program variable or host variable) or a constant. When running dynamically, however, the use of host variables is restricted by SQL/DS. For further details, refer to the relevant SQL/DS literature by IBM.

comparison

The comparison operators specific to SQL/DS belong to the Natural Extended Set. For a description, refer to *Comparison Predicate* in *Search Condition*, Natural *SQL Statements* in the Natural *Statements* documentation.

factor

The following factors are specific to SQL/DS and belong to the Natural SQL Extended Set:

```
special-register
scalar-function(scalar-expression, ...)
scalar-expression unit
case-expression
```

scalar-function

A scalar function is a built-in function that can be used in the construction of scalar computational expressions. Scalar functions are specific to SQL/DS and belong to the Natural SQL Extended Set.

The following scalar functions are supported:

```
CHAR
DATE
DAY
DAYS
DECIMAL
DIGITS
FLOAT
HEX
HOUR
INTEGER
LENGTH
MICROSECOND
MINUTE
MONTH
SECOND
```

```
STRIP
SUBSTR
TIME
TIMESTAMP
TRANSLATE
VALUE
VARGRAPHIC
YEAR
```

Each scalar function is followed by one or more scalar expressions in parentheses. The number of scalar expressions depends upon the scalar function. Multiple scalar expressions must be separated from one another by commas.

Example:

```
SELECT NAME
  INTO NAME
  FROM SQL-PERSONNEL
  WHERE SUBSTR ( NAME, 1, 3 ) = 'Fri'
       ...
```

scalar-operator

The concatenation operator (`CONCAT` or `||`) does not conform to standard SQL. It is specific to SQL/DS and belongs to the Natural Extended Set.

special-register

The following special registers do not conform to standard SQL. They are specific to SQL/DS and belong to the Natural SQL Extended Set:

```
USER
CURRENT TIMEZONE
CURRENT DATE
CURRENT TIME
CURRENT TIMESTAMP
```

A reference to a special register returns a scalar value.

units

Units, also called "durations", are specific to SQL/DS and belong to the Natural SQL Extended Set.

The following units are supported:

```
DAY
DAYS
HOUR
HOURS
MICROSECOND
MICROSECONDS
MINUTE
MINUTES
MONTH
MONTHS
SECOND
SECONDS
YEAR
YEARS
```

COMMIT - SQL

The Natural SQL statement `COMMIT` indicates the end of a logical transaction and releases all SQL/DS data locked during the transaction. All data modifications are made permanent.

`COMMIT` is a synonym for the Natural native DML statement `END TRANSACTION` as described in the section ***Using Natural Native DML Statements***.

As all cursors are closed when a logical unit of work ends, the `COMMIT` statement must not be placed within a database loop; instead, it has to be placed outside such a loop or after the outermost loop of nested loops.

If an external program written in another standard programming language is called from a Natural program, this external program must not contain its own `COMMIT` command if the Natural program issues database calls, too. The calling Natural program must issue the `COMMIT` statement on behalf of the external program.

For further details and statement syntax, see *COMMIT - SQL* in the Natural *Statements* documentation.

DELETE - SQL

Both the cursor-oriented or Positioned `DELETE`, and the non-cursor or Searched `DELETE` statements are supported as part of Natural SQL; the functionality of the Positioned `DELETE` statement corresponds to that of the Natural native DML `DELETE` statement.

With SQL/DS, a table name in the `FROM` clause of a Searched `DELETE` statement can be assigned a *`correlation-name`*. This does not correspond to the standard SQL syntax definition and therefore belongs to the Natural SQL Extended Set.

For further details and statement syntax, see *DELETE - SQL* in the Natural *Statements* documentation.

INSERT - SQL

The Natural SQL statement `INSERT` is used to add one or more new rows to a table.

Since the SQL `INSERT` statement can contain a select expression, all the SQL/DS-specific **common syntactical items** described above apply.

For further details and statement syntax, see *INSERT - SQL* in the Natural *Statements* documentation.

PROCESS SQL

The Natural SQL statement `PROCESS SQL` is used to issue SQL statements to the underlying database. The statements are specified in a *`statement-string`*, which can also include constants and parameters. The set of statements which can be issued is also referred to as Flexible SQL and comprises those statements which can be issued with the SQL statement `EXECUTE`.

In addition, Flexible SQL includes the following SQL/DS-specific statement `CONNECT`.

With the `PROCESS SQL` statement you can also specify the *`statement-string`* `SQLDISCONNECT` to release the connection to your SQL/DS application server. `SQLDISCONNECT` is transformed into the SQL/DS `ROLLBACK WORK RELEASE` command.

Execution of `SQLDISCONNECT` is only allowed if no transaction (logical unit of work) is open. Therefore, an explicit `COMMIT` (`END TRANSACTION`) or `ROLLBACK` (`BACKOUT TRANSACTION`) statement is required before executing `SQLDISCONNECT`, otherwise an error message is returned.

Note: To avoid transaction synchronization problems between the Natural environment and SQL/DS, the `COMMIT` and `ROLLBACK` statements must not be used within `PROCESS SQL`.

For further details and statement syntax, see *PROCESS SQL* in the Natural *Statements* documentation.

ROLLBACK - SQL

The Natural SQL statement `ROLLBACK` undoes all database modifications made since the beginning of the last logical transaction. Logical transactions can start either after the beginning of a session or after the last `COMMIT/END TRANSACTION` or `ROLLBACK/BACKOUT TRANSACTION` statement. All records held during the transaction are released.

`ROLLBACK` is a synonym for the Natural statement `BACKOUT TRANSACTION` as described in the section ***Using Natural Native DML Statements***.

As all cursors are closed when a logical unit of work ends, a `ROLLBACK` statement must not be placed within a database loop; instead, it has to be placed outside such a loop or after the outermost loop of nested loops.

If an external program written in another standard programming language is called from a Natural program, this external program must not contain its own `ROLLBACK` command if the Natural program issues database calls, too. The calling Natural program must issue the `ROLLBACK` statement on behalf of the external program.

For further details and statement syntax, see *ROLLBACK -SQL* in the Natural *Statements* documentation.

SELECT - SQL

The Natural SQL `SELECT` statement supports both the cursor-oriented selection, which is used to retrieve an arbitrary number of rows, and the non-cursor selection (Singleton `SELECT`), which retrieves at most one single row.

SELECT - Cursor-Oriented

Like the Natural native DML `FIND` statement, the cursor-oriented `SELECT` statement is used to select a set of rows (records) from one or more SQL/DS tables, based on a search criterion. Since a database loop is initiated, the loop must be closed by a `LOOP` statement (in reporting mode) or by an `END-SELECT` statement (in structured mode). With this construction, Natural uses the same loop processing as with the `FIND` statement. In addition, no cursor management is required from the application program; it is automatically handled by Natural.

For further details and syntax, see *SELECT SQL, Syntax 1 - Cursor-Oriented Selection* in the Natural *Statements* documentation.

SELECT SINGLE - Non-Cursor-Oriented

The Natural SQL statement `SELECT SINGLE` provides the functionality of a non-cursor selection (Singleton `SELECT`); that is, a select expression that retrieves at most one row without using a cursor.

Since SQL/DS supports the Singleton `SELECT` command in static SQL only, in dynamic mode, the Natural `SELECT SINGLE` statement is executed like a set-level `SELECT` statement, which results in a cursor operation. However, Natural checks the number of rows returned by SQL/DS. If more than one row is selected, a corresponding error message is returned.

For further details and syntax, see *SELECT SQL*, *Syntax 2 - Non-Cursor Selection* in the Natural *Statements* documentation.

UPDATE - SQL

Both the cursor-oriented or Positioned `UPDATE` and the non-cursor or Searched `UPDATE` statements are supported as part of Natural SQL. Both of them reference either a table or a Natural view.

With SQL/DS, the name of a table or Natural view to be referenced by a Searched `UPDATE` can be assigned a *`correlation-name`*. This does not correspond to the standard SQL syntax definition and therefore belongs to the Natural Extended Set.

The Searched `UPDATE` statement must be used, for example, to update a primary key field, since SQL/DS does not allow updating of columns of a primary key by using a Positioned `UPDATE` statement.

Note: If you use the `SET *` notation, all fields of the referenced Natural view are added to the `FOR UPDATE OF` and `SET` lists. Therefore, ensure that your view contains only fields which can be updated; otherwise, a negative `SQLCODE` is returned by SQL/DS.

For further details and syntax, see *UPDATE - SQL* in the Natural *Statements* documentation.

Using Natural System Variables

When used with DB2, there are restrictions and/or special considerations concerning the following Natural system variables:

- `*ISN`
- `*NUMBER`
- `*ROWCOUNT`

For information on restrictions and/or special considerations, refer to the section *Database-Specific Information* in the corresponding system variable documentation.

Error Handling

In contrast to the normal Natural error handling, where either an `ON ERROR` statement is used to intercept execution time errors or standard error message processing is performed and program execution is terminated, the enhanced error handling of Natural for DB2 provides an application controlled reaction to the encountered SQL error.

Two Natural subprograms, `NDBERR` and `NDBNOERR`, are provided to disable the usual Natural error handling and to check the encountered SQL error for the returned SQL code. This functionality replaces the `E` function of the `DB2SERV` interface, which is still provided but no longer documented.

For further information on Natural subprograms provided for SQL/DS, see the section ***Interface Subprograms***.

Example:

```
DEFINE DATA LOCAL
  01 #SQLCODE             (I4)
  01 #SQLSTATE            (A5)
  01 #SQLCA               (A136)
  01 #DBMS                (B1)
  END-DEFINE
  *
  *        Ignore error from next statement
  *
  CALLNAT 'NDBNOERR'
  *
  *        This SQL statement produces an SQL error
  *
  INSERT INTO SYSIBH-SYSTABLES (CREATOR, NAME, COLCOUNT)
    VALUES ('SAG', 'MYTABLE', '3')
  *
  *        Investigate error
  *
  CALLNAT 'NDBERR' #SQLCODE #SQLSTATE #SQLCA #DBMS
  *
  IF #DBMS NE 2                            /* not DB2
    MOVE 3700 TO *ERROR-NR
  END-IF
  *
  DECIDE ON FIRST VALUE OF #SQLCODE
    VALUE 0, 100                           /* successful execution
      IGNORE
    VALUE -803                             /* duplicate row
      /* UPDATE existing record
      /*
      IGNORE
    NONE VALUE
```

```
    MOVE 3700 TO *ERROR-NR
END-DECIDE
*
END
```

30 Interface Subprograms

Several Natural subprograms and a non-Natural program (DB2SERV Interface, written in Assembler) are available to provide you with internal information from the Natural interface to SQL/DS or specific functions that are not available within the interface itself.

Natural Interface Subprograms

From within a Natural program, Natural subprograms are invoked with the CALLNAT statement and non-Natural subprograms are invoked with the CALL statement.

All Natural subprograms are provided in the library SYSSQL and should be copied to the SYSTEM or steplib library, or to any library where they are needed. The corresponding parameters must be defined by using either the DEFINE DATA statement in structured mode or the RESET statement in reporting mode.

The Natural subprograms NDBBRM, NDBDBR2, NDBDBR3 allow the optional specification of the database ID, file number, password and cipher code of the library file containing the program to be examined.

If these parameters are not specified, either the current system file FNAT or the system file FUSER is used to locate the program to be examined depending on whether the library name begins with SYS or the library name does not begin with SYS.

Programs invoking NDBBRM, NDBDBR2, NDBDBR3 without these parameters will also work like before this change as the added parameters are declared as optional.

Overview of Interface Subprograms

Subprogram	Function
NDBDBRM	Checks whether a Natural program contains SQL access and whether it has been modified for static execution.
NDBDBR2	Checks whether a Natural program contains SQL access and whether it has been modified for static execution.
NDBDBR3	Checks whether a Natural program contains SQL access, whether it has been modified for static execution, and whether it can be generated as static.
NDBERR	Provides diagnostic information on the most recently executed SQL call.
NDBISQL	Executes SQL statements in dynamic mode.
NDBNOERR	Suppresses normal Natural error handling.
NDBNROW	Obtains the number of rows affected by a Natural SQL statement.
NDBSTMP	Provides an SQL/DS TIMESTAMP column as an alphanumeric field and vice versa.

For detailed information on these subprograms, follow the links shown in the table above and read the description of the call format and of the parameters in the text member provided with the subprogram (*subprogram-name*T).

NDBDBRM Subprogram

The Natural subprogram NDBDBRM is used to check whether a Natural program contains SQL access and whether it has been modified for static execution. It is also used to obtain the corresponding package name from the header of a Natural program generated as static (see also *Preparing Natural Programs for Static Execution*).

A sample program called CALLDBRM is provided on the installation tape; it demonstrates how to invoke NDBDBRM. A description of the call format and of the parameters is provided in the text member NDBDBRMT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBDBRM' #LIB #MEM #DBRM #RESP #DBID #FILENR #PASSWORD #CIPHER
```

The various parameters are described in the following table:

Parameter	Format/Length	Explanation
#LIB	A8	Contains the name of the library of the program to be checked.
#MEM	A8	Contains the name of the program (member) to be checked
#DBRM	A8	Returns the DBRM name.
#RESP	I2	Returns a response code. The possible codes are listed below.
#DBID	N5	Optional, Database ID of library file.
#FILENR	N5	Optional, File number of library file.
#PASSWORD	A8	Optional, Password of library file.
#CIPHER	N8	Optional, Cipher code of library file.

The #RESP parameter can contain the following response codes:

Code	Explanation
0	The member #MEM in library #LIB has SQL access; it is static if #DBRM contains a value.
-1	The member #MEM in library #LIB has no SQL access.
-2	The member #MEM in library #LIB does not exist.
-3	No library name has been specified.
-4	No member name has been specified.
-5	The library name must start with a letter.
<-5	Further negative response codes correspond to error numbers of Natural error messages.
> 0	Positive response codes correspond to error numbers of Natural Security messages.

NDBDBR2 Subprogram

The Natural subprogram NDBDBR2 is used to check whether a Natural program contains SQL access and whether it has been modified for static execution. It is also used to obtain the corresponding DBRM name from the header of a Natural program generated as static (see also *Preparing Natural Programs for Static Execution*) and the time stamp generated by the precompiler.

A sample program called CALLDBR2 is provided on the installation tape; it demonstrates how to invoke NDBDBR2. A description of the call format and of the parameters is provided in the text member NDBDBR2T.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBDBR2' #LIB #MEM #DBRM #TIMESTAMP #PCUSER #PCRELLEV #ISOLLEVL #DATEFORM
#TIMEFORM #RESP #DBID #FILENR #PASSWORD #CIPHER
```

The various parameters are described in the following table:

Parameter	Format/Length	Explanation
#LIB	A8	Contains the name of the library of the program to be checked.
#MEM	A8	Contains the name of the program (member) to be checked
#DBRM	A8	Returns the DBRM name.
#TIMESTAMP	B8	Consistency token generated by precompiler
#PCUSER	A1	User ID used at precomplile (only SQL/DS)
#PCRELLEV	A1	Release level of precompiler (only SQL/DS)
#ISOLLEVL	A1	Precomplier isolation level (only SQL/DS)
#DATEFORM	A1	Date format (only SQL/DS)
#TIMEFORM	A1	Time format (only SQL/DS)
#RESP	I2	Returns a response code. The possible codes are listed below.
#DBID	N5	Optional, Database ID of library file.
#FILENR	N5	Optional, File number of library file.
#PASSWORD	A8	Optional, Password of library file.
#CIPHER	N8	Optional, Cipher code of library file.

The #RESP parameter can contain the following response codes:

Code	Explanation
0	The member #MEM in library #LIB has SQL access; it is static if #DBR2 contains a value.
-1	The member #MEM in library #LIB has no SQL access.
-2	The member #MEM in library #LIB does not exist.
-3	No library name has been specified.
-4	No member name has been specified.
-5	The library name must start with a letter.
<-5	Further negative response codes correspond to error numbers of Natural error messages.
> 0	Positive response codes correspond to error numbers of Natural Security messages.

NDBDBR3 Subprogram

The Natural subprogram NDBDBR3 is used to check whether a Natural program contains SQL access (#RESP 0), whether the Natural program contains solely SQL statements, which are dynamically executable (#RESP 0, #DBRM '*DYNAMIC') and whether it has been modified for static execution (#RESP 0, #DBRM *dbrmname*). It is also used to obtain the corresponding DBRM name from the header of a Natural program generated as static (see also ***Preparing Programs for Static Execution***) and the time stamp generated by the precompiler.

A sample program called CALLDBR3 is provided on the installation tape; it demonstrates how to invoke NDBDBR3. A description of the call format and of the parameters is provided in the text member NDBDBR3T.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBDBR3' #LIB #MEM #DBRM #TIMESTAMP #PCUSER #PCRELLEV #ISOLLEVL #DATEFORM
#TIMEFORM #RESP #DBID #FILENR #PASSWORD #CIPHER
```

The various parameters are described in the following table:

Parameter	Format/Length	Explanation
#LIB	A8	Contains the name of the library of the program to be checked.
#MEM	A8	Contains the name of the program (member) to be checked
#DBRM	A8	Returns the DBRM name. ■ Space, if program has SQL access ■ *DYNAMIC, if program contains only dynamically executable SQL

Parameter	Format/Length	Explanation
		■ DBRM name, if program has been generated static.
#TIMESTAMP	B8	Consistency token generated by precompiler
#PCUSER	A1	User ID used at precomplile (only SQL/DS)
#PCRELLEV	A1	Release level of precompiler (only SQL/DS)
#ISOLLEVL	A1	Precomplier isolation level (only SQL/DS)
#DATEFORM	A1	Date format (only SQL/DS)
#TIMEFORM	A1	Time format (only SQL/DS)
#RESP	I2	Returns a response code. The possible codes are listed below.
#DBID	N5	Optional, Database ID of library file.
#FILENR	N5	Optional, File number of library file.
#PASSWORD	A8	Optional, Password of library file.
#CIPHER	N8	Optional, Cipher code of library file.

The #RESP parameter can contain the following response codes:

Code	Explanation
0	The member #MEM in library #LIB has SQL access; it is static, if #DBRM contains a value other than space and *DYNAMIC.
-1	The member #MEM in library #LIB has no SQL access.
-2	The member #MEM in library #LIB does not exist.
-3	No library name has been specified.
-4	No member name has been specified.
-5	The library name must start with a letter.
<-5	Further negative response codes correspond to error numbers of Natural error messages.
> 0	Positive response codes correspond to error numbers of Natural Security messages.

NDBERR Subprogram

The Natural subprogram NDBERR replaces the E function of the DB2SERV interface, which is still provided but no longer documented. It provides diagnostic information on the most recent SQL call. It also returns the database type which returned the error. NDBERR is typically called if a database call returns a non-zero SQL code (which means a NAT3700 error); see *Error Handling*.

A sample program called CALLERR is provided on the installation tape; it demonstrates how to invoke NDBERR. A description of the call format and of the parameters is provided in the text member NDBERRT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBERR' #SQLCODE #SQLSTATE #SQLCA #DBTYPE
```

The various parameters are described in the following table:

Parameter	Format/Length	Explanation
#SQLCODE	I4	Returns the SQL return code.
#SQLSTATE	A5	Returns a return code for the output of the most recently executed SQL statement.
#SQLCA	A136	Returns the SQL communication area of the most recent SQL/DS access.
#DBTYPE	B1	Returns the identifier (in hexadecimal format) for the currently used database (where X'03' identifies SQL/DS).

NDBISQL Subprogram

The Natural subprogram NDBISQL is used to execute SQL statements in dynamic mode. The SELECT statement and all SQL statements which can be prepared dynamically (according to the Adabas SQL Server documentation) can be passed to NDBISQL.

A sample program called CALLISQL is provided on the installation tape; it demonstrates how to invoke NDBISQL. A description of the call format and of the parameters is provided in the text member NDBISQLT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBISQL'#FUNCTION #TEXT-LEN #TEXT (*) #SQLCA #RESPONSE #WORK-LEN #WORK (*)
```

The various parameters are described in the following table:

Parameter	Format/Length	Explanation
#FUNCTION	A8	For valid functions, see below.
#TEXT-LEN	I2	Length of the SQL statement or of the buffer for the return area.
#TEXT	A1(1:V)	Contains the SQL statement or receives the return code.
#SQLCA	A136	Contains the SQLCA.
#RESPONSE	I4	Returns a response code.
#WORK-LEN	I2	Length of the workarea specified by #WORK (optional).
#WORK	A1(1:V)	Workarea used to hold SQLDA/SQLVAR and auxiliary fields across calls (optional).

Valid functions for the #FUNCTION parameter are:

Function	Parameter	Explanation
CLOSE		Closes the cursor for the SELECT statement.
EXECUTE	#TEXT-LEN #TEXT (*)	Executes the SQL statement. Contains the length of the statement. Contains the SQL statement. The first two characters must be blank.
FETCH	#TEXT-LEN #TEXT (*)	Returns a record from the SELECT statement. Size of #TEXT (in bytes). Buffer for the record.
TITLE	#TEXT-LEN #TEXT (*)	Returns the header for the SELECT statement. Size of #TEXT (in bytes); receives the length of the header (= length of the record). Buffer for the header line.

The #RESPONSE parameter can contain the following response codes:

Code	Function	Explanation
5	EXECUTE	The statement is a SELECT statement.
6	TITLE, FETCH	Data are truncated; only set on first TITLE or FETCH call.
100	FETCH	No record / end of data.
-2		Unsupported data type (for example, GRAPHIC).
-3	TITLE, FETCH	No cursor open; probably invalid call sequence or statement other than SELECT.
-4		Too many columns in result table.
-5		SQL code from call.
-6		Version mismatch.
-7		Invalid function.
-8		Error from SQL call.
-9		Workarea invalid (possibly relocation).
-10		Interface not available.
-11	EXECUTE	First two bytes of statement not blank.

Call Sequence

The first call must be an EXECUTE call. NDBISQL has a fixed SQLDA AREA holding space for 50 columns. If this area is too small for a particular SELECT it is possible to supply an optional work area on the calls to NDBISQL by specifying #WORK-LEN (I2) and #WORK(A1/1:V).

This workarea is used to hold the SQLDA and temporary work fields like null indicators and auxiliary fields for numeric columns. Calculate 16 bytes for SQLDA header and 44 bytes for each result

column and 2 bytes null indicator for each column and place for each numeric column, when supplying #WORK-LEN and #WORK(*) during NDBISQL calls. If these optional parameters are specified on an EXECUTE call, they have also to be specified on any following call.

If the statement is a SELECT statement (that is, response code 5 is returned), any sequence of TITLE and FETCH calls can be used to retrieve the data. A response code of 100 indicates the end of the data.

The cursor must be closed with a CLOSE call.

Notes:

1. Function code EXECUTE implicitly closes a cursor which has been opened by a previous EXECUTE call for a SELECT statement.
2. In TP environments, no terminal I/O can be performed between an EXECUTE call and any TITLE, FETCH or CLOSE call that refers to the same statement.

NDBNOERR Subprogram

The Natural subprogram NDBNOERR is used to suppress Natural NAT3700 errors caused by the next SQL call. This allows a program-controlled continuation if an SQL statement produces a non-zero SQL code. After the SQL call has been performed, NDBERR is used to investigate the SQL code; see *Error Handling*.

A sample program called CALLNOER is provided on the installation tape; it demonstrates how to invoke NDBNOERR. A description of the call format and of the parameters is provided in the text member NDBNOERT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBNOERR'
```

There are no parameters provided with this subprogram.

Note: Only NAT3700 errors (that is, non-zero SQL response codes) are suppressed, and also only errors caused by the next following SQL call.

Restrictions with Database Loops

- If NDBNOERR is called before a statement that initiates a database loop and an initialization error occurs, no processing loop will be initiated, unless a IF NO RECORDS FOUND clause has been specified.

- If NDBNOERR is called within a database loop, it does not apply to the processing loop itself, but only to the SQL statement subsequently executed inside this loop.

NDBNROW Subprogram

The Natural subprogram NDBNROW is used to obtain the number of rows affected by the Natural SQL statements Searched UPDATE, Searched DELETE, and INSERT. The number of rows affected is read from the SQL communication area (SQLCA). A positive value represents the number of affected rows, whereas a value of minus one (-1) indicates that all rows of a table in a segmented tablespace have been deleted; see also the Natural system variable *NUMBER as described in the Natural *System Variables* documentation.

A sample program called CALLNROW is provided on the installation tape; it demonstrates how to invoke NDBNROW. A description of the call format and of the parameters is provided in the text member NDBNROWT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBNROW' #NUMBER
```

The parameter #NUMBER (I4) contains the number of affected rows.

NDBSTMP Subprogram

For SQL/DS, Natural provides a TIMESTAMP column as an alphanumeric field (A26) of the format *YYYY-MM-DD-HH.MM.SS.MMMMMM*; see also ***List Columns of an SQL Table***.

Since Natural does not yet support computation with such fields, the Natural subprogram NDBSTMP is provided to enable this kind of functionality. It converts Natural time variables to SQL/DS time stamps and vice versa and performs SQL/DS time stamp arithmetics.

A sample program called CALLSTMP is provided on the installation tape; it demonstrates how to invoke NDBSTMP. A description of the call format and of the parameters is provided in the text member NDBSTMPT.

The functions available are:

Code	Explanation
ADD	Adds time units (labeled durations) to a given SQL/DS time stamp and returns a Natural time variable and a new SQL/DS time stamp.
CNT2	Converts a Natural time variable (format T) into a SQL/DS time stamp (column type TIMESTAMP) and labeled durations.
C2TN	Converts a SQL/DS time stamp (column type TIMESTAMP) into a Natural time variable (format T) and labeled durations.
DIFF	Builds the difference between two given SQL/DS time stamps and returns labeled durations.
GEN	Generates a SQL/DS time stamp from the current date and time values of the Natural system variable *TIMX and returns a new SQL/DS time stamp.
SUB	Subtracts labeled durations from a given SQL/DS time stamp and returns a Natural time variable and a new SQL/DS time stamp.
TEST	Tests a given SQL/DS time stamp for valid format and returns TRUE or FALSE.

Note: Labeled durations are units of year, month, day, hour, minute, second and micro-second.

DB2SERV Interface

DB2SERV is an Assembler program entry point which can be called from within a Natural program.

DB2SERV performs either of the following functions:

- **Function** D, which performs the SQL statement EXECUTE IMMEDIATE;
- **Function** U, which calls the database connection services (z/VSE batch mode only).

The parameter or variable values returned by each of these functions are checked for their format, length and number.

Function D

Function D performs the SQL statement EXECUTE IMMEDIATE. This allows SQL statements to be issued from within a Natural program.

The SQL statement string that follows the EXECUTE IMMEDIATE statement must be assigned to the Natural program variable STMT. It must contain valid SQL statements allowed with the EXECUTE IMMEDIATE statement as described in the relevant IBM documentation. Examples can be found below and in the demonstration programs DEM2* in library SYSSQL.

Note: The conditions that apply to issuing Natural `END TRANSACTION` or `BACKOUT TRANSACTION` statements also apply when issuing Natural SQL `COMMIT` or `ROLLBACK` statements.

Command Syntax

```
CALL 'DB2SERV' 'D' STMT STMTL SQLCA RETCODE
```

The variables used in this command are described in the following table:

Variable	Format/Length	Explanation	
STMT	A*nnn*	Contains a command string which consists of SQL syntax as described above.	
STMTL	I2	Contains the length of the string defined in the Natural program variable STMT.	
SQLCA	A136	Returns the current contents of the SQL communication area.	
RETCODE	I2	Returns an interface return code. The following codes are possible:	
		0	No warning or error occurred.
		4	SQL statement produced an SQL warning.
		8	SQL statement produced an SQL error.
		12	Internal error occurred;the corresponding Natural error message number can be displayed with SYSERR.

The current contents of the SQLCA and an interface return code (RETCODE) are returned. The SQLCA is a collection of variables that are used by SQL/DS to provide an application program with information on the execution of its SQL statements.

The following example shows you how to use DB2SERV with function "D":

Example of Function D - DEM2CREA:

```
************************************************************************
*  DEM2CREA - CREATE TABLE NAT.DEMO
     *
************************************************************************
*
DEFINE DATA
LOCAL USING DEMSQLCA
LOCAL
*                                    Parameters for DB2SERV
1 STMT         (A250)
1 STMTL        (I2)     CONST <250>
1 RETCODE      (I2)
*
END-DEFINE
```

```
*
COMPRESS  'CREATE TABLE NAT.DEMO'
  '(NAME        CHAR(20)     NOT NULL,'
  ' ADDRESS     VARCHAR(100) NOT NULL,'
  ' DATEOFBIRTH DATE         NOT NULL,'
  ' SALARY      DECIMAL(6,2),'
  ' REMARKS     VARCHAR(500))'
  INTO STMT
CALL 'DB2SERV' 'D' STMT STMTL SQLCA RETCODE
*
END TRANSACTION
*
IF RETCODE = 0
  WRITE 'Table NAT.DEMO created'
ELSE
  FETCH 'SQLERR'
END-IF
END
************************************************************************
```

Note: The functionality of the `DB2SERV` function `D` is also provided with the `PROCESS SQL` statement (see also the section *SQL Statements* in the Natural *Statements* documentation).

Function U

Function `U` calls the database connection services when running in batch mode under z/VSE; see also ***Sample Batch Verification Job (z/VSE only)***.

The user ID and password for the connection to SQL/DS must be assigned to the Natural program variables `USER-ID` and `PASSWORD`, respectively. An interface return code (`RETCODE`) is returned.

Command Syntax

```
CALL 'DB2SERV' 'U' USER-ID PASSWORD RETCODE
```

The variables used in this command are described in the following table:

Variable	Format/Length	Explanation
`USER-ID`	A8	A Natural variable that contains the user ID for the connection to SQL/DS.
`PASSWORD`	A8	A Natural variable that contains the user password for the connection to SQL/DS.
`RETCODE`	I2	A Natural variable that returns an interface return code. The following codes are possible: 0 No warning or error occurred. 4 SQL statement produced an SQL warning. 8 SQL statement produced an SQL error.

Variable	Format/Length	Explanation
		12 Internal error occurred; information on this error can be displayed with the Natural Utility SYSERR.

Variable	Format/Length	Explanation	
USER-ID	A8	A Natural variable that contains the user ID for the connection to SQL/DS.	
PASSWORD	A8	A Natural variable that contains the user password for the connection to SQL/DS.	
RETCODE	I2	A Natural variable that returns an interface return code. The following codes are possible:	
		0	No warning or error occurred.
		4	SQL statement produced an SQL warning.
		8	SQL statement produced an SQL error.
		12	Internal error occurred;the corresponding Natural error message number can be displayed with the Natural Utility SYSERR.

31 Natural SQL Gateway

With Natural SQL Gateway, a Natural user residing on z/OS can access data in an SQL database residing either on a UNIX or a Windows system.

This documentation describes the client and server parts of Natural SQL Gateway.

General Information	Special considerations on the environments supported by Natural SQL Gateway, known incompatibilities and constraints when using Natural SQL Gateway, terms used in this documentation, and on error messages related to Natural SQL Gateway.
Installing Natural SQL Gateway	Installation of the Natural SQL Gateway and description of the Natural SQL Gateway parameter module.
Introduction to Natural SQL Gateway	Purpose, usage, and product structure.
Accessing an SQL Table	Enable access to an SQL table with a Natural program.
Using Natural System Commands for Natural SQL Gateway	An overview of special Natural system commands which are part of Natural SQL Gateway.
Generating Natural Data Definition Modules (DDMs)	Generation of Natural data definition modules (DDMs) using the SQL Services function of the Natural `SYSDDM` utility.
Dynamic SQL Support	Internal handling of dynamic statements.
Using Natural Statements and System Variables	Special considerations on Natural DML statements, Natural SQL statements and Natural system variables when used with SQL. In addition, the Natural SQL Gateway enhanced error handling is discussed.
Interface Subprograms	Several Natural and non-Natural subprograms to be used for various purposes.
Natural File Server	Information on the Natural File Server in the supported environments.

Natural SQL Gateway Server Concept and structure of the server for Natural SQL Gateway, how to install, configure and operate a server for the Natural SQL Gateway under the operating system z/OS, purpose and use of the monitor client `NATMOPI` and the HTML monitor client.

Related Documentation

- For various aspects of accessing data in a database with Natural, refer to Accessing Data in a Database.
- For information on logging SQL statements contained in a Natural program, refer to *DBLOG Utility* in the Natural *Utilities* documentation.

32 General Information

This section covers the following topics:

Environment-Specific Considerations

Natural SQL Gateway can be run in the TP-monitor environments CICS and Com-plete and in TSO and as well as in a z/OS batch environment.

This section covers the following topics:

- Natural SQL Gateway under CICS
- Natural SQL Gateway under Com-plete
- Natural SQL Gateway under TSO
- Natural SQL Gateway in Batch Mode

Natural SQL Gateway under CICS

The following topics are covered below:

- Natural SQL Gateway Server Deployment
- File Server under CICS

Natural SQL Gateway Server Deployment

In order to access SQL tables from a CICS environment via Natural SQL Gateway, the **Natural SQL Gateway Server** has to be deployed. The `NDBPARM` parameters `NSBAHOST` and `NSBAPORT` are used to specify the address and port number of the Natural SQL Gateway server.

File Server under CICS

In a CICS environment, the file server is an optional feature to relieve the problems of switching to conversational processing. Before a screen I/O, Natural detects if there are any open cursors and if so, saves the data contained by these cursors into the file server. With the file server, database loops can be continued across terminal I/Os, but database modifications made before a terminal I/O can no longer be backed out.

For a detailed description of the file server, refer to the section ***Natural File Server***.

Natural SQL Gateway under Com-plete

In order to access SQL tables from a Com-plete environment via Natural SQL Gateway, the **Natural SQL Gateway server** has to be deployed. The `NDBPARM` parameters `NSBAHOST` and `NSBAPORT` are used to specify the address and port number of the Natural SQL Gateway server.

Natural SQL Gateway under TSO

Natural SQL Gateway can run under TSO without requiring any changes to the Natural/TSO interface. Just supply the `hlq.RCI.LOAD` library from the CXX Adabas precompiler installation in the JCL.

Apart from z/OS Batch, the batch environment for Natural can also be the TSO background, which invokes the TSO terminal monitor program by an `EXEC PGM=IKJEFT01` statement in a JCL stream.

File Server under TSO

In a TSO environment, the file server is an optional feature to be able to emulate during development status a future CICS production environment.

With each terminal I/O, Natural issues a `COMMIT WORK` command to simulate CICS or IMS TM syncpoints. Therefore, database modifications made before a terminal I/O can no longer be backed out.

For a detailed description of the file server, refer to the section ***Natural File Server***.

Natural SQL Gateway in Batch Mode

Natural SQL Gateway can run in a z/OS batch environment. Just supply the `hlq.RCI.LOAD` library from the CXX Adabas precompiler installation in the JCL.

Incompatibilities and Constraints

This section lists the known incompatibilities and constraints when using Natural SQL Gateway to access data from from an SQL database system:

Data Type DECIMAL or NUMERIC

Most SQL database systems support packed decimal numbers with a maximal precision of 31 digits and a scale (fractional part of the number) of up to 31 digits. The scale has to be positive and not greater than the precision. Natural allows only a precision of 29 digits and the scale could not be greater than 7.

LOBs

Natural SQL Gateway does not support large database objects.

Stored Procedures

Natural SQL Gateway does not support stored procedures.

Static Execution

Natural SQL Gateway does not support static execution of Natural programs.

Messages Related to Natural SQL Gateway

The message number ranges of Natural system messages related to Natural SQL Gateway are 3275 - 3286, 3700-3749, and 7386-7395.

Terms Used in this Documentation

The following table provides an overview of important terms used in the Natural SQL Gateway documentation:

Term	Explanation
NSB	This is the product code of Natural SQL Gateway. In this documentation the product code is often used as prefix in the names of datasets, modules, etc.
NSERV	Short for **Natural SQL Gateway server**.
File Server	The term “file server” refers to the **Natural file server**.
DB2	DB2 refers to the family of IBM's licensed programs for relational database management.

33 Installing Natural SQL Gateway

This section describes how to install the Natural SQL Gateway (in the remainder of this section also referred to as NSB) in the various environments supported.

The installation procedures contain a number of options that depend on the TP monitor being used as well as on other site requirements.

This section covers the following topics:

Installing Natural SQL Gateway - General Information

This section covers the following topics:

Installation Jobs

The installation of Software AG products is performed by installation jobs. These jobs are either created manually or generated by System Maintenance Aid (SMA).

For each step of the installation procedure described later in the section Installing Natural SQL Gateway , the job number of a job performing the respective task is indicated. This job number refers to an installation job generated by SMA. If you are not using SMA, an example job of the same number is provided in the job library on the NSB installation tape; you must adapt this example job to your requirements. Note that the job numbers on the tape are preceded by a product code (for example, `NSBI070`).

Using System Maintenance Aid

For information on the use of Software AG's System Maintenance Aid for the installation process, refer to the *System Maintenance Aid* documentation.

Prerequisites

- Base Natural must be installed first; you cannot install Natural and Natural SQL Gateway at the same time.
- Software AG Editor must be installed (see *Installing the Software AG Editor* in the Natural *Installation* documentation).
- ConnecX SQL Engine (CXX) must be installed included in the Natural SQL Gateway delivery.

  For information, refer to the installation documentation of ConnecX SQL Engine.

Note: Ensure that you have selected the Adabas Precompiler component during installation.

- A Natural SQL Adapter for each SQL database system that you want to access through Natural SQL Gateway is required.
- If you install the Natural SQL Gateway Software without Natural for DB2, nevertheless, set `NDB` to status `INSTALLED` by using System Maintenance Aid (SMA), and the SMA parameter `NSB-ONLY` to `Y` (Yes).
- Product/version dependencies are specified under *Natural and Other Software AG Products* and *Operating/Teleprocessing Systems Required* in the current Natural *Release Notes*.

Special considerations for DB2 Systems

- In order to perform `CREATE TABLE` statements so that the table name qualifier on the target DB2 system is the same as the table name qualifier in the CDD and as specified in the `CREATE TABLE` statement the registry entry `USECONNXSCHEMAFORNATIVE` of ConnecX SQL Engine has to be set to `1`.
- On Windows systems, this could be done by the Configuration Manager of the ConnecX SQL Engine.
- On UNIX systems, this has to be accomplished by the following command `SQLREGISTRY 5 CONNX.USECONNXSCHEMAFORNATIVE 0 1`. The result of the above command could be verified by the following command `SQLREGISTRY 1`.

Installation Tape

The installation tape contains the datasets listed in the table below. The sequence of the datasets is shown in the *Report of Tape Creation* which accompanies the installation tape.

Dataset Name	Contents
`NSBvrs.LOAD`	Load modules
`NSBvrs.JOBS`	Example installation jobs
`NSBvrs.OBJS`	Contains the object modules of the server. See ***Installing the Natural SQL Gateway Server under z/OS***.

The installation tape for NSB also contains the following NDB datasets:

Dataset Name	Contents
NDB*vrs*.SRCE	Source modules
NDB*vrs*.LOAD	Load modules
NDB*vrs*.INPL	Utility programs in INPL format
NDB*vrs*.ERRN	Error messages

The notation *vrs* in dataset names represents the version number of the product.

Important Note for Installations with Natural for DB2 License

If you have already installed the latest Natural for DB2 version, you *must not* copy the NDB datasets from the tape again.

Copying the Tape Contents to a z/OS Disk

If you are using SMA, refer to the *System Maintenance Aid* documentation (included in the current edition of the Natural documentation CD).

If you are *not* using SMA, follow the instructions below.

This section explains how to:

- Copy dataset COPY.JOB from tape to disk.
- Modify this dataset to conform to your local naming conventions.

The JCL in this dataset is then used to copy all datasets from tape to disk.

If the datasets for more than one product are delivered on the tape, the dataset COPY.JOB contains the JCL to unload the datasets for all delivered products from the tape to your disk.

After that, you will have to perform the individual install procedure for each component.

- Step 1 - Copy Dataset COPY.JOB from Tape to Disk
- Step 2 - Modify COPY.JOB on Your Disk

- Step 3 - Submit COPY.JOB

Step 1 - Copy Dataset COPY.JOB from Tape to Disk

The dataset `COPY.JOB` (Label 2) contains the JCL to unload all other existing datasets from tape to disk. To unload `COPY.JOB`, use the following sample JCL:

```
//SAGTAPE JOB SAG,CLASS=1,MSGCLASS=X
//* ---------------------------------
//COPY EXEC PGM=IEBGENER
//SYSUT1 DD DSN=COPY.JOB,
// DISP=(OLD,PASS),
// UNIT=(CASS,,DEFER),
// VOL=(,RETAIN,SER=tape-volume),
// LABEL=(2,SL)
//SYSUT2 DD DSN=hilev.COPY.JOB,
// DISP=(NEW,CATLG,DELETE),
// UNIT=3390,VOL=SER=volume,
// SPACE=(TRK,(1,1),RLSE),
// DCB=*.SYSUT1
//SYSPRINT DD SYSOUT=*
//SYSIN DD DUMMY
//
```

where:

`hilev` is a valid high level qualifier
`tape-volume` is the tape volume name, for example: T12345
`volume` is the disk volume name

Step 2 - Modify COPY.JOB on Your Disk

Modify the `COPY.JOB` on your disk to conform to your local naming conventions and set the disk space parameters before submitting this job:

- Set `HILEV` to a valid high level qualifier.
- Set `LOCATION` to a storage location.
- Set `EXPDT` to a valid expiration date.

Step 3 - Submit COPY.JOB

Submit `COPY.JOB` to unload all other datasets from the tape to your disk.

Natural SQL Gateway Installation Procedure

This section describes how to install Natural SQL Gateway in various environments and covers the the following topics:

- NSB Common Installation Steps

NSB Common Installation Steps

The following steps describe the procedure for installing the components of Natural SQL Gateway that are common to all environments:

- Step 1: Modify, Assemble and Link NSB Parameter Module NDBPARM
- Step 2: Link-Edit NATGWDB2
- Step 3: Create Natural Parameter Module
- Step 4: Link Natural Nucleus
- Step 5: Load Natural SQL Gateway Objects into System File
- Step 6: Load Natural SQL Gateway Error Messages into System File
- Step 7: Create Natural Parameter Module and Link the Nucleus

Step 1: Modify, Assemble and Link NSB Parameter Module NDBPARM

Job I055, Steps 1640 or 1660 or 1675

- The NSB parameter module `NDBPARM` contains the macro `NDBPRM` with parameters specific to the Natural SQL Gateway and the macro `NDBID` to specify the database type of an SQL DBID.

  You can generally use the default values for all parameters. Modify only the values of the parameters whose default values do not suit your requirements.

  The individual parameters are described in the section ***Parameter Module NDBPARM***.
- When Natural SQL Gateway will be used within a TP environment (CICS or Com-plete)

  Specify via `NSBAHOST` and `NSBAPORT` the TCP/IP address and port number of the Natural SQL Gateway server to be deployed for passing the SQL requests and results to and from the JDBC server.
- **When the file server is not to be used:**

  Execute the Steps 1640 and 1650; the resulting parameter module is called `NDBPARM`.
- **When the file server is to be used:**

Execute the Steps 1660 and 1670; the resulting additional parameter module is called `NDBPARMF`.

- **When the file server uses the Software AG Editor buffer pool as the storage medium:**

  Execute the Steps 1675 and 1676, the resulting additional parameter module is called `NDBPARME`.

Step 2: Link-Edit NATGWDB2

Job I055, Step 1680

Link-edit the environment-independent NSB nucleus `NATGWDB2`. Verify that the `INCLUDE` cards refer to the corresponding DD names for the load libraries.

Step 3: Create Natural Parameter Module

Job I060, Steps 0010, 0015

Assemble and link the Natural parameter module for batch mode.

Adapt your Natural parameter module `NATPARM` by adding parameters specific to Natural for SQL Gateway (see *Natural Parameter Modification for Natural SQL Gateway*) and reassemble `NATPARM`.

Step 4: Link Natural Nucleus

Job I060, Step 0020

Link the nucleus (Step 0020) for batch Natural.

Modify the JCL used to link your Natural environment-dependent nucleus by adding the following `INCLUDE` cards and the corresponding DD statements:

`INCLUDE SMALIB(NDBPARM)`	NDB parameter module created in Step 1
`INCLUDE SMALIB(NSBCNXTB)`	ConnecX SQL Engine (CXX) interface entry point table
`INCLUDE RCIOBJ(xxxxxxx)`	Environment-dependent interface (see below)
`INCLUDE NATLIB(NAT2LE)`	Interface module required to call C runtime functions in a CICS or Com-plete environment
`INCLUDE NCIOLIB(NCI2TCP)`	Natural TCP/IP interface required in a CICS environment

Natural SQL Gateway basically consists of:

- An environment-independent nucleus, which can be shared by multiple environments.
- Environment-dependent components, which must be linked to the appropriate Natural environment-dependent interface.

Job I060, Step 0105

Modify the JCL used to link your Natural shared nucleus by adding the following `INCLUDE` card:

`INCLUDE SMALIB(NATGWDB2)`	Environment-independent NSB nucleus from Step 2

Notes for CICS Environments:

1. Add an `INCLUDE` for the CICS socket module `EZACIC17` contained in the CICS socket library (usually `hlq.SEZARNT1`, `hlq.SEZATCP` or `hlq.SEZACMTX`).
2. Resolve unresolved external references from the CICS socket library and the current LE library (usually `hlq.SCEELKED`), that is, add these libraries to the `SYSLIB` definition of your link job and do *not* specify the `NCAL` parameter for the link.
3. Configure the CICS TCP/IP environment as described in the IP CICS Socket Guide by IBM.

`RCIOBJ` denotes the `RCI.OBJ` library from the installation of ConnecX SQL Engine.

Interface	Library	Description	Environment
API3GL	RCIOBJ	ConnecX Client	TSO and batch
CXXCLNT	RCIOBJ	Natural SQL Gateway Client	CICS and Com-plete.

If you want to use the Natural File Server, include `SMALIB(NDBPARMF)` or `SMALIB(NDBPARME)` instead of `SMALIB(NDBPARM)`; see also Step 1 above.

Note: If you want to use NSB in various environments (that is, with different TP monitors), you must repeat this step for each of these environments.

Instead of link-editing your Natural nucleus in the way described above, you have the following alternatives:

1. If you do not use a Natural shared nucleus, all modules must be included in the link-edit of the Natural nucleus.
2. Remove `NATGWDB2` from the link-edit of the Natural shared nucleus and run it as a separate module with the mandatory entry name `NATGWDB2`. You can modify the name of the module created in Step 2. However, if you use a name different from `NATGWDB2`, this name must be specified as an alias name in an `NTALIAS` macro entry of the Natural parameter module. This way of link-editing only applies if the Natural Resolve CSTATIC Addresses feature (RCA) is used.
3. Include all modules in the link-edit job of a separate Natural parameter module with the mandatory entry name `CMPRMTB`. The name of the resulting module is arbitrary. This way of link-editing only applies if an alternative parameter module (profile parameter `PARM`) is used. If link-editing is done in this way, you can install NSB without having to modify your Natural nucleus or driver.

Step 5: Load Natural SQL Gateway Objects into System File

Job I061, Step 1610

Before executing this step, change the `CMWKF01` DD statement to point to the `NDB`*`vrs`*`.INPL` dataset.

In this step, the Natural SQL Gateway system programs, maps and DDMs are loaded into the Natural system file. The `INPL` job loads objects into the Natural system libraries `SYSDDM`, `SYSTEM` and `SYSDB2` in the `FNAT` system file.

Step 6: Load Natural SQL Gateway Error Messages into System File

Job I061, Step 1620

Before executing this step, change the `CMWKF02` DD statement to point to the `NDB`*`vrs`*`.ERRN` dataset.

This step executes a batch Natural job that runs an error load program by using the `NDB`*`vrs`*`.ERRN` dataset as input. The `ERRLODUS` job loads error messages into the library `SYSERR` in the `FNAT` system file.

Step 7: Create Natural Parameter Module and Link the Nucleus

Job I080, Steps 2210, 2220, 2230 (CICS), Steps 2300, 2310, 2320 (Com-plete), Steps 0010, 0015, 0020 (TSO)

Assemble and link the Natural parameter module and link the nucleus.

Natural SQL Gateway Installation Steps Specific to CICS

This section describes how to install Natural SQL Gateway in a CICS environment:

This section covers the following topics:

- Using the File Server with VSAM
- Specification of Natural SQL Server TCP/IP address and port number

- Connect to the desired JDBC server

Using the File Server with VSAM

- Step 1: Define VSAM dataset for file server
- Step 2: Format file server dataset
- Step 3: Modify, assemble and link CICS tables
- Step 4: Restart CICS

Step 1: Define VSAM dataset for file server

Job I008, Step 1610

Specify the size and the name of the VSAM RRDS that is to be used as the file server (see also ***Installing the File Server*** in ***Natural File Server***).

Step 2: Format file server dataset

Job I075, Step 1610

Specify the five input parameters required to format the file server dataset (see also ***Natural File Server***).

Step 3: Modify, assemble and link CICS tables

Shown below are sample additional CICS table entries needed for the file server and for the DB2 components of Natural:

FCT entry:

```
CMFSERV DFHFCT TYPE=DATASET,                          X
               ACCMETH=VSAM ,                         X
               BUFND=5,                               X
               BUFNI=4,                               X
               DATASET=CMFSERV,                       X
               DISP=SHR,                              X
               DSNAME=SAGLIB.NCIDB2.SERVER,           X
               FILSTAT=(ENABLED,CLOSED),              X
               JID=NO,                                X
               LOG=NO,                                X
               LSRPOOL=NONE,  1-8 ONLY FOR XA; NONE   X
               RECFORM=(FIXED,BLOCKED),               X
               RSL=PUBLIC,                            X
               SERVREQ=(ADD,UPDATE,DELETE,BROWSE),    X
               STRNO=4
```

Step 4: Restart CICS

Restarting CICS is required, because of the additional FCT entry above.

Specify the five input parameters required to format the file server dataset (see also ***Installing the File Server*** in ***Natural File Server***).

Specification of Natural SQL Server TCP/IP address and port number

Modify the `NDBPARM` module by specification of the `NSBAHOST` parameter to denote the TCP/IP address and the `NSBAPORT` parmeter to denote the port number of the **Natural SQL Gateway server**.

Connect to the desired JDBC server

Invoke Natural with an appropriate `DB2SIZE`.

Ensure that SQL tables can be accessed. Before the first SQL call you must connect to the ConnecX SQL Engine JDBC server. For this, use a `PROCESS SQL` statement to specify the desired hostname, port number and CDD file, plus user ID and password.

Natural SQL Gateway Installation Steps Specific to Com-plete

This section describes how to install Natural SQL Gateway in a Com-plete environment:

This section covers the following topics:

- Specification of Natural SQL Server TCP/IP address and port number
- Connect to the desired JDBC server

Specification of Natural SQL Server TCP/IP address and port number

Modify the `NDBPARM` module by specification of the `NSBAHOST` parameter to denote the TCP/IP address and the `NSBAPORT` parmeter to denote the port number of the **Natural SQL Gateway server**.

Connect to the desired JDBC server

Invoke Natural with a appropriate `DB2SIZE`.

Ensure that SQL tables can be accessed. Before the first SQL call you must connect to the ConnecX SQL Engine JDBC server. For this, use a `PROCESS SQL` statement to specify the desired hostname, port number and CDD file, plus user ID and password.

Natural SQL Gateway Installation Steps Specific to TSO

This section describes how to install Natural SQL Gateway in a TSO environment:

This section covers the following topics:

- Using the File Server with VSAM
- Sample JCL for Starting and Using Natural SQL Gateway

Using the File Server with VSAM

If you want to use the **Natural File Server** (VSAM), perform the following additional steps:

- Step 1: Modify NDBFSRV in NATTSO
- Step 2: Define VSAM dataset for file server
- Step 3: Format file server dataset

Step 1: Modify NDBFSRV in NATTSO

Set the `NDBFSRV` parameter in the `NATTSO` macro to `YES` and reassemble and relink your Natural TSO interface `NATTSO`.

Step 2: Define VSAM dataset for file server

Job I008, Step 1620

Specify the size and the name of the VSAM RRDS that is to be used as the file server (see also ***Installing the File Server*** in *Natural File Server*).

Step 3: Format file server dataset

Job I075, Step 1620

Specify the five input parameters required to format the file server dataset (see also ***Installing the File Server*** in *Natural File Server*).

Sample JCL for Starting and Using Natural SQL Gateway

To test the TSO installation of Natural SQL Gateway, perform the following steps:

- Step 1: Adapt TSO CLIST
- Step 2: Invoke Natural

Step 1: Adapt TSO CLIST

Job I070, Step 2400

Change the library and program names in the TSO CLIST to meet site requirements. If you do not use the file server, remove the `ALLOC` and `FREE` statements for `CMFSERV`.

Step 2: Invoke Natural

Invoke Natural by executing the CLIST created in the previous step. Ensure that SQL tables can be accessed. Before the first SQL call you must connect to the ConnecX SQL Engine JDBC server. For this, use a `PROCESS SQL` statement to specify the desired hostname, port number and CDD file, plus user ID and password.

Natural SQL Gateway Installation Verification

This section provides example batch jobs and online methods for verifying the installation of Natural SQL Gateway:

This section covers the following topics:

- Test Natural SQL Gateway in Batch Mode - Job NSBBATCA
- Online Verification Methods

Test Natural SQL Gateway in Batch Mode - Job NSBBATCA

`NSBBATCA` contains sample JCL to test Natural SQL Gateway in batch mode. Modify the sample JCL to meet site requirements.

Before the first SQL call you must call `NSBDCON` to explicitly connect to the ConnecX SQL Engine JDBC server. `NSBDCON` can be edited to specify the appropriate host name, port number and CDD registry name.

Online Verification Methods

The online verification can only be done in a TSO, Com-plete or CICS environment.

Natural SQL Gateway Sample Programs

The following table contains all Natural SQL Gateway (NSB) sample programs. They are all provided during the Natural SQL Gateway installation.

Program Name	Purpose
NSBDCON	Connect to ConnecX SQL Engine JDBC server.
NSBDCREA	Create table NSB.DEMO.
NSBDISC	Disconnect from ConnecX SQL Engine JDBC server.
NSBDROP	Drop table NSB.DEMO.
NSBDFIND	Read NSB.DEMO by FIND statement.
NSBDINS	Load NSB.DEMO by INSERT statement.
NSBDPDEL	Delete from NSB.DEMO by positioned DELETE.
NSBDPUPD	Update NSB.DEMO by positioned UPDATE.
NSBDSDEL	Delete from NSB.DEMO by searched UPDATE.
NSBDSEL	Read NSB.DEMO by SELECT statement.
NSBDSET	Show **SET SCHEMA** and **SET CATALOG** statements.
NSBDSTOR	Load NSB.DEMO by STORE statement.
NSBDSUPD	Update NSB.DEMO by searched UPDATE.

All programs use DDM NSB-DEMO, which uses the LFILE 102. Therefore the NATPARM has to map the LFILE 102 to a DBID which is mapped to the database type CNX by a NDBID definition in the NDBPARM module.

Before the demo programs can be executed the user has to connect to a ConnecX SQL Engine JDBC server. This could be done by a modified copy of the NSBDCON program.

The results of demo programs differ depending on the sequence of their execution.

If you receive the message NAT3700, enter the Natural system command SQLERR to display the corresponding SQL return code.

Natural Parameter Modification for Natural SQL Gateway

This section covers the following topics:

- Natural Profile Parameter Settings
- Performance Considerations for the DB2SIZE Parameter

Natural Profile Parameter Settings

To set the Natural profile parameters

1. Add the following Natural profile parameter to your NATPARM module:

```
DB2SIZE=nn
```

The DB2SIZE parameter can also be specified dynamically. It indicates the size of the DB2 buffer area, which must be set to at least 6 KB.

The setting of DB2SIZE also depends on whether you use the file server or not. If the file server is not used, the setting can be calculated according to the following formula:

```
((1064 + n1 * 40 + n2 * 120) + 1023) / 1024 KB
```

If the file server is used, the setting can be calculated according to the following formula:

```
((1060 + n1 * 40 + n2 * 160 + n3 * 8) 1023) / 1024 KB
```

The variables *n1*, *n2* and *n3* correspond to:

n1	the number of statements for dynamic access as specified as the second parameter in Job I055, Step 1600;
n2	the maximum number of nested database loops as specified with the MAXLOOP parameter in NDBPARM;
n3	the maximum number of file server blocks to be allocated per user specified as the fifth parameter in Job I075, Step 1620 or the EBPMAX parameter of NDBPARM, if you decided to use the Software AG Editor buffer pool as file server.

Important: Ensure that you have also added the Natural parameters required for the Software AG Editor; see the relevant installation description in the section Installing the Software AG Editor, in the Natural *Installation* documentation.

As DB2SIZE applies to Natural for DB2 and Natural SQL Gateway, it must be set to the maximum value if you run more than one of these environments.

Add an NTDB entry with database-type SQL specifying the list of logical database numbers that relate to SQL tables. All Natural DDMs that refer to an SQL table must be cataloged with a DBID from this list. DBIDs can be any number from 1 to 254; a maximum of 254 entries can be specified. For most user environments, one entry is sufficient.

Important: Ensure that all SQL DDMs used when cataloging a given program have a valid SQL DBID. Also ensure that the DBIDs selected in the NTDB macro for SQL do not conflict with DBIDs selected for other database systems

At execution time of a program catalogued with a DBID of database-type SQL, the SQL database-type specified for that DBID in the NDB parameter module via NDBID macro determines which kind of database interface is used to access the SQL database. If the associated type is CNX, the Natural SQL Gateway will be used.

```
NTDB SQL,(200,249)
```

2. Add an LFILE entry for LFILE 102 specifying a logical database number (DBID), that relates to database type CNX. This is necessary for usage of ISQL or calls to NDBISQL using Natural SQL Gateway.

NTLFILE 102,249,1	SQL system file for CNX

Performance Considerations for the DB2SIZE Parameter

During execution of an SQL statement, storage is allocated dynamically to build the SQLDA for passing the host variables to the CXX interface stub.

For performance reasons, it is first attempted to meet the storage requirements by free space in the Natural for DB2 buffer (DB2SIZE). If there is not enough space available in this buffer, the TP monitor or operating system is invoked.

To take advantage of this performance enhancement, you must specify your DB2SIZE larger than calculated according to the formula; see *Natural Profile Parameter Settings*.

Depending on the SQL execution mode and on the usage of the **Natural file server**, the additional storage requirements (in bytes) can be calculated as follows:

- Dynamic Mode
- Storage Requirements for the Natural File Server
- Sample Calculation for Dynamic Mode without Using the Natural File Server

- Considerations for VARCHAR Fields

Dynamic Mode

With sending fields:

```
80 + n * 56
```

With sending fields including LOB columns:

```
80 + 2 * n * 56
```

where *n* is the number of sending fields in an SQL statement. The storage is freed immediately after the execution of the SQL statement.

With receiving fields (that is, with variables of the `INTO` list of a `SELECT` statement):

```
80 + n * 56 + 24 + n * 2
```

With receiving fields including LOB columns:

```
80 + 2 * n * 56 + 24 + n * 2
```

where *n* is the number of receiving fields in an SQL statement.

The storage remains allocated until the loop is terminated.

Storage Requirements for the Natural File Server

When using the file server, additional storage is required for each database loop that contains positioned `UPDATE` and/or `DELETE` statements.

For each of such loops, a buffer is allocated to save the contents of all receiving fields contained in the `INTO` list. Therefore, the size of this buffer corresponds to the total length of all receiving fields:

```
20 + 4 + sum (length (v1), ..., length (vn))
```

where *v1* ... *vn* refers to the variables contained in the `INTO` list.
The buffer remains allocated until the loop is terminated.

Sample Calculation for Dynamic Mode without Using the Natural File Server

If you use the default value 10 for both variables (*n1* and *n2*), the calculated DB2SIZE will be 2208 bytes. However, if you specify a DB2SIZE of 20 KB instead, the available space for dynamically allocated storage will be 18272 bytes, which means enough space for up to either 325 sending fields or 313 receiving fields.

Since space for receiving fields remains allocated until a database loop is terminated, the number of fields that can be used inside such a loop is reduced accordingly: for example, if you retrieve 200 fields, you can update about 110 fields inside the loop.

Considerations for VARCHAR Fields

When using VARCHAR fields (that is, fields with either an accompanying L@ field in the Natural view or an explicit LINDICATOR clause), additional storage is allocated dynamically if the L@ or LINDICATOR field is not specified directly in front of the corresponding base field. Therefore, always specify these fields in front of their base fields.

Parameter Module NDBPARM

The source module NDBPARM is used in several Natural add-on products. It contains parameter macros specific to an SQL environment:

- NDBPRM
- NDBID

These macros are described below.

Parameter Macro NDBPRM

The default values of the parameters contained in this macro can be modified to meet site-specific requirements (see the corresponding step of the *Installation Procedure*). The values of the parameters cannot be dynamically overwritten.

Complete List of Parameters Contained in NDBPRM

Below is a description of all parameters contained in the NDBPRM macro:

BTIGN | CONVERS | CONVRS2 | DDFSERV | DELIMID | EBPFSRV | EBPPRAL | EBPSEC | EBPMAX | ETIGN | FSERV | MAXLOOP | NNPSF | NSBAHOST | NSBAPORT | PSCIGN | REFRESH | RETRYPO | RWRDONL | STATDYN

List of Parameters Applicable to Natural SQL Gateway

The following parameters in the NDBPRM parameter macro are relevant to Natural SQL Gateway. All other parameters contained in the module are ignored.

DDFSERV | DELIMID | EBPFSRV | EBPPRAL | EBPSEC | EBPMAX | FSERV | MAXLOOP | NNPSF | NSBAHOST | NSBAPORT | PSCIGN | RWRDONL

BTIGN - Ignore BACKOUT TRANSACTION Error

Note: This parameter does not apply to Natural SQL Gateway and is ignored.

This parameter is relevant in CICS and IMS TM environments only.

BTIGN ignores the error which results from a BACKOUT TRANSACTION statement that was issued too late for backing out the current transaction, because an implicit Syncpoint has previously been issued by the TP monitor.

Possible Values:

Value	Explanation
ON	The error after a late BACKOUT TRANSACTION is ignored. This is the default value.
OFF	The error after a late BACKOUT TRANSACTION is *not* ignored.

CONVERS - Conversational Mode under CICS

This parameter is used to allow conversational mode in CICS environments where no **Natural file server** is used.

Possible Values:

Value	Explanation
ON	Conversational mode is allowed. This is the default value.
OFF	Conversational mode is *not* allowed.

If this parameter is set to OFF and no **Natural file server** is used, you cannot continue database loops across terminal I/Os; if so, the DB2 SQL codes -501, 504, 507, 514, or 518 may occur.

CONVRS2 - Allow Conversational Mode 2 under CICS

This parameter is used to allow conversational mode 2 in CICS environments.

Possible Values:

Value	Explanation
ON	Conversational mode 2 is allowed.
OFF	Conversational mode 2 is *not* allowed. This is the default value.

This parameter is used to control conversational mode 2 in CICS environments. Conversational mode 2 means that update transactions are spawned across terminal I/Os until either an explicit COMMIT or explicit ROLLBACK has been issued (Caution: DB2 and CICS resources are kept across terminal I/Os!). This means CONVRS2=ON has the same effect as the Natural parameter PSEUDO=OFF, except that the conversational mode is entered after an DB2 update statement (UPDATE, DELETE, INSERT) and left again after a COMMIT or ROLLBACK, while PSEUDO=OFF causes conversational mode for the total Natural session.

See also CALLNAT subprogram NDBCONV, which allows setting or resetting conversational mode 2 dynamically.

DDFSERV - Alternate DD Name for Natural File Server

This parameter specifies a DD name for the **Natural file server** module other than CMFSERV.

Possible Values:

Value	Explanation
DD-name	Any valid DD name. There is no default value.

DELIMID - Escape Character for Delimited Identifiers

This parameter determines the escape character to be used for generating delimited SQL identifiers for the column names and table names in SQL statements. A delimited identifier is a sequence of one or more characters enclosed in escape characters. You must specify a delimited identifier if you use SQL-reserved words for column names and table names, as demonstrated in the ***Example of DELIMID*** below.

Possible Values:

Value	Explanation
"	Double quotation mark
'	Single quotation mark
None	No value: Delimited identifiers are not enabled. This is the default value.

To enable generation of delimited identifiers, `DELIMID` must be set to double quotation mark (") or single quotation mark (').

The escape character specified for `DELIMID` and the SQL `STRING DELIMITER` are mutually exclusive. This implies that the mark (double or single quotation) used to enclose alphanumeric strings in SQL statements must be different from the value specified for `DELIMID`. If you enable delimited identifiers, ensure that the value specified for `DELIMID` also complies with the SQL `STRING DELIMITER` value of your DB2 installation.

See also the `RWRDONL` parameter to determine which delimited identifiers are generated in the SQL string.

Note: For Natural SQL Gateway users:

If generation of delimited identifiers is enabled, switch on the ConnecX CDD option **Use Quoted Delimiter**.

Example of DELIMID:

In the following example, a double quotation mark (") has been specified as the escape character for the delimited identifier:

Natural statement:

```
SELECT FUNCTION INTO #FUNCTION FROM XYZ-T1000
```

Generated SQL string:

```
SELECT "FUNCTION" FROM XYZ.T1000
```

EBPFSRV - Editor Buffer Pool for Natural File Server

This parameter is used to determine whether the **Natural file server** uses the Software AG Editor buffer pool as the storage medium.

Possible Values:

Value	Explanation
ON	The Software AG buffer pool is to be used as the storage medium for the Natural file server. ON *must* be set if the file server is to be used in a Parallel Sysplex environment. In this case, your Natural session must use the auxiliary editor buffer pool (see also *Support of a z/OS Parallel Sysplex Environment* in the *Installation* documentation).
OFF	A VSAM file is to be used as the storage medium for the Natural file server. This is the default value.

EBPPRAL - Editor Buffer Pool Primary Allocation

This parameter specifies the number of blocks to be allocated primarily to each user of the **Natural file server**, if the Software AG Editor buffer pool is used as the storage medium.

Possible Values:

Value	Explanation
0 - 32676	Number of blocks to be allocated primarily.
20	This is the default value.

If the EBPFSRV parameter is set to OFF, EBPPRAL is not used at runtime.

EBPSEC - Editor Buffer Pool Secondary Allocation

This parameter specifies the number of blocks to be allocated secondarily to each user of the **Natural file server** if the Software AG Editor buffer pool is used as the storage medium. The secondary allocation is used to allocate buffer pool blocks to the user if the primary allocation amount is already exhausted.

Possible Values:

Value	Explanation
0 - 32676	Number of blocks to be allocated secondarily.
10	This is the default value.

If the EBPFSRV parameter is set to OFF, EBPSEC is not used at runtime.

EBPMAX - Editor Buffer Pool Maximum Allocation

This parameter specifies the maximum number of blocks to be allocated to each user of the **Natural file server** if the Software AG Editor buffer pool is used as the storage medium. This parameter serves as upper limit for the allocation of buffer pool blocks to a single user.

Possible Values:

Value	Explanation
0 - 32676	Maximum number of blocks to be allocated.
100	This is the default value.

If the EBPFSRV parameter is set to OFF, EBPMAX is not used at runtime.

ETIGN - Ignore END TRANSACTION Error

Note: This parameter does not apply to Natural SQL Gateway and is ignored.

This parameter is relevant in IMS TM MPP and message-oriented BMP environments only.

It is used to handle END TRANSACTION statements in a message-driven IMS region (MPP or message-oriented BMP).

In such a region, an END TRANSACTION cannot be executed by the Natural/IMS interface and is therefore ignored without any notification. In such situations, the ETIGN parameter can be used to issue an error message instead.

Possible Values:

Value	Explanation
ON	The END TRANSACTION error is ignored and processing is continued. This is the default value.
OFF	The END TRANSACTION error is *not* ignored.

FSERV - Activate Natural File Server

This parameter determines whether the **Natural file server** is to be used and whether it can be disabled in the case of an initialization error.

Possible Values:

Value	Explanation
ON	Natural file server is to be used.
OFF	Natural file server is not to be used. This is the default value.
DIS	Natural file server is to be used but is to be disabled if it cannot be initialized.

If FSERV is set to ON and the file server is not operational, the initialization of the Natural SQL Gateway is terminated with a corresponding Natural error message. The Natural SQL Gateway is disabled and any SQL call is rejected with a corresponding error message.

MAXLOOP - Maximum Number of Nested Program Loops

This parameter specifies the maximum possible number of nested database loops accessing SQL databases.

Possible Values:

Value	Explanation
1 - 99	Maximum possible number of nested database loops.
10	This is the default value.

NNPSF - Set Natural Numerics' Positive Sign to F

This parameter changes the sign character of positive Natural variables which have format N, if they are filled from the SQL database system. Usually these variables have the `C` as positive sign character. If the parameter `NNPSF` is set to `ON`, `F` is used as positive sign character.

Possible Values:

Value	Explanation
`ON`	Positive numbers put into Natural numeric variables by the SQL database system get the sign `F`.
`OFF`	Positive numbers put into Natural numeric variables by the SQL database system remain unchanged. This is the default value.

NSBAHOST - Set Natural SQL Gateway Server Hostname

This parameter specifies the **Natural SQL Gateway server** TCP/IP hostname used to communicate from TP-monitor environments like CICS hosting Natural to ConnecX JDBC server talking to SQL databases.

Possible Values:

Value	Explanation
`hostname`	This hostname designates the TCP/IP address of the Natural SQL Gateway server who communicates with the CXX JDBC server.
`''(Empty string)`	This is the default value, meaning no Natural SQL Gateway server hostname is specified.

Example:

```
NSBAHOST=IBM2.HQ.SAG
```

NSBAPORT – Set Natural SQL Gateway Server TCP/IP Port Number

This parameter specifies the TCP/IP port number the **Natural SQL Gateway server** is listening to.

Possible Values:

Value	Explanation
`integer`	Specifies the port number the Natural SQL Gateway server listens to.
`0`	This is the default value, meaning no Natural SQL Gateway server port number is specified.

Example:

```
NSBAPORT=4713
```

PSCIGN - Treat Positive Sqlcodes as Sqlcode 0

This parameter influences the treatment of positive sqlcodes returned from the SQL database system. If the parameter `PSCIGN` is set to `OFF`, a NAT3700 error message is issued. If the parameter `PSCIGN` is set to `ON`, positive sqlcodes are treated as if they were zero, that is, no NAT3700 error message is issued.

Possible Values:

Value	Explanation
`ON`	Positive sqlcodes are treated as zero.
`OFF`	Positive sqlcodes cause a NAT3700 error message. This is the default value.

REFRESH - Refresh Setting of DB2 Server and Package Set

Note: This parameter does not apply to Natural SQL Gateway and is ignored.

This parameter is used to automatically set the DB2 server and package set to the values that applied when the last transaction was executed. Server and package set are refreshed by using the `CONNECT TO` *`server-name`* and `SET CURRENT PACKAGESET = '`*`package-name`*`'` SQL statements of DB2.

Possible Values:

Value	Explanation
`ON`	An automatic refresh is performed every time before a database transaction starts and if a server or package set has been specified.
`OFF`	No automatic refresh is performed. This is the default value.

RETRYPO - Number of Positioning Retries

Note: This parameter does not apply to Natural SQL Gateway and is ignored.

This parameter delimits the number of retries done by Natural for DB2 (NDB) in order to reposition a dynamic scrollable cursor in a pseudo-conversational environment (IMS MPP or CICS).

Possible Values:

Value	Explanation
`0 - 2147483648`	Number of retries done by Natural for DB2.
`10`	This is the default value.

This parameter applies only for dynamic scrollable cursors.

In pseudo-conversational environments, cursors are closed at terminal I/O. For dynamic scrollable cursors the current absolute position number and the current key column values are saved. After terminal I/O the dynamic scrollable cursor is opened again and positioned absolutely to the position of the saved absolute position. The contents of the key columns are compared with the saved values. If they match, processing continues with the next requested database operation.

If the contents of the key columns do not match the saved values, the next rows are fetched and compared with the saved values until either the values match or no row is found or the `RETRYPO` count is exhausted. In the latter cases the cursor is repositioned to the saved position and the prior rows are fetched and compared until either the values match or no row is found or the `RETRYPO` count is exhausted. In the latter cases a NAT3703 error message is issued. If a row is fetched whose key columns matches the saved values, processing continues with the next database instruction.

`RETRYPO` delimits the retries in each direction (*`next`* or *`prior`*).

If `RETRYPO` is zero no repositioning takes place.

RWRDONL - Generate Delimited Identifiers for Reserved Words Only

This parameter determines which identifiers are generated as delimited identifier in an SQL string. `RWRDONL` only takes effect if the setting of the `DELIMID` parameter allows delimited identifiers.

Possible Values:

Value	Explanation
ON	Only identifiers that are reserved words are generated as delimited identifiers. The list of reserved words is contained in the NDBPARM macro. This list has been merged from the lists of reserved words for DB2 for z/OS, DB2 for VSE/VM, DB2 for LINUX, OS/2, Windows and UNIX, and ISO/ANSI SQL99. This is the default value.
OFF	All identifiers are generated as delimited identifiers.

STATDYN - Allow Static to Dynamic Switch

Note: This parameter does not apply to Natural SQL Gateway and is ignored.

This parameter is used to allow dynamic execution of statically generated SQL statements if the static execution returns an error.

Possible Values:

Value	Explanation
NEVER	Dynamic execution is never allowed. This is the default value.
ALWAYS	Dynamic execution is always allowed after an error.
SPECIAL	Dynamic execution is allowed after special errors only. These special errors are: ■ NAT3706: Load module not found ■ SQL -805: DBRM (database request module) does not exist in plan ■ SQL -818: Mismatch of timestamps

Parameter Macro NDBID

The parameter macro NDBID determines the database type of an SQL DBID.

The NDBID macro is specified as follows:

1. Default Database Definition

The default database type is specified as follows. It applies to all database IDs not explicitly specified by `NDBID`.

```
NDBID=database-type
```

2. Single Database Definition

   A single database ID and its type is specified as follows:

```
NDBID=database-type,database-id
```

3. Multiple Database Definition

   Multiple database IDs of the same database type can be specified together, enclosed in parentheses:

```
NDBID=(database-type,database-id1,database-id2,...)
```

database-type

Possible Values	Explanation
DB2	Databases are accessed via Natural for DB2 (NDB). This is the default value.
CNX	Databases are accessed via Natural SQL Gateway (NSB).

database-id

Possible Values
1-254

34 Introduction to Natural SQL Gateway

Purpose and Usage

With Natural SQL Gateway, a Natural user residing on z/OS can access data in an SQL database residing either on a UNIX or a Windows system.

In general, there is no difference between using Natural with an SQL database and using it with Adabas, VSAM or DL/I. Natural SQL Gateway allows Natural programs to access SQL data, using the same Natural DML statements that are available for Adabas, VSAM, and DL/I.

Therefore, programs written for SQL tables can also be used to access Adabas, VSAM, or DL/I databases. Moreover, some additional Natural SQL statements are available.

Product Structure

Natural SQL Gateway is comprised of the following parts:

- **ConnecX Client**

  The ConnecX client part resides on the z/OS platform and communicates with the JDBC Server from a batch or TSO address space .

- **Natural SQL Gateway Client**

  The Natural SQL Gateway client part resides on the z/OS platform linked to Natural in a TP environment.

  The client part of Natural SQL Gateway is currently supported for CICS and Com-plete.

- **Natural SQL Gateway Server**

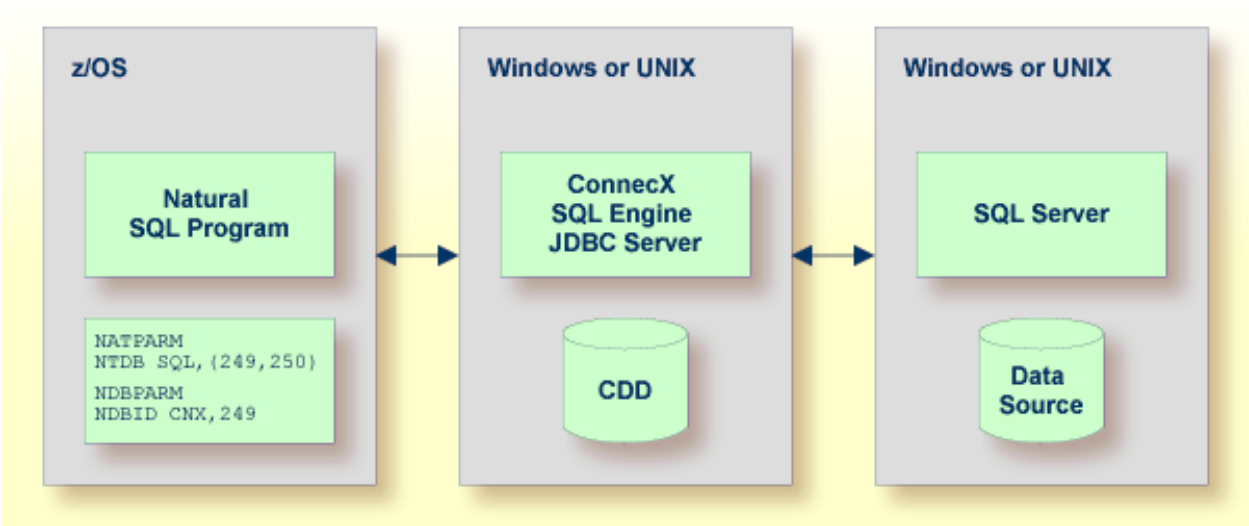
  The **Natural SQL Gateway server** runs the Natural SQL Gateway Client in a batch address space.

- **ConnecX SQL Engine JDBC Server**

  The ConnecX SQL Engine JDBC server resides either on a Windows or a Unix platform which accesses the SQL database system residing elsewhere.

  The ConnecX SQL Engine JDBC server utilises a data dictionary (CDD) in order to access the SQL database. The CDD describes the structures of tables and databases being accessed. The CDD provides a Windows based administration tool for easy maintenance of the metadata contained in the CDD. In addition, a Windows based query tool named InfoNaut is offered. InfoNaut allows developing SQL syntax, saving queries and query results in different formats.

  For further information, see the *ConnecX SQL Engine* documentation.



The z/OS section in the figure above differs depending on whether the SQL program runs in Batch/TSO or within a TP environment.

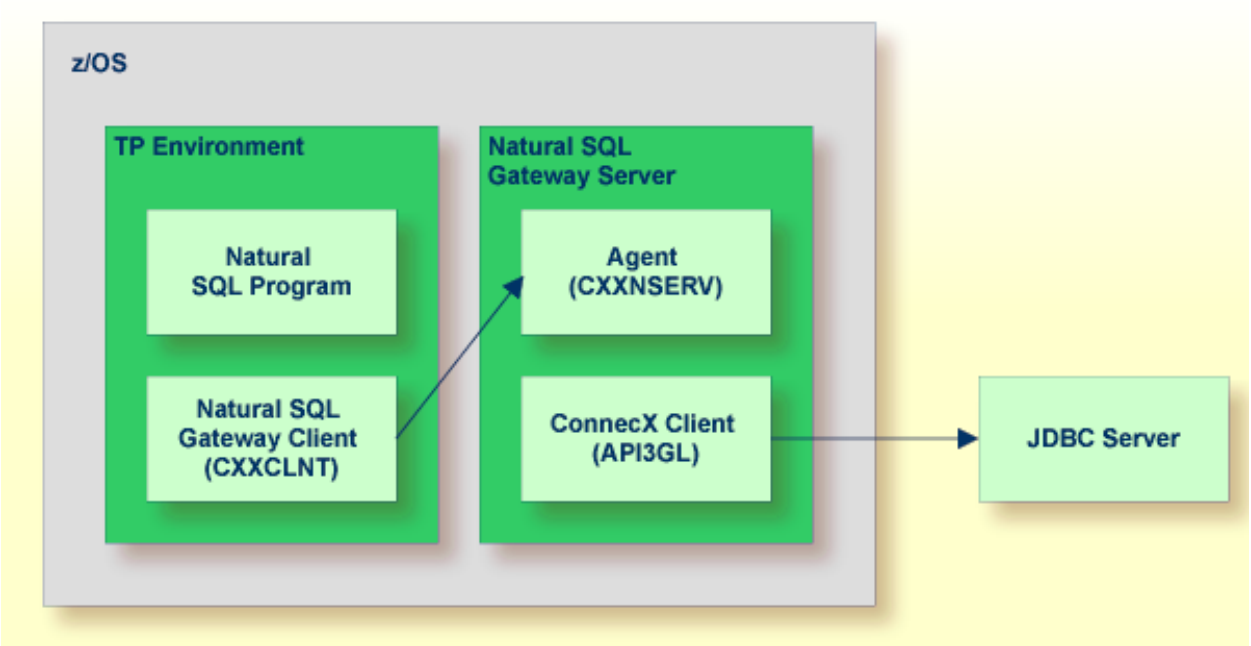
SQL Program Running under Batch/TSO

The following figure shows the constellation under batch/TSO.

The ConnecX Client (namely `API3GL`) is directly linked to the Natural SQL program.

SQL Program Running in a TP Environment

The following figure shows the constellation if the SQL program runs within a TP environment.



Since the ConnecX Client is not capable to run in a TP environment, it is moved into the **Natural SQL Gateway server** process, which runs in a batch environment. The Natural SQL Gateway Client and the Natural SQL Gateway server are responsible for transmitting the SQL requests from the Natural program to the JDBC server and the results backward.

35 Accessing an SQL Table

To be able to access an SQL table with a Natural program via Natural SQL Gateway

1 Establish a connection to the ConnecX SQL Engine JDBC server.

2 Deploy a ConnecX SQL Engine data dictionary (CDD) containing the definition of the SQL table to be accessed.

- If the table does not yet exists on the SQL database system, it can be created with a `CREATE TABLE` statement.
- If the table already exists, the table definition can be imported from the SQL catalog into the CDD, using the ConnecX SQL Engine data dictionary manager. Keep in mind that the **Import** function of the data dictionary manager creates the table definition with the qualifier name `dbo`. This is usually undesired and can be easily reverted to the original qualifier by means of the **Change Owner** tool of the data dictionary manager.

3 Invoke the Natural utility `SYSDDM` and enter function code `Z` to create a Natural data definition module (DDM) describing the SQL table.

4 In the `NTDB` macro in the Natural parameter module `NATPARM`, define the DBID of the DDM as database type SQL.

5 In the `NDBID` macro in the `NDBPARM` module, define the DBID of the DDM as database type CNX. The SQL table to be accessed has to be defined in the CDD, see also the *ConnecX SQL Engine Data Dictionary* documentation.

6 Once you have defined a DDM for an SQL table, you can access the data stored in this table, using a Natural program.

Natural SQL Gateway translates the statements of a Natural program into SQL statements.

Natural SQL Gateway automatically provides for the preparation and execution of each statement in dynamic mode. Static execution is currently not supported. A statement is only prepared once (if possible) and can then be executed several times. For this purpose, Natural

internally maintains a table of all prepared statements (see ***Statement Table*** in *Internal Handling of Dynamic Statements*).

Almost the full range of possibilities offered by the Natural programming language can be used for the development of Natural applications which access SQL tables. For a number of Natural DML statements, however, there are certain restrictions and differences as far as their use with SQL is concerned; see *Using Natural DML Statements* as described in ***Using Natural Statements and System Variables***. In the Natural *Statements* documentation, you can find notes on Natural usage with SQL in the descriptions of the statements concerned.

Note: As there is no SQL equivalent to Adabas Internal Sequence Numbers (ISNs), any Natural features which use ISNs are not available when accessing SQL tables with Natural.

In addition to the Natural DML statements, Natural provides SQL statements for SQL databases as discussed in *Using Natural SQL Statements*. In the section *SQL Statements* in the Natural *Statements* documentation, you can find detailed information on these statements.

36 Using Natural System Commands for Natural SQL Gateway

The following Natural system commands are part of Natural SQL Gateway:

Natural System Command	Explanation
LISTSQL	Lists Natural DML statements and their corresponding SQL statements.
SQLERR	Provides information of the SQLCA on an SQL error.

For a description of these commands, follow the links leading to the Natural *System Commands* documentation.

37 Generating Natural Data Definition Modules (DDMs)

To enable Natural to access an SQL table, a logical Natural data definition module (DDM) of the table must be generated. This is done either with Predict (see the relevant Predict documentation for details) or with the Natural utility `SYSDDM`.

If you do not have Predict installed, use the `SYSDDM` function **SQL Services** to generate Natural DDMs from SQL tables. This function is invoked from the main menu of `SYSDDM` and is described on the following pages.

For further information on Natural DDMs, see *Data Definition Modules - DDMs* in the Natural *Programming Guide*.

This section covers the following topics:

SQL Services (NSB)

To access SQL tables, you may use the **SQL Services (NSB)** function of the Natural `SYSDDM` utility; see *Function Code* `Z` in the section *Description of Functions* in the Natural *Editors* documentation. You access the CXX CDD (ConnecX data dictionary) of your current CXX connection to retrieve table definitions for Natural DDM generation. The name of the CDD catalog you access is displayed in the top left-hand corner of the screen SQL Services Menu. You can access any catalog contained in the CDD. For further details on the CDD structure read the *ConnecX* documentation.

To invoke the SQL Services (NSB) function

1. In the command line, enter the Natural system command `SYSDDM`.

   The menu of the `SYSDDM` utility appears.

2. In the **Code** field, enter function code `Z`.

   A menu is displayed, which offers you the following functions:

   - **Select Catalog name from a List**
   - **CXX Connection handling**
   - **Select SQL Table from a List**
   - **Generate DDM from an SQL Table**
   - **List Columns of an SQL Table**

These Functions are described in the following sections.

Select Catalog Name from a List

This function is used to select a catalog from the catalogs defined in the CDD for further processing.

To invoke the Select Catalog Name from a List function

1 On the **SQL Services (NSB)** menu, enter function code `C` and press Enter.

A list of all catalogs defined in the current CDD is displayed.

2 On the list, you can mark an SQL catalog with an `S` to select a catalog for further processing.

The selected catalog is displayed in the left corner of the second header line of following maps and in the **Catalog name** field of the **SQL Services (NSB)** menu, where the catalog name could also be entered. If you did not explicitly specify a catalog name it is set to either the current default catalog of the CXX connection – if it is not equal spaces – or the first catalog found in the current CDD.

CXX Connection Handling

This function is used to verify and to change the actual CXX connection. It displays the current parameters of the connection.

To invoke the CXX Connection Handling function

- On the **SQL Services (NSB)** menu, enter function code `X` and press Enter.

  The **CXX Connection Handling** screen is displayed.

  The following parameters are available:

Parameter	Description
`GATEWAY`	Specifies the IP-address of the CXX server connected to.
`DD`	Specifies the registered data source name of the CDD in use.
`PORT`	Specifies the port number the CXX server is listening to.
`User`	Specifies the user name of the CXX connection.
`Password`	Specifies the password used for the CXX connection(invisible).
`Catalog`	Specifies the current default catalog name of the CXX connection.
`Schema`	Specifies the current default schema name of the CXX connection.
`Version`	Displays the RCI version string of the CXX connection.
`State`	Displays the CXX connection state.

To change the parameters of the connection

- Enter the new parameter data and press PF5 (Update).

  The connection is (re-)established with the entered parameters.

Select SQL Table from a List

This function is used to select an SQL table from a list for further processing.

To invoke the Select SQL Table from a List function

1. On the **SQL Services (NSB)** menu, enter function code S.

   - If you enter the function code only, you obtain a list of all tables defined in the selected SQL catalog.
   - If you do not want a list of all tables but would like only a certain range of tables to be listed, you can, in addition to the function code, specify a start value in the **Table Name** and/or **Schema** fields. You can also use asterisk notation (*) for the start value.

   Press Enter.

   The **Select SQL Table from a List** screen appears, displaying a list of all SQL tables requested.

2. On the list, you can mark an SQL table with either G for **Generate DDM from an SQL Table** or L for **List Columns of an SQL Table**.

   Press Enter.

   The selected function is displayed for the marked table. For further information, see the corresponding descriptions in the following sections.

Generate DDM from an SQL Table

This function is used to generate a Natural DDM from a DB2 table, based on the definitions in the DB2 catalog.

The following topics are covered below:

- Invoking the Generate DDM from an SQL Table function
- DBID/FNR Assignment
- Long Field Redefinition
- Length Indicator for Variable Length Fields: VARCHAR, LONG VARCHAR, VARGRAPHIC, LONG VARGRAPHIC

- Null Values

Invoking the Generate DDM from an SQL Table function

To invoke the Generate DDM from an SQL Table function

- On the **SQL Services (NSB)** menu, enter function code `G` along with the name and creator of the table for which you wish a DDM to be generated.
  - If you do not know the table name/schema, you can use the function **Select SQL Table** from a list to choose the table you want.
  - If you do not want the schema name of the table to be part of the DDM name, enter an `N` in the field **DDM Name with Creator** (default is `Y`).

    Important: Since the specification of any special characters as part of a field or DDM name does not comply with Natural naming conventions, any special characters allowed within SQL must be avoided. SQL delimited identifiers must be avoided, too.

  - If you wish to generate a DDM for a table for which a DDM already exists and you want the existing one to be replaced by the newly generated one, enter a `Y` in the **Replace** field.

    By default, **Replace** is set to `N` to prevent an existing DDM from being replaced accidentally.

    Note: If **Replace** is `N`, you cannot generate another DDM for a table for which a DDM has already been generated.

DBID/FNR Assignment

When the function **Generate DDM from an SQL Table** is invoked for a table for which a DDM is to be generated for the first time, the **DBID/FNR Assignment** screen is displayed.

If a DDM is to be generated for a table for which a DDM already exists, the existing DBID and FNR are used and the **DBID/FNR Assignment** screen is suppressed.

On the **DBID/FNR Assignment** screen, enter one of the database IDs (DBIDs) chosen at Natural installation time, and the file number (FNR) to be assigned to the DB2 table. Natural requires these specifications for identification purposes only.

The range of DBIDs which is reserved for SQL tables is specified in the `NTDB` parameter macro of the Natural parameter module (see the Natural *Parameter Reference* documentation) in combination with the `NDBID` macro of the parameter module `NDBPARM`. Any DBID not within this range is not accepted. The FNR can be any valid file number within the database (between 1 and 255).

Long Field Redefinition

The maximum field length supported by CXX is 32 KB - 1. If an SQL table contains a column which is longer than 253 bytes, the pop-up window **Long Field Generation** will appear automatically.

A field which is longer than 253 bytes may be defined as a simple Natural field with a maximum length of 32 KB -1, or as an array. In the DDM, such an array is represented as a multiple-value variable.

If, for example, a DB2 column has a length of 2000 bytes, you can specify an array element length of 200 bytes, and you receive a multiple-value field with 10 occurrences, each occurrence with a length of 200 bytes.

Since redefined long fields are not multiple-value fields in the sense of Natural, the Natural C* notation makes no sense here and is therefore not supported.

When such a redefined long field is defined in a Natural view to be referenced by Natural SQL statements (that is, by host variables which represent multiple-value fields), both when defined and when referenced, the specified range of occurrences (index range) must always start with occurrence 1. If not, a Natural syntax error is returned.

Example:

```
UPDATE table SET varchar = #arr(*)
SELECT ... INTO #arr(1:5)
```

Note: When such a redefined long field is updated with the Natural DML `UPDATE` statement (see the relevant section in the *Statements* documentation), care must be taken to update each occurrence appropriately.

Length Indicator for Variable Length Fields: VARCHAR, LONG VARCHAR, VARGRAPHIC, LONG VARGRAPHIC

For each of the columns listed above, an additional length indicator field (format/length I2) is generated in the DDM. The length is always measured in number of characters, not in bytes. To obtain the number of bytes of a `VARGRAPHIC` or `LONG VARGRAPHIC` field, the length must be multiplied by 2.

The name of a length indicator field begins with `L@` followed by the name of the corresponding field. The value of the length indicator field can be checked or updated by a Natural program.

If the length indicator field is not part of the Natural view and if the corresponding field is a redefined long field, the length of this field with `UPDATE` and `STORE` operations is calculated without trailing blanks.

Null Values

With Natural, it is possible to distinguish between a null value and the actual value zero (0) or blank in an SQL column.

When a Natural DDM is generated from the SQL catalog, an additional `NULL` indicator field is generated for each column which can be `NULL`; that is, which has neither `NOT NULL` nor `NOT NULL WITH DEFAULT` specified.

The name of the `NULL` indicator field begins with `N@` followed by the name of the corresponding field.

When the column is read from the database, the corresponding indicator field contains either zero (0) (if the column contains a value, including the value 0 or blank) or -1 (if the column contains no value).

Example:

The column `NULLCOL CHAR(6)` in an SQL table definition would result in the following view fields:

```
NULLCOL  A 6.0
N@NULLCOL  I 2.0
```

When the field `NULLCOL` is read from the database, the additional field `N@NULLCOL` contains:

- `0` (zero) if `NULLCOL` contains a value (including the value 0 or blank),
- `-1` (minus one) if `NULLCOL` contains no value.

A null value can be stored in a database field by entering `-1` as input for the corresponding `NULL` indicator field.

Note: If a column is `NULL`, an implicit `RESET` is performed on the corresponding Natural field.

List Columns of an SQL Table

This function lists all columns of a specific SQL table.

To invoke the List Columns of an SQL Table function

- On the **SQL Services Menu**, enter Function Code `L` along with the name and creator of the table whose columns you wish to be listed, and press Enter.

The **List Columns** screen for this table is invoked, which lists all columns of the specified table and displays the following information for each column:

Variable	Content
Name	The name of the column.
Type	The column type.
Length	The length (or precision if Type is DECIMAL) of the column as defined in the DB2 catalog.
Scale	The decimal scale of the column (only applicable if Type is DECIMAL).
Update	Y - The column can be updated. N - The column cannot be updated.
Nulls	Y - The column can contain null values. N - The column cannot contain null values.
Not	A column which is of a scale length or type not supported by Natural is marked with an asterisk (*). For such a column, a view field cannot be generated. The maximum scale length supported is 7 bytes. Types supported are: CHAR, VARCHAR, LONG VARCHAR, GRAPHIC, VARGRAPHIC, LONG VARGRAPHIC, DECIMAL, INTEGER, SMALLINT, DATE, TIME, TIMESTAMP, FLOAT, ROWID, BLOB, CLOB and DBCLOB.

The data types DATE, TIME, TIMESTAMP, FLOAT and ROWID are converted into numeric or alphanumeric fields of various lengths: DATE is converted into A10, TIME into A8, TIMESTAMP into A26, FLOAT into F8 and ROWID into A40.

For SQL, Natural provides an SQL TIMESTAMP column as an alphanumeric field (A26) in the format *YYYY-MM-DD-HH.SS.MMMMMM*.

Since Natural does not yet support computations with such fields, a Natural subprogram called NDBSTMP is provided to enable this kind of functionality.

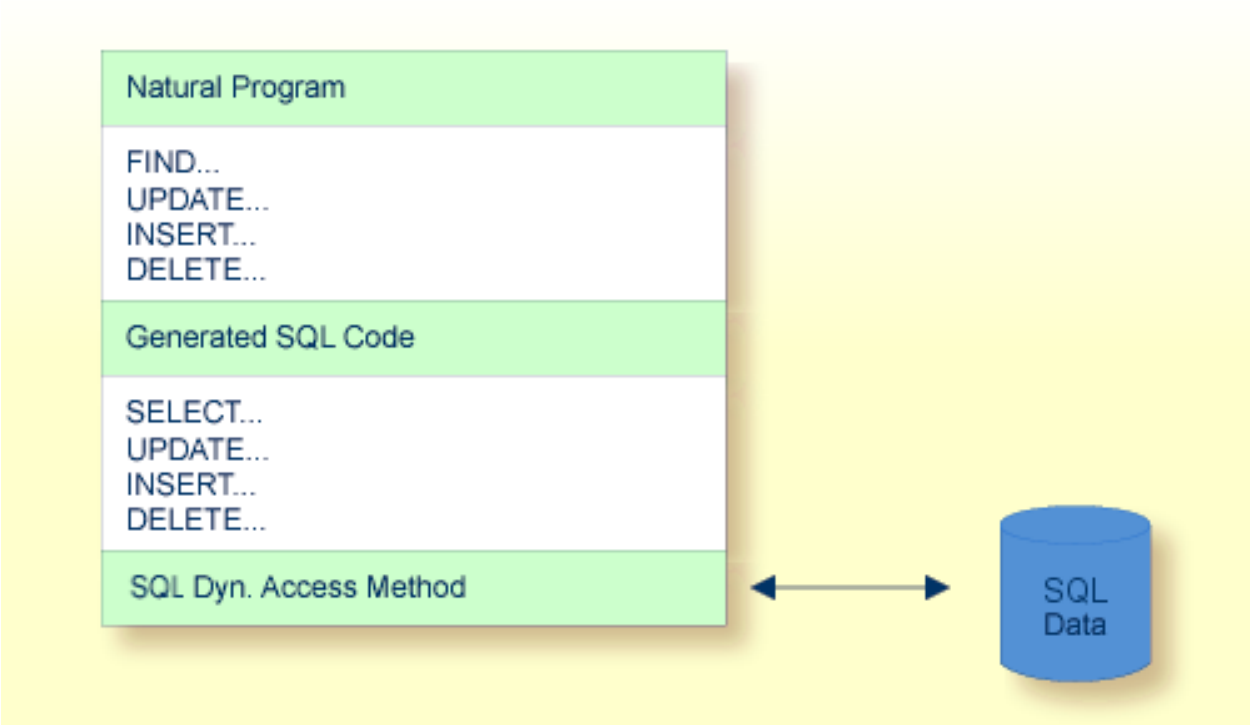
38 Dynamic SQL Support

This section describes the dynamic SQL support provided by Natural SQL Gateway. Natural SQL Gateway does not support static SQL.

SQL Support - General Information

The SQL support of Natural SQL Gateway provides the flexibility of dynamic SQL support.

In contrast to static SQL support, the Natural dynamic SQL support does not require any special consideration with regard to the operation of the SQL interface. All SQL statements required to execute an application request are generated automatically and can be executed immediately with the Natural `RUN` command. Before executing a program, you can look at the generated SQL code, using the `LISTSQL` command.



Internal Handling of Dynamic Statements

Natural automatically provides for the preparation and execution of each SQL statement and handles the opening and closing of cursors used for scanning a table.

Statement Table

If possible, an SQL statement is only prepared once and can then be executed several times if required. For this purpose, Natural internally maintains a table of all SQL statements that have been prepared. In addition, this table maintains the cursors used by the SQL statements `SELECT`, `FETCH`, `UPDATE` (positioned), and `DELETE` (positioned).

Each SQL statement is uniquely identified by:

- the name of the Natural program that contains this SQL statement,
- the line number of the SQL statement in this program,
- the name of the Natural library, into which this program was stowed,
- the time stamp when this program was stowed.

Once a statement has been prepared, it can be executed several times with different variable values, using the dynamic SQL statement `EXECUTE USING DESCRIPTOR` or `OPEN CURSOR USING DESCRIPTOR` respectively.

When the full capacity of the statement table is reached, the entry for the next prepared statement overwrites the entry for a free statement whose latest execution is the least recent one.

When a new `SELECT` statement is requested, a free entry in the statement table with the corresponding cursor is assigned to it and all subsequent `FETCH`, `UPDATE`, and `DELETE` statements referring to this `SELECT` statement will use this cursor. Upon completion of the sequential scanning of the table, the cursor is released and free for another assignment. While the cursor is open, the entry in the statement table is marked as used and cannot be reused by another statement.

If the number of nested `FIND` (`SELECT`) statements reaches the number of entries available in the statement table, any further SQL statement is rejected at execution time and a Natural error message is returned.

Since the statement table is contained in the SQL buffer area, the `DB2SIZE` parameter (see ***Natural Parameter Modification for Natural SQL Gateway*** in *Installing Natural SQL Gateway*) may not be sufficient and may need to be increased.

39 Using Natural Statements and System Variables

This section contains special considerations concerning Natural data manipulation language (DML) statements (that is, Natural native DML statements and Natural SQL DML statements), and Natural system variables when used with SQL.

It mainly consists of information also contained in the Natural basic documentation set where each Natural statement and variable is described in detail.

For an explanation of the symbols used in this section to describe the syntax of Natural statements, see *Syntax Symbols* in the Natural *Statements* documentation.

For information on logging SQL statements contained in a Natural program, refer to *DBLOG Trace Screen for SQL Statements* in the *DBLOG Utility* documentation.

Special Register Consideration

Natural SQL Gateway supports the following special registers, which can be set via the `PROCESS SQL` statement:

- `SCHEMA`

The `SCHEMA` special register determines the implicitly first level qualifier of table names, that is, the schema or creator name of the table, if the first qualifier is not explicitly specified. The `SCHEMA` special register could be set by `PROCESS SQL` *`ddm-name`* `<< SET SCHEMA = :`*`hv`*`>>`, where *`ddm-name`* denotes the DDM whose DBID is mapped to type CNX and `:`*`hv`* denotes an alphanumeric variable containing the first level qualifier.

The `SCHEMA` special register cannot be retrieved or interrogated by SQL statements.

- `CATALOG`

The `CATALOG` special register determines the implicitly second level qualifer of table names, that is, the location or database name of the table, if the second level qualifier is not explicitly specified. The `CATALOG` special register could be set by `PROCESS SQL` *`ddm-name`* `<< SET CATALOG = :`*`hv`*`>>`, where *`ddm-name`* denotes DDM whose DBID is mapped to type `CNX` and `:`*`hv`* denotes a alphanumeric variable containing the second level qualifier.

The `CATALOG` special register could not be retrieved or interrogated by SQL statements.

- `RCI_VERSION`

The `RCI_VERSION` is an alphanumeric character string containing the version of the remote client interface used to communicate with the CONNX JDBC server. The `RCI_VERSION` is a read-only special register which could be retrieved by `PROCESS SQL ddm-name <<GET :hv = RCI_VERSION>>`, where *ddm-name* denotes a DDM whose DBID is mapped to type `CNX` and *:hv* denotes a alphanumeric variable. The `RCI_VERSION` string has the following format:

```
RCI: 4.1.1 CONNX 10.5 SP2 (build 7294)
```

Using Natural Native DML Statements

This section summarizes particular points you have to consider when using Natural DML statements with SQL. Any Natural statement *not* mentioned in this section can be used with SQL without restriction.

- BACKOUT TRANSACTION
- DELETE
- END TRANSACTION
- FIND
- GET
- HISTOGRAM
- READ
- STORE
- UPDATE

BACKOUT TRANSACTION

The Natural native DML statement `BACKOUT TRANSACTION` undoes all database modifications made since the beginning of the last logical transaction. Logical transactions can start either after the beginning of a session or after the last `SYNCPOINT`, `END TRANSACTION`, or `BACKOUT TRANSACTION` statement.

How the statement is translated and which command is actually issued depends on the TP-monitor environment:

- In batch mode and under TSO, the `BACKOUT TRANSACTION` statement is translated into an SQL `ROLLBACK` command.

As all cursors are closed when a logical unit of work ends, a `BACKOUT TRANSACTION` statement must not be placed within a database loop; instead, it has to be placed outside such a loop or after the outermost loop of nested loops.

If an external program written in another standard programming language is called from a Natural program, this external program must not contain its own `ROLLBACK` command if the Natural program

issues database calls, too. The calling Natural program must issue the BACKOUT TRANSACTION statement for the external program.

If a program tries to backout updates which have already been committed, for example by a terminal I/O, a corresponding Natural error message (NAT3711) is returned.

DELETE

The Natural native DML statement DELETE is used to delete a row from an SQL table which has been read with a preceding FIND, READ, or SELECT statement. It corresponds to the SQL statement DELETE WHERE CURRENT OF *cursor-name*, which means that only the row which was read last can be deleted.

Example:

```
FIND EMPLOYEES WITH NAME = 'SMITH'
    AND FIRST_NAME = 'ROGER'
DELETE
```

Natural would translate the above Natural statements into SQL and assign a cursor name (for example, CURSOR1) as follows:

```
DECLARE CURSOR1 CURSOR FOR
SELECT FROM EMPLOYEES
 WHERE NAME = 'SMITH' AND FIRST_NAME = 'ROGER'
DELETE FROM EMPLOYEES
 WHERE CURRENT OF CURSOR1
```

Both the SELECT and the DELETE statement refer to the same cursor.

Natural translates a DML DELETE statement into an SQL DELETE statement in the same way it translates a FIND statement into an SQL SELECT statement.

A row read with a FIND SORTED BY cannot be deleted due to SQL restrictions explained with the FIND statement. A row read with a READ LOGICAL cannot be deleted either.

DELETE when using the File Server

If a row rolled out to the file server is to be deleted, Natural rereads automatically the original row from the database to compare it with its image stored in the file server. If the original row has not been modified in the meantime, the DELETE operation is performed. With the next terminal I/O, the transaction is terminated, and the row is deleted from the actual database.

If the DELETE operates on a scrollable cursor, the row on the file server is marked as DELETE hole and is deleted from the base table.

However, if any modification is detected, the row will not be deleted and Natural issues the NAT3703 error message for non-scrollable cursors.

Since a `DELETE` statement requires that Natural rereads a single row, a unique index must be available for the respective table. All columns which comprise the unique index must be part of the corresponding Natural view.

END TRANSACTION

The Natural native DML statement `END TRANSACTION` indicates the end of a logical transaction and releases all SQL data locked during the transaction. All data modifications are committed and made permanent.

How the statement is translated and which command is actually issued depends on the TP-monitor environment:

- In batch mode and under TSO, the `END TRANSACTION` statement is translated into an `SQL COMMIT WORK` command.

An `END TRANSACTION` statement must not be placed within a database loop, since all cursors are closed when a logical unit of work ends. Instead, it has to be placed outside such a loop or after the outermost loop of nested loops.

If an external program written in another standard programming language is called from a Natural program, this external program must not contain its own `COMMIT` command if the Natural program issues database calls, too. The calling Natural program must issue the `END TRANSACTION` statement for the external program.

Note: Transaction data cannot be written to SQL databases.

FIND

The Natural native DML statement `FIND` corresponds to the SQL `SELECT` statement.

Example:

Natural statements:

```
FIND EMPLOYEES WITH NAME = 'BLACKMORE'
   AND AGE EQ 20 THRU 40
OBTAIN PERSONNEL_ID NAME AGE
```

Equivalent SQL statements:

```
SELECT PERSONNEL_ID, NAME, AGE
  FROM EMPLOYEES
    WHERE NAME = 'BLACKMORE'
      AND AGE BETWEEN 20 AND 40
```

Natural internally translates a FIND statement into an SQL SELECT statement as described in *Processing of SQL Statements Issued by Natural* in the section *Internal Handling of Dynamic Statements*. The SELECT statement is executed by an OPEN CURSOR statement followed by a FETCH command. The FETCH command is executed repeatedly until either all records have been read or the program flow exits the FIND processing loop. A CLOSE CURSOR command ends the SELECT processing.

The WITH clause of a FIND statement is converted to the WHERE clause of the SELECT statement. The basic search criterion for an SQL table can be specified in the same way as for an Adabas file. This implies that only database fields which are defined as descriptors can be used to construct basic search criteria and that descriptors cannot be compared with other fields of the Natural view (that is, database fields) but only with program variables or constants.

Note: As each database field (column) of an SQL table can be used for searching, any database field can be defined as a descriptor in a Natural DDM.

The WHERE clause of the FIND statement is evaluated by Natural after the rows have been selected via the WITH clause. Within the WHERE clause, non-descriptors can be used and database fields can be compared with other database fields.

Note: SQL tables do not have sub-, super-, or phonetic descriptors.

A FIND NUMBER statement is translated into a SELECT statement containing a COUNT(*) clause. The number of rows found is returned in the Natural system variable *NUMBER as described in the Natural *System Variables* documentation.

The FIND UNIQUE statement can be used to ensure that only one record is selected for processing. If the FIND UNIQUE statement is referenced by an UPDATE statement, a non-cursor (searched) UPDATE operation is generated instead of a cursor-oriented (positioned) UPDATE operation. Therefore, it can be used if you want to update an SQL primary key. It is, however, recommended to use Natural SQL Searched UPDATE statement to update a primary key.

In static mode, the FIND NUMBER and FIND UNIQUE statements are translated into a SELECT SINGLE statement as described in the section *Natural SQL Statements*.

The FIND FIRST statement cannot be used. The PASSWORD, CIPHER, COUPLED and RETAIN clauses cannot be used either.

The SORTED BY clause of a FIND statement is translated into the SQL SELECT ... ORDER BY clause, which follows the search criterion. Because this produces a read-only result table, a row read with a FIND statement that contains a SORTED BY clause cannot be updated or deleted.

A limit on the depth of nested database loops can be specified at installation time. If this limit is exceeded, a Natural error message is returned.

FIND when Using the File Server

As far as the file server is concerned, there are no programming restrictions with selection statements. It is, however, recommended to make yourself familiar with its functionality considering performance and file server space requirements.

GET

The Natural native DML statement `GET` is based on Adabas internal sequence numbers (ISNs) and therefore cannot be used with SQL tables.

HISTOGRAM

The Natural DML statement `HISTOGRAM` returns the number of rows in a table which have the same value in a specific column. The number of rows is returned in the Natural system variable `*NUMBER` as described in Natural *System Variables* documentation.

Example:

Natural native DML statements:

```
HISTOGRAM EMPLOYEES FOR AGE
OBTAIN AGE
```

Equivalent Natural SQL statement:

```
SELECT COUNT(*), AGE FROM EMPLOYEES
  WHERE AGE > -999
  GROUP BY AGE
  ORDER BY AGE
```

Natural translates the `HISTOGRAM` statement into an SQL `SELECT` statement, which means that the control flow is similar to the flow explained for the `FIND` statement.

READ

The Natural DML statement READ can also be used to access SQL tables. Natural translates a READ statement into an SQL SELECT statement.

READ PHYSICAL and READ LOGICAL can be used; READ BY ISN, however, cannot be used, as there is no SQL equivalent to Adabas ISNs. The PASSWORD and CIPHER clauses cannot be used either.

Since a READ LOGICAL statement is translated into a SELECT ... ORDER BY statement - which produces a read-only table -, a row read with a READ LOGICAL statement cannot be updated or deleted (see Example 1). The start value can only be a constant or program variable; any other field of the Natural view (that is, any database field) cannot be used.

A READ PHYSICAL statement is translated into a SELECT statement without an ORDER BY clause and can therefore be updated or deleted (see Example 2).

Example 1:

Natural native DML statements:

```
READ PERSONNEL BY NAME
OBTAIN NAME FIRSTNAME DATEOFBIRTH
```

Equivalent Natural SQL statements:

```
SELECT NAME, FIRSTNAME, DATEOFBIRTH FROM PERSONNEL
  WHERE NAME >= ' '
    ORDER BY NAME
```

Example 2:

Natural native DML statements:

```
READ PERSONNEL PHYSICAL
OBTAIN NAME
```

Equivalent Natural SQL statement:

```
SELECT NAME FROM PERSONNEL
```

If the READ statement contains a WHERE clause, this clause is evaluated by the Natural processor after the rows have been selected according to the descriptor value(s) specified in the search criterion.

READ when Using the File Server

As far as the file server is concerned there are no programming restrictions with selection statements. It is, however, recommended to make yourself familiar with its functionality considering performance and file server space requirements.

STORE

The Natural DML statement `STORE` is used to add a row to an SQL table. The `STORE` statement corresponds to the SQL statement `INSERT`.

Example:

Natural native DML statements:

```
STORE RECORD IN EMPLOYEES
  WITH PERSONNEL_ID = '2112'
       NAME         = 'LIFESON'
       FIRST_NAME   = 'ALEX'
```

Equivalent Natural SQL statements:

```
INSERT INTO EMPLOYEES (PERSONNEL_ID, NAME, FIRST_NAME)
  VALUES ('2112', 'LIFESON', 'ALEX')
```

The `PASSWORD`, `CIPHER` and `USING/GIVING NUMBER` clauses cannot be used.

UPDATE

The Natural DML `UPDATE` statement updates a row in an SQL table which has been read with a preceding `FIND`, `READ`, or `SELECT` statement. It corresponds to the SQL statement `UPDATE WHERE CURRENT OF` *`cursor-name`* (positioned `UPDATE`), which means that only the row which was read last can be updated.

UPDATE when Using the File Server

If a row rolled out to the file server is to be updated, Natural automatically rereads the original row from the database to compare it with its image stored in the file server. If the original row has not been modified in the meantime, the `UPDATE` operation is performed. With the next terminal I/O, the transaction is terminated and the row is definitely updated on the database.

If the `UPDATE` operates on a scrollable cursor, the row on the file server and the row in the base table are updated. If the row no longer qualifies for the search criteria of the related `SELECT` statement after the update, the row is marked as `UPDATE` hole on the file server.

However, if any modification is detected, the row will not be updated and Natural issues the NAT3703 error message.

Since an UPDATE statement requires rereading a single row by Natural, a unique index must be available for this table. All columns which comprise the unique index must be part of the corresponding Natural view.

UPDATE with FIND/READ

As explained with the FIND statement, Natural translates a FIND statement into an SQL SELECT statement. When a Natural program contains a Natural native DML UPDATE statement, this statement is translated into an SQL UPDATE statement and a FOR UPDATE OF clause is added to the SELECT statement.

Example:

```
FIND EMPLOYEES WITH SALARY < 5000
  ASSIGN SALARY = 6000
  UPDATE
```

Natural would translate the above Natural statements into SQL and assign a cursor name (for example, CURSOR1) as follows:

```
DECLARE CURSOR1 CURSOR FOR
SELECT SALARY FROM EMPLOYEES WHERE SALARY < 5000
  FOR UPDATE OF SALARY
UPDATE EMPLOYEES SET SALARY = 6000
  WHERE CURRENT OF CURSOR1
```

Both the SELECT and the UPDATE statement refer to the same cursor.

Due to SQL logic, a column (field) can only be updated if it is contained in the FOR UPDATE OF clause; otherwise updating this column (field) is rejected. Natural includes automatically all columns (fields) into the FOR UPDATE OF clause which have been modified anywhere in the Natural program or which are input fields as part of a Natural map.

However, an SQL column is not updated if the column (field) is marked as “not updateable” in the Natural DDM. Such columns (fields) are removed from the FOR UPDATE OF list without any warning or error message. The columns (fields) contained in the FOR UPDATE OF list can be checked with the LISTSQL command.

The Adabas short name in the Natural DDM determines whether a column (field) can be updated.

The following table shows the ranges that apply:

Short-Name Range	Type of Field
AA - N9	non-key field that can be updated.
Aa - Nz	non-key field that can be updated.
OA - O9	primary key field.
PA - P9	ascending key field that can be updated.
QA - Q9	descending key field that can be updated.
RA - X9	non-key field that cannot be updated.
Ra - Xz	non-key field that cannot be updated.
YA - Y9	ascending key field that cannot be updated.
ZA - Z9	descending key field that cannot be updated.
1A - 9Z	non-key field that cannot be updated.
1a - 9z	non-key field that cannot be updated.

Be aware that a primary key field is never part of a `FOR UPDATE OF` list. A primary key field can only be updated by using a non-cursor `UPDATE` operation (see also `UPDATE` in the section *Natural SQL Statements*).

A row read with a `FIND` statement that contains a `SORTED BY` clause cannot be updated (due to SQL limitations as explained with the `FIND` statement). A row read with a `READ LOGICAL` cannot be updated either (as explained with the `READ` statement).

If a column is to be updated which is redefined as an array, it is strongly recommended to update the whole column and not individual occurrences; otherwise, results are not predictable. To do so, in reporting mode you can use the `OBTAIN` statement (as described in the Natural Statements documentation), which must be applied to all field occurrences in the column to be updated. In structured mode, however, all these occurrences must be defined in the corresponding Natural view.

The data locked by an `UPDATE` statement are released when an `END TRANSACTION` (`COMMIT WORK`) or `BACKOUT TRANSACTION` (`ROLLBACK WORK`) statement is executed by the program.

Note: If a length indicator field or `NULL` indicator field is updated in a Natural program without updating the field (column) it refers to, the update of the column is not generated for SQL and thus no updating takes place.

UPDATE with SELECT

In general, the DML `UPDATE` statement can be used in both structured and reporting mode. However, after a `SELECT` statement, only the syntax defined for Natural structured mode is allowed:

```
UPDATE [ RECORD ]  [ IN ] [ STATEMENT ] [( r )]
```

This is due to the fact that in combination with the `SELECT` statement, the DML `UPDATE` statement is only allowed in the special case of:

```
   ...
SELECT ...
   INTO VIEW view-name
   ...
```

Thus, only a whole Natural view can be updated; individual columns (fields) cannot.

Example:

```
DEFINE DATA LOCAL
01 PERS VIEW OF SQL-PERSONNEL
  02 NAME
  02 AGE
END-DEFINE

SELECT *
  INTO VIEW PERS
  FROM SQL-PERSONNEL
  WHERE NAME LIKE 'S%'

    IF NAME = 'SMITH'
      ADD 1 TO AGE
    UPDATE
    END-IF

END-SELECT
    ...
```

In combination with the Natural native DML `UPDATE` statement, any other form of the `SELECT` statement is rejected and an error message is returned.

In all other respects, the Natural native DML `UPDATE` statement can be used with the `SELECT` statement in the same way as with the Natural `FIND` statement described earlier in this section and in the *Natural Statements* documentation.

Using Natural SQL Statements

This section covers points you have to consider when using Natural SQL statements with Natural SQL Gateway. These SQL specific points mainly consists in syntax restrictions or enhancements which belong to the Extended Set of Natural SQL syntax. The Extended Set is provided in addition to the Common Set to support database specific features; see *Common Set and Extended Set* in the section *SQL Statements* in the Natural *Statements* documentation.

This section covers the following topics:

Syntactical Items Common to Natural SQL Statements

The following common syntactical items are either Natural SQL Gateway (NSB) specific and do not conform to the standard SQL syntax definitions (that is, to the Common Set of Natural SQL syntax) or impose restrictions when used with Natural SQL Gateway (see also *SQL Statements* in the Natural *Statements* documentation).

This section covers the following topics:

- case-expression

atom

An atom can be either a parameter (that is, a Natural program variable or host variable) or a constant.

factor

The following factors are specific to Natural SQL Gateway and belong to the Natural Extended Set:

```
special-register
scalar-function(scalar-expression, ...)
case-expression
```

scalar-function

A scalar function is a built-in function that can be used in the construction of scalar computational expressions. Scalar functions are specific to Natural SQL Gateway and belong to the Natural Extended Set.

See the *CONNX Users Guide* for available scalar functions.

Each scalar function is followed by one or more scalar expressions in parentheses. The number of scalar expressions depends upon the scalar function. Multiple scalar expressions must be separated from one another by commas.

Example:

```
SELECT NAME
  INTO NAME
  FROM SQL-PERSONNEL
  WHERE SUBSTR ( NAME, 1, 3 ) = 'Fri'
       ...
```

column-function

A column function returns a single-value result for the argument it receives. The argument is a set of like values, such as the values of a column. Column functions are also called aggregating functions.

The following column functions conform to standard SQL.

```
AVG
COUNT
MAX
MIN
SUM
```

scalar-operator

The concatenation operator (`CONCAT` or "`||`") does not conform to standard SQL and belongs to the Extended Set.

special-register

The following special registers do not conform to standard SQL and belong to the Extended Set:

```
USER
```

A reference to a special register returns a scalar value.

case-expression

```
CASE { searched-when-clause } [ ELSE { NULL              } ] END
     { ...                   }       { scalar expression }
     { simple-when-clause    }
```

`case-expressions` do not conform to standard SQL and are therefore supported by the Natural SQL Extended Set only.

Example:

```
DEFINE DATA LOCAL
01 #EMP
02 #EMPNO (A10)
02 #FIRSTNME (A15)
02 #MIDINIT  (A5)
02 #LASTNAME (A15)
02 #EDLEVEL   (A13)
02 #INCOME (P7)
END-DEFINE
```

```
SELECT EMPNO, FIRSTNME, MIDINIT, LASTNAME,
       (CASE WHEN EDLEVEL < 15 THEN 'SECONDARY'
             WHEN EDLEVEL < 19 THEN 'COLLEGE'
             ELSE             'POST GRADUATE'
        END ) AS EDUCATION, SALARY + COMM AS INCOME
       INTO
       #EMPNO, #FIRSTNME, #MIDINIT, #LASTNAME,
       #EDLEVEL, #INCOME
         FROM DSN8510-EMP
         WHERE (CASE WHEN SALARY = 0 THEN NULL
                                     ELSE SALARY / COMM
                                     END ) > 0.25
DISPLAY #EMP
END-SELECT
END
```

COMMIT - SQL

The Natural SQL `COMMIT` statement indicates the end of a logical transaction and releases all SQL data locked during the transaction. All data modifications are made permanent.

`COMMIT` is a synonym for the Natural native DML statement `END TRANSACTION` as described in the section *Using Natural DML Statements*.

No transaction data can be provided with the `COMMIT` statement.

If the file server is used, an implicit end-of-transaction is issued after each terminal I/O.

If an external program written in another standard programming language is called from a Natural program, this external program must not contain its own `COMMIT` command if the Natural program issues database calls, too. The calling Natural program must issue the `COMMIT` statement for the external program.

For further details and statement syntax, see *COMMIT - SQL* in the Natural *Statements* documentation.

DELETE - SQL

Both the cursor-oriented or positioned `DELETE`, and the non-cursor or searched `DELETE` SQL statements are supported as part of Natural SQL Gateway; the functionality of the positioned `DELETE` statement corresponds to that of the Natural DML `DELETE` statement.

With Natural SQL Gateway, a table name in the `FROM` clause of a searched `DELETE` statement can be assigned a correlation-name. This does not correspond to the standard SQL syntax definition and therefore belongs to the Natural Extended Set.

The searched `DELETE` statement must be used, for example, to delete a row from a self-referencing table, since with self-referencing tables a positioned `DELETE` is not allowed by Natural SQL Gateway.

For further details and statement syntax, see *DELETE - SQL* in the Natural *Statements* documentation.

INSERT - SQL

The Natural SQL `INSERT` statement is used to add one or more new rows to a table.

Since the `INSERT` statement can contain a select expression, all the syntactical items described in the section ***Syntactical Items Common to Natural SQL Statements*** apply.

For further details and statement syntax, see *INSERT - SQL* in the Natural *Statements* documentation.

PROCESS SQL

The Natural `PROCESS SQL` statement is used to issue SQL statements to the underlying database. The statements are specified in a statement-string, which can also include constants and parameters.

The set of statements which can be issued is also referred to as Flexible SQL and comprises those statements which can be issued with the SQL statement `EXECUTE`.

In addition, Flexible SQL includes the following Natural SQL Gateway specific statements:

```
CONNECT
SET CATALOG
SET SCHEMA
GET host-variable = RCI_VERSION
```

For further details and statement syntax, see *PROCESS SQL* in the Natural *Statements* documentation.

CONNECT

The `CONNECT` statement establishes a connection to the CONNX JDBC server. It has to be executed before any SQL statement is issued against the CONNX JDBC server.

Syntax

```
PROCESS SQL ddm << CONNECT TO :U:server USER :U:user PASSWORD :U:password >>
```

Parameter	Format/Length	Explanation
ddm	Constant 1-32 characters	Specifies the name of a DDM whose DBID is mapped by `NTDBID` to type SQL and mapped by `NTDBID` to type `CNX`.
server	A1 to A128	Specifies a string addressing the CONNX JDBC server , the port number the server listens to and the CDD to be used to access the RDBMS. The string has to have the following format:

Parameter	Format/Length	Explanation
		`GATEWAY=location-name;PORT=number;DD=cdd-registered-name` *location-name* denotes the the TCP/IP name of the location where the CONNX JDBC server resides. *number* denotes the port number the CONNX JDBC server listens to. Default port number is 7500. *cdd-registered-name* denotes the CDD to be used for this connection. It is a registry name entry, which is mapped to file name in the registry.
user	A1 to A32	Denotes the user ID to logon to the CONNX JDBC server or RDBMS.
password	A1 to A32	Denotes the password to logon to the CONNX JDBC server or RDBMS.

SET CATALOG

Syntax

```
PROCESS SQL ddm << SET CATALOG :U:catalog >>
```

The `SET CATALOG` statement sets the default catalog to the catalog identified by catalog. The default catalog will be used to identify the database system to be accessed, if the database system is not explicitly specified as first qualifier of a table name in the SQL syntax and if the CDD contains definitions of more than one database system.

Parameter	Format/Length	Explanation
ddm	Constant 1-32 characters	Specifies the name of a DDM whose DBID is mapped by `NTDBID` to type SQL and mapped by `NTDBID` to type `CNX`.
catalog	A1 to A32	Denotes the catalog name to be used as default catalog.

SET SCHEMA

Syntax

```
PROCESS SQL ddm << SET SCHEMA :U:schema >>
```

The `SET SCHEMA` statement sets the default schema to the schema identified by schema. The default schema will be used to identify the schema to be accessed, if the schema is not explicitly specified as qualifier of a table name in the SQL syntax and if the CDD contains definitions of more than one schema.

Parameter	Format/Length	Explanation
ddm	Constant 1-32 characters	Specifies the name of a DDM whose DBID is mapped by NTDBID to type SQL and mapped by NTDBID to type CNX.
schema	A1 to A32	Denotes the schema name to be used as default schema.

GET host-variable = RCI_VERSION

Syntax

```
PROCESS SQL ddm << GET:G:version = RCI_VERSION >>
```

The GET RCI_VERSION statement retrieves the version of the CONNX client software used in the actual session. It could be executed before any connection is established.

Parameter	Format/Length	Explanation
ddm	Constant 1-32 characters	Specifies the name of a DDM whose DBID is mapped by NTDBID to type SQL and mapped by NTDBID to type CNX.
version	A1 to A128	Receives the version string of the CONNX client software. It looks like the following: RCI: 4.1.1 CONNX 10.5 SP3 (build 8003).

To avoid transaction synchronization problems between the Natural environment and SQL, the COMMIT and ROLLBACK statements must not be used within PROCESS SQL.

For further details and statement syntax, see PROCESS SQL in the Natural *Statements* documentation.

ROLLBACK - SQL

The Natural SQL ROLLBACK statement undoes all database modifications made since the beginning of the last logical transaction. Logical transactions can start either after the beginning of a session or after the last COMMIT/END TRANSACTION or ROLLBACK/BACKOUT TRANSACTION statement. All records held during the transaction are released.

ROLLBACK is a synonym for the Natural statement BACKOUT TRANSACTION as described in the section *Using Natural DML Statements*.

However, if the file server is used, only changes made to the database since the last terminal I/O are undone.

As all cursors are closed when a logical unit of work ends, a ROLLBACK statement must not be placed within a database loop; instead, it has to be placed outside such a loop or after the outermost loop of nested loops.

If an external program written in another standard programming language is called from a Natural program, this external program must not contain its own ROLLBACK command if the Natural program

issues database calls, too. The calling Natural program must issue the `ROLLBACK` statement for the external program.

For further details and statement syntax, see *ROLLBACK -SQL* in the Natural *Statements* documentation.

SELECT - SQL

The Natural SQL `SELECT` statement supports both the cursor-oriented selection, which is used to retrieve an arbitrary number of rows, and the non-cursor selection (singleton `SELECT`), which retrieves at most one single row.

For further details and statement syntax, see *SELECT - SQL* in the Natural *Statements* documentation.

SELECT - Cursor-Oriented

Like the Natural native DML `FIND` statement, the cursor-oriented `SELECT` statement is used to select a set of rows (records) from one or more SQL tables, based on a search criterion. Since a database loop is initiated, the loop must be closed by a `LOOP` (in reporting mode) or `END-SELECT` statement (in structured mode). With this construction, Natural uses the same loop processing as with the `FIND` statement. In addition, no cursor management is required from the application program; it is automatically handled by Natural.

For further details and syntax, see *SELECT - SQL*, *Syntax 1 - Cursor-Oriented Selection* in the Natural *Statements* documentation.

SELECT SINGLE - Non-Cursor-Oriented

The Natural SQL statement `SELECT SINGLE` provides the functionality of a non-cursor selection (Singleton `SELECT`); that is, a select expression that retrieves at most one row without using a cursor.

Since SQL supports the Singleton `SELECT` command in static SQL only, in dynamic mode, the Natural `SELECT SINGLE` statement is executed in the same way as a set-level `SELECT` statement, which results in a cursor operation. However, Natural checks the number of rows returned by SQL. If more than one row is selected, a corresponding error message is returned.

For further details and syntax, see *SELECT - SQL*, *Syntax 2 - Non-Cursor Selection* in the Natural *Statements* documentation.

UPDATE - SQL

Both the cursor-oriented or positioned `UPDATE` and the non-cursor or Searched `UPDATE` SQL statements are supported as part of Natural SQL. Both of them reference either a table or a Natural view.

With SQL, the name of a table or Natural view to be referenced by a searched `UPDATE` can be assigned a correlation-name. This does not correspond to the standard SQL syntax definition and therefore belongs to the Natural Extended Set.

The Searched `UPDATE` statement must be used, for example, to update a primary key field, since SQL does not allow updating of columns of a primary key by using a positioned `UPDATE` statement.

Note: If you use the `SET *` notation, all fields of the referenced Natural view are added to the `FOR UPDATE OF` and `SET` lists. Therefore, ensure that your view contains only fields which can be updated; otherwise, a negative `SQLCODE` is returned by SQL.

For further details and syntax, see *UPDATE - SQL* in the Natural *Statements* documentation.

Using Natural System Variables

When used with SQL, there are restrictions and/or special considerations concerning the following Natural system variables:

- `*ISN`
- `*NUMBER`
- `*ROWCOUNT`

For information on restrictions and/or special considerations, refer to the section *Database-Specific Information* in the corresponding system variable documentation.

Error Handling

In contrast to the normal Natural error handling, where either an `ON ERROR` statement is used to intercept execution time errors or standard error message processing is performed and program execution is terminated, the enhanced error handling of Natural SQL Gateway provides an application controlled reaction to the encountered SQL error.

Two Natural subprograms, `NDBERR` and `NDBNOERR`, are provided to disable the usual Natural error handling and to check the encountered SQL error for the returned SQL code.

For further information on Natural subprograms provided for SQL, see the section ***Interface Subprograms***.

40 Interface Subprograms

Several Natural and non-Natural subprograms are available to provide you with internal information from Natural SQL Gateway or specific functions for which no equivalent Natural statements exist. Natural subprograms are invoked with the Natural CALLNAT statement.

Overview of Interface Subprograms

Subprogram	Function
NDBCONV	Sets or resets conversational mode 2.
NDBERR	Provides diagnostic information on the most recently executed SQL call.
NDBISQL	Executes SQL statements in dynamic mode.
NDBNOERR	Suppresses normal Natural error handling.
NDBNROW	Obtains the number of rows affected by a Natural SQL statement.
NDBSTMP	Provides an SQL TIMESTAMP column as an alphanumeric field and vice versa.

All these subprograms are provided in the Natural system library SYSTEM on the system file FNAT.

For detailed information on these subprgrams, follow the links shown in the table above and read the description of the call format and of the parameters in the text member provided with the subprogram (*subprogram-name*T).

NDBCONV Subprogram

The Natural subprogram NDBCONV is used to either set or reset the conversational mode 2 in CICS environments. Conversational mode 2 means that update transactions are spawned across terminal I/Os until either a COMMIT or ROLLBACK has been issued (Caution SQL and CICS resources are kept across terminal I/Os!). This means conversational mode 2 has the same effect as the Natural profile parameter PSEUDO=OFF, except that the conversational mode is entered after an SQL update statement (UPDATE, DELETE, INSERT) and left again after a COMMIT or ROLLBACK, while PSEUDO=OFF causes conversational mode for the total Natural session.

A sample program called CALLCONV is provided in library SYSDB2; it demonstrates how to invoke NDBCONV. A description of the call format and of the parameters is provided in the text member NDBCONVT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBCONV' #CONVERS #RESPONSE
```

The various parameters are described in the following table:

Parameter	Format/Length	Explanation
#CONVERS	I1	Contains the desired conversational mode(input)
#RESPONSE	I4	Contains the response of NDBCONV(output)

The #CONVERS parameter can contain the following values:

Code	Explanation
0	The conversational mode 2 has to be reset.
1	The conversational mode 2 has to be set.

The #RESPONSE parameter can contain the following response codes:

Code	Explanation
0	The conversational mode 2 has been successfully set or reset.
-1	The specified value of #CONVERS is invalid, the conversational mode has not been changed.
-2	NDBCONV is called in a environment, which is not a CICS environment, where the conversational mode 2 is not supported.

NDBERR Subprogram

The Natural subprogram NDBERR replaces Function E of the DB2SERV interface, which is still provided but no longer documented. It provides diagnostic information on the most recent SQL call. It also returns the database type which returned the error. NDBERR is typically called if a database call returns a non-zero SQL code, which means a NAT3700 error.

A sample program called CALLERR is provided on the installation tape; it demonstrates how to invoke NDBERR. A description of the call format and of the parameters is provided in the text member NDBERRT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBERR' #SQLCODE #SQLSTATE #SQLCA #DBTYPE
```

The parameters are described in the following table:

Parameter	Format/Length	Explanation	
#SQLCODE	I4	Returns the SQL return code.	
#SQLSTATE	A5	Returns a return code for the output of the most recently executed SQL statement.	
#SQLCA	A136	Returns the SQL communication area of the most recent SQL access.	
#DBTYPE	B1	Returns the identifier (in hexadecimal format) for the currently used database.	
		X'04'	Identifies access via Natural SQL Gateway.
		X'02'	Identifies access via Natural for DB2.

NDBISQL Subprogram

The Natural subprogram NDBISQL is used to execute SQL statements in dynamic mode. The SELECT statement and all SQL statements which can be prepared dynamically by the accessed SQL database system can be passed to NDBISQL.

A sample program called CALLISQL is provided on the installation tape; it demonstrates how to invoke NDBISQL. A description of the call format and of the parameters is provided in the text member NDBISQLT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBISQL'#FUNCTION #TEXT-LEN #TEXT (*) #SQLCA #RESPONSE #WORK-LEN #WORK (*)
```

The various parameters are described in the following table:

Parameter	Format/Length	Explanation
#FUNCTION	A8	For valid functions, see below.
#TEXT-LEN	I2	Length of the SQL statement or of the buffer for the return area.
#TEXT	A1(1:V)	Contains the SQL statement or receives the return code.
#SQLCA	A136	Contains the SQLCA.
#RESPONSE	I4	Returns a response code.
#WORK-LEN	I2	Length of the workarea specified by #WORK (optional).
#WORK	A1(1:V)	Workarea used to hold SQLDA/SQLVAR and auxiliary fields across calls (optional).

Valid functions for the #FUNCTION parameter are:

Function	Parameter	Explanation
CLOSE		Closes the cursor for the SELECT statement.
EXECUTE	#TEXT-LEN #TEXT (*)	Executes the SQL statement. Contains the length of the statement. Contains the SQL statement. The first two characters must be blank.
FETCH	#TEXT-LEN #TEXT (*)	Returns a record from the SELECT statement. Size of #TEXT (in bytes). Buffer for the record.
TITLE	#TEXT-LEN #TEXT (*)	Returns the header for the SELECT statement. Size of #TEXT (in bytes); receives the length of the header (= length of the record). Buffer for the header line.

The #RESPONSE parameter can contain the following response codes:

Code	Function	Explanation
5	EXECUTE	The statement is a SELECT statement.
6	TITLE, FETCH	Data are truncated; only set on first TITLE or FETCH call.
100	FETCH	No record / end of data.
-2		Unsupported data type (for example, GRAPHIC).
-3	TITLE, FETCH	No cursor open; probably invalid call sequence or statement other than SELECT.
-4		Too many columns in result table.
-5		SQL code from call.
-6		Version mismatch.
-7		Invalid function.
-8		Error from SQL call.
-9		Workarea invalid (possibly relocation).
-10		Interface not available.
-11	EXECUTE	First two bytes of statement not blank.

Call Sequence

The first call must be an EXECUTE call. NDBISQL has a fixed SQLDA AREA holding space for 50 columns. If this area is too small for a particular SELECT it is possible to supply an optional work area on the calls to NDBISQL by specifying #WORK-LEN (I2) and #WORK(A1/1:V).

This workarea is used to hold the SQLDA and temporary work fields like null indicators and auxiliary fields for numeric columns. Calculate 16 bytes for SQLDA header and 44 bytes for each

result column and 2 bytes null indicator for each column and place for each numeric column, when supplying #WORK-LEN and #WORK(*) during NDBISQL calls. If these optional parameters are specified on an EXECUTE call they have also to be specified on any following call.

If the statement is a SELECT statement (that is, response code 5 is returned), any sequence of TITLE and FETCH calls can be used to retrieve the data. A response code of 100 indicates the end of the data.

The cursor must be closed with a CLOSE call.

Function code EXECUTE implicitly closes a cursor which has been opened by a previous EXECUTE call for a SELECT statement.

In TP environments, no terminal I/O can be performed between an EXECUTE call and any TITLE, FETCH or CLOSE call that refers to the same statement.

NDBNOERR Subprogram

The Natural subprogram NDBNOERR is used to suppress Natural NAT3700 errors caused by the next SQL call. This allows a program controlled continuation if an SQL statement produces a non-zero SQL code. After the SQL call has been performed, NDBERR is used to investigate the SQL code.

A sample program called CALLNOER is provided on the installation tape; it demonstrates how to invoke NDBNOERR. A description of the call format and of the parameters is provided in the text member NDBNOERT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBNOERR'
```

There are no parameters provided with this subprogram.

Note: Only NAT3700 errors (that is, non-zero SQL response codes) are suppressed, and also only errors caused by the next following SQL call.

Restrictions with Database Loops

- If NDBNOERR is called before a statement that initiates a database loop and an initialization error occurs, no processing loop will be initiated, unless a IF NO RECORDS FOUND clause has been specified.
- If NDBNOERR is called within a database loop, it does not apply to the processing loop itself, but only to the SQL statement subsequently executed inside this loop.

NDBNROW Subprogram

The Natural subprogram NDBNROW is used to obtain the number of rows affected by the Natural SQL statements Searched UPDATE, Searched DELETE, and INSERT. The number of rows affected is read from the SQL communication area (SQLCA). A positive value represents the number of affected rows, whereas a value of minus one (-1) indicates that all rows of a table in a segmented tablespace have been deleted; see also the Natural system variable *NUMBER as described in the Natural *System Variables* documentation.

A sample program called CALLNROW is provided on the installation tape; it demonstrates how to invoke NDBNROW. A description of the call format and of the parameters is provided in the text member NDBNROWT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBNROW' #NUMBER
```

The parameter #NUMBER (I4) contains the number of affected rows.

NDBSTMP Subprogram

For SQL, Natural provides a TIMESTAMP column as an alphanumeric field (A26) of the format *YYYY-MM-DD-HH.MM.SS.MMMMMM*.

Since Natural does not yet support computation with such fields, the Natural subprogram NDBSTMP is provided to enable this kind of functionality. It converts Natural time variables to SQL time stamps and vice versa and performs SQL time stamp arithmetics.

A sample program called CALLSTMP is provided on the installation tape; it demonstrates how to invoke NDBSTMP. A description of the call format and of the parameters is provided in the text member NDBSTMPT.

The functions available are:

Code	Explanation
ADD	Adds time units (labeled durations) to a given SQL time stamp and returns a Natural time variable and a new SQL time stamp.
CNT2	Converts a Natural time variable (format T) into a SQL time stamp (column type TIMESTAMP) and labeled durations.
C2TN	Converts a SQL time stamp (column type TIMESTAMP) into a Natural time variable (format T) and labeled durations.

Code	Explanation
DIFF	Builds the difference between two given SQL time stamps and returns labeled durations.
GEN	Generates a SQL time stamp from the current date and time values of the Natural system variable *TIMX and returns a new SQL time stamp.
SUB	Subtracts labeled durations from a given SQL time stamp and returns a Natural time variable and a new SQL time stamp.
TEST	Tests a given SQL time stamp for valid format and returns TRUE or FALSE.

Note: Labeled durations are units of year, month, day, hour, minute, second and micro-second.

41 Natural File Server

In all supported TP-monitor environments, the Natural SQL Gateway provides an intermediate work file, referred to as the File Server, to prevent database selection results from being lost with each terminal I/O.

This section covers the following topics:

Concept of the File Server

To avoid reissuing the selection statement used and repositioning the cursors, Natural writes the results of a database selection to an intermediate file. The saved selected rows, which may be required later, are then managed by Natural as if the facilities for conversational processing were available. This is achieved by automatically scrolling the intermediate file for subsequent screens, maintaining position in the work file rather than in the SQL table.

All rows of all open cursors are rolled out to the file server before the first terminal I/O operation. Subsequently, all data is retrieved from this file if Natural refers to one of the cursors which were previously rolled out (see the description of roll out in ***Logical Structure of File Server*** below).

If a row is to be updated or deleted, the row is first checked to see if it has been updated in the meantime by some other process. This is done by reselecting and fetching the row from the SQL database, and then comparing it with the original version as retrieved from the file server. If the row is still unchanged, the update or delete operation can be executed. If not, a corresponding error message is returned. The reselection required when updating or deleting a row is possible in both dynamic mode and static mode.

Only the fields which are stored in the file server are checked for consistency against the record retrieved from the SQL table.

As the row must be uniquely identified, the Natural view must contain a field for which a unique row has been created. This field must be defined as a unique key in the SQL table. In a Natural DDM, it will then be indicated as a unique key via the corresponding Natural-specific short name.

Installing the File Server

The size of a row which can be written to the file server is limited to 32 KB or 32767 bytes. If a row is larger, a corresponding error message is returned.

The File Server can use either a VSAM RRDS file or the Software AG Editor buffer pool as the storage medium to save selected rows of SQL tables.

This section covers the following topics:

- Installing the File Server - VSAM

- Installing the File Server - Editor Buffer Pool

Installing the File Server - VSAM

The file server is installed via a batch job, which defines and formats the intermediate file. Samples of this batch job are supplied on the **installation tape** as described in the relevant section.

Defining the Size of the File Server

The file server is created by defining an RRDS VSAM file using AMS (Access Method Services). Its physical size and its name must be specified.

Formatting the File Server

The file server is formatted by a batch job, which requires five input parameters specified by the user, and which formats the file server according to these parameters. The parameters specify:

1. The number of blocks to be formatted (logical size of the VSAM file); this value is taken from the first parameter of the `RECORD` subcommand of the AMS `DEFINE CLUSTER` command.
2. The number of users that can log on to Natural concurrently.
3. The number of formatted blocks to be defined as primary allocation per user.
4. The number of formatted blocks to be used as secondary allocation per user.
5. The maximum number of file server blocks to be allocated by each user. If this number is exceeded, a corresponding Natural error message is returned.

Immediately before the first access to the file server, a file server directory entry is allocated to the Natural session and the amount of blocks specified as primary allocation is allocated to the Natural session.

The primary allocation is used as intermediate storage for the result of a database selection and should be large enough to accommodate all rows of an ordinary database selection. Should more space in the file server be required for a large database selection, the file server modules allocate a secondary allocation equal to the amount that was specified for secondary allocation when the file server was formatted.

Thus, a secondary area is allocated only when your current primary allocation is not large enough to contain all of the data which must be written to the intermediate file. The number of secondary allocations allowed depends upon the maximum number of blocks you are allowed to allocate. This parameter is also specified when formatting the file server.

The number of blocks defined as the secondary allocation is allocated repeatedly, until either all selected data has been written to the file or the maximum number of blocks you are allowed to allocate is exceeded. If so, a corresponding Natural error message is returned. When the blocks received as a secondary allocation are no longer needed (that is, once the Natural loop associated with this allocation is closed), they are returned to the free blocks pool of the file server.

Your primary allocation of blocks, however, is always allocated to you, until the end of your Natural session.

Changes Required for a Multi-Volume File Server

To minimize channel contention or bottlenecks that can be caused by placing a large and heavily used file server on a single DASD volume, you can create a file server that spans several DASD volumes.

To create and format such a file server, two changes are needed in the job that is used to define the VSAM cluster:

1. Change `VOLUME ()` to `VOLUMES (vol1,vol2,...)`.
2. Divide the total number of records required for the file (as specified with the first format job parameter) by the number of volumes specified above. The result of the calculation is used for the `RECORDS` parameter of the `DEFINE CLUSTER` command.

This means that in the file server format job, the value of the first parameter is the result of multiplying two parameters taken from the `DEFINE CLUSTER` command: `RECORDS` and `VOLUMES`.

Installing the File Server - Editor Buffer Pool

The Software AG Editor buffer pool is used as the storage medium when `EBPFSRV=ON` is set in the `NDBPARM` module. In this case, the primary, secondary and maximum allocation amounts for the file server are specified by `EBPPRAL`, `EBPSEC`, `EBPMAX` parameters of the `NDBPRM` macro. Before Natural SQL Gateway tries to write data from a Natural user session to the file server for the first time, a Software AG Editor buffer pool logical file is allocated with the Natural terminal identifier as user name and the number 2240 as session number.

The operation of the file server is in this case depending on the definition of the Software AG Editor buffer pool as described in the Natural *Operations* documentation.

The number of logical files for the buffer pool limits the number of users concurrently accessing the file server. The number of work file blocks limits the amount of data to be saved at a specific moment. (You also have to consider that there are other users than Natural SQL Gateway of the Software AG Editor.)

However, using the Software AG Editor buffer pool as the storage medium for the file server enables Natural SQL Gateway to run in a Parallel Sysplex environment. In this case, your Natural session must use the auxiliary editor buffer pool. See also *Support of a z/OS Parallel Sysplex Environment* in the *Installation* documentation.

Logical Structure of the File Server

Immediately before a Natural user session accesses the file server, a file server directory entry (VSAM) or a logical file (Software AG Editor buffer pool) is allocated to the Natural user session and the number of blocks specified as primary allocation is reserved until the end of the session.

Generally, the file server is only used when a terminal I/O occurs within an active `READ`, `FIND`, or `SELECT` loop, where database selection results would be lost. Before each terminal I/O operation, Natural checks for any open cursors. For each non-scrollable cursor found, all remaining rows are retrieved from the SQL table and written to an intermediate file. In the Natural SQL Gateway documentation, this process is referred to as cursor roll out.

For each cursor roll out, a logical file is opened to hold all the rows fetched from this cursor. The space for the intermediate file is managed within the space allocated to your session. The logical file is then positioned on the row that was `CURRENT OF CURSOR` when the terminal I/O occurred.

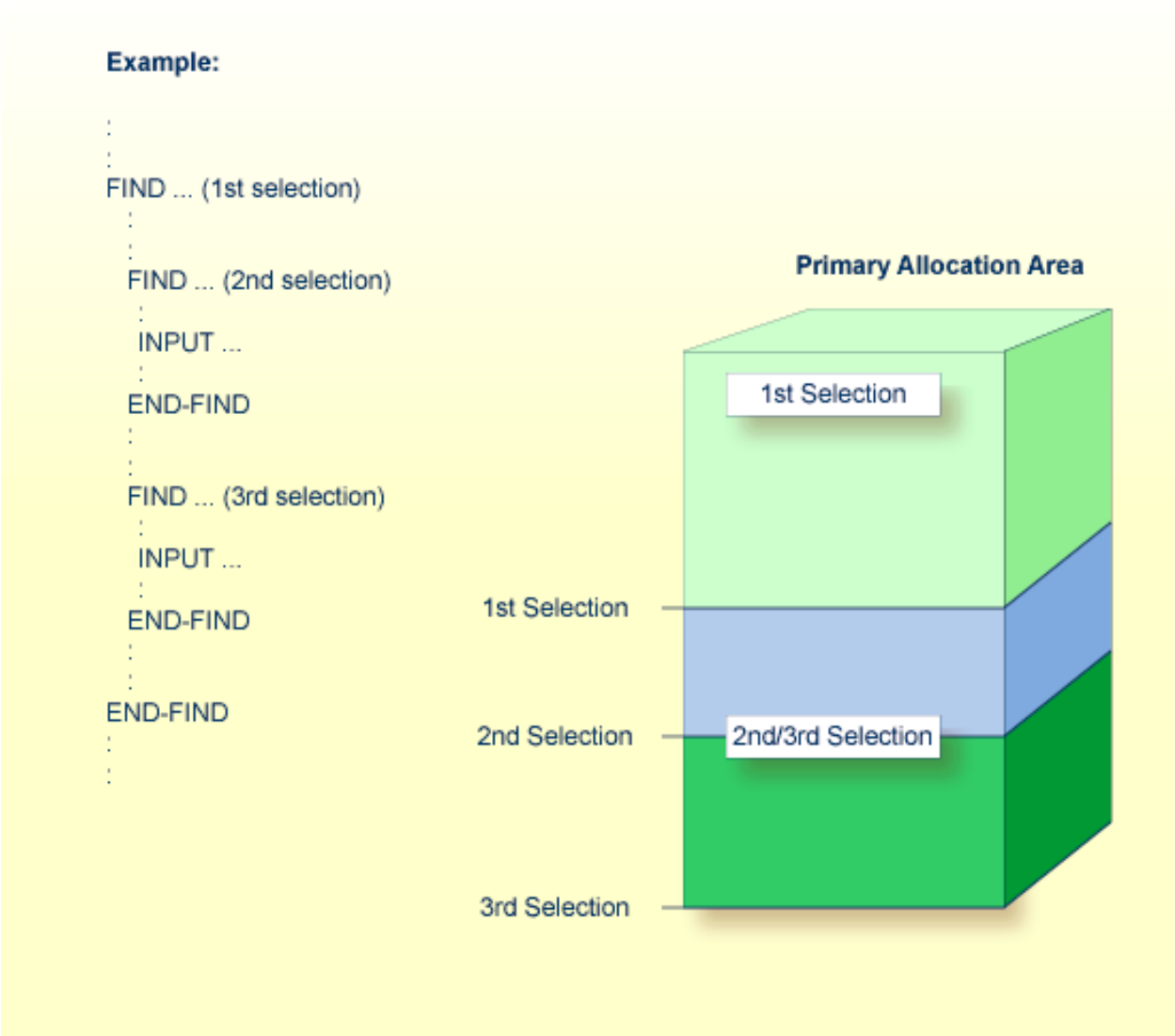
Subsequent requests for data are then satisfied by reading the rows directly from the intermediate file. The database is no longer involved, and SQL is only used for update, delete or store operations.

Once the corresponding processing loop in the application has been closed, the file is no longer needed and the blocks it occupies are returned to your pool of free blocks. From here, the blocks are returned to the free blocks pool of the file server, so that you are left with your primary allocation only.

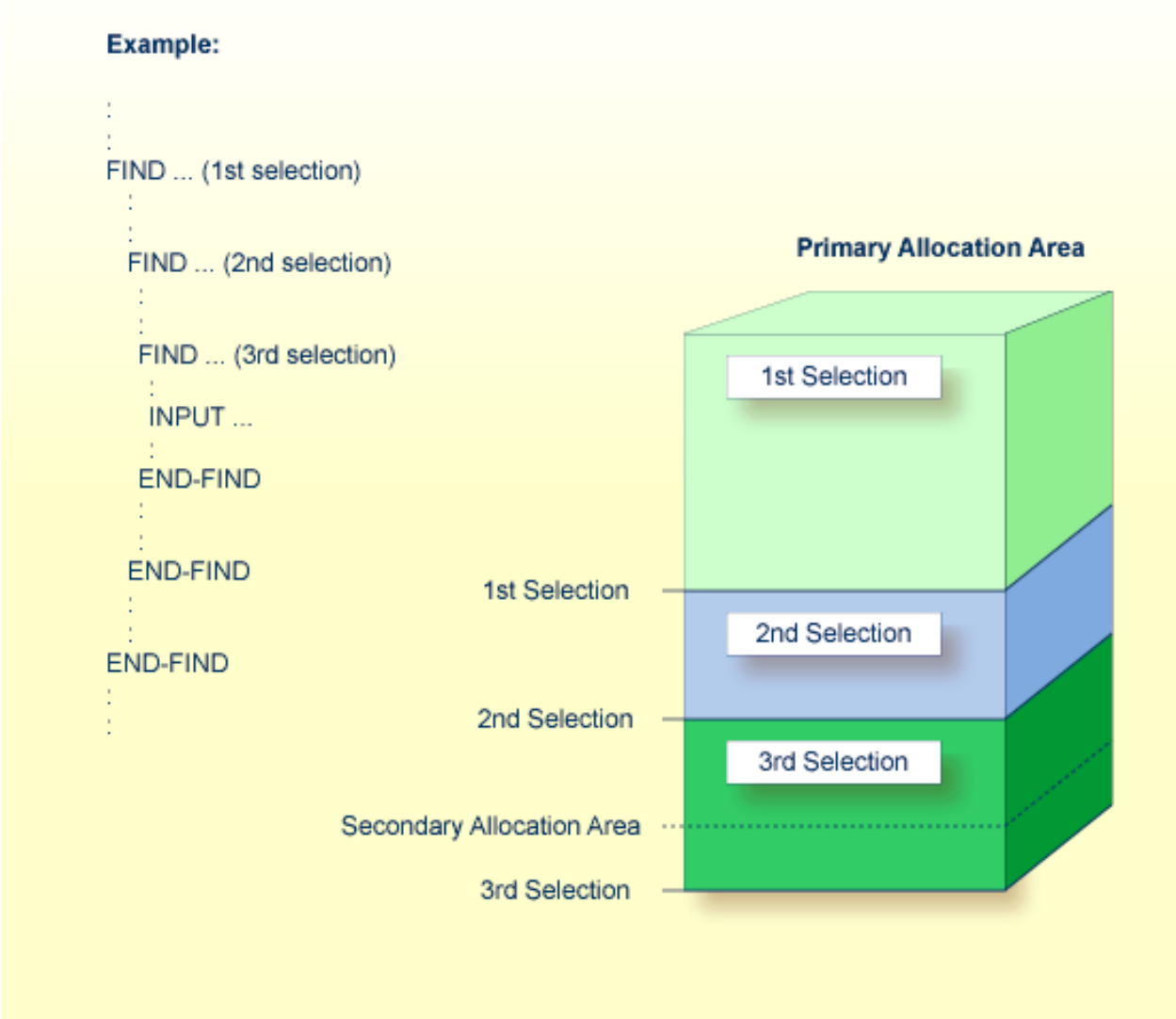
In the following example, the space allocated to the first selection is not released until all rows selected during the third selection have been retrieved. The same applies to the space allocated to the third selection.

The space allocated to the second selection, however, is released immediately after the last row of the corresponding selection result has been retrieved.

Therefore, the space allocated to the second selection can be used for the selection results of the third selection.



If the primary allocation area is not large enough, for example, if the third selection is nested within the second selection, the secondary allocation area is used.



When a session is terminated, all of a user's blocks are returned to the free blocks pool. If a session ends abnormally, Natural checks, where possible, whether a file server directory entry for the corresponding user exists. If so, all resources held by this user are released.

If Natural is unable to free the resources of an abnormally-ended user session, these resources are not released until the same user ID logs on from the same logical terminal again.

If the same user ID and/or logical terminal are not used again for Natural, the existing directory entry and the allocated space remain until the file server is formatted again. A new run of the formatting job deletes all existing data and recreates the directory.

42 Natural SQL Gateway Server

This section covers the following topics:

Natural SQL Gateway Server Concept

This section describes the concept and the structure of the server for the Natural SQL Gateway.

This server is necessary if the Natural SQL Gateway runs within a TP environment. For additional information, see ***Product Structure*** in the section ***Introduction to Natural SQL Gateway***.

A Natural SQL Gateway server is a multi-user, multi-tasking application. The server is responsible for maintaining the persistent connection to the JDBC server for each client, because a client running in a TP environment cannot cope with persistent JDBC connections. The client opens a so called SQL session at the Natural SQL Gateway server. This is done implicitly with the SQL `CONNECT` statement. This session represents the client from the JDBC server point of view and keeps the persistent connection. The client is loosely coupled to this session just by maintaining a session identifier. The session remains until the client disconnects with the SQL `DISCONNECT` statement.

The Natural SQL Gateway server can host SQL sessions for multiple users and execute their requests concurrently.

To enable the administrator to monitor the status of the Natural SQL Gateway server, a monitor task is provided which is initialized automatically at server startup. Using the monitor commands, the administrator is able to control the server activities, cancel particular user sessions, terminate the entire server, etc. For further information, see ***Monitoring the Natural SQL Gateway Server*** in the section *Operating the SQL Gateway Server*.

Installing the Natural SQL Gateway Server under z/OS

This document describes how to install a server for the Natural SQL Gateway (product code NSB) under the operating system z/OS.

The installation of the Natural SQL Gateway server is performed by installation jobs. The sample jobs are contained in the dataset `NSB`*`vrs`*`.JOBS` and are prefixed with `NSB`, or generated by System Maintenance Aid (SMA).

The following topics are covered:

- Prerequisites
- Content of the NSB Server Distribution Tape

- Installation Procedure

Prerequisites

For details, refer to ***Prerequisites*** in the section ***Installing Natural SQL Gateway***.

Content of the NSB Server Distribution Tape

The installation tape contains the datasets listed in the table below. The sequence of the datasets and the number of library blocks needed are shown in the *Report of Tape Creation* which accompanies the installation tape.

Dataset Name	Contents
`NSBvrs.OBJS`	Contains the object modules of the server.
`NSBvrs.JOBS`	Example installation jobs.

The notation `vrs` in dataset names represents the version, release and system maintenance level of the product.

Installation Procedure

- Step 1: Allocate the Natural SQL Gateway server LOAD library
- Step 2: Create a Natural SQL Gateway server configuration file and sample Clist
- Step 3: Link the object modules into the NSB load library
- Step 4: Create server startup JCL

Step 1: Allocate the Natural SQL Gateway server LOAD library

(Job I008, Step 9510)

Step 2: Create a Natural SQL Gateway server configuration file and sample Clist

(Job I009 / Step 9510, 9520, 9530)

Step 9510 creates the `NSBCONFG` sample member for the batch server.

Step 9520 creates a Clist sample member to ping and terminate a Natural SQL Gateway server.

Step 9530 creates a sample member with a batch job to ping and terminate a Natural SQL Gateway server.

The following parameters of the configuration file have to be defined. See *Configuring the Natural SQL Gateway Server*. For the other parameters, the default values may be used:

FRONTEND_NAME	Specify the name of the Natural SQL Gateway server front-end module you will generate in one of the following steps.
PORT_NUMBER	Specify the TCP/IP port number under which the server can be connected.

Step 3: Link the object modules into the NSB load library

(Job I054, Step 9510)

The NSB object modules must be linked with the necessary runtime extensions of your batch installations into executable load modules.

See sample job NSBI054 on dataset NSB*vrs*.JOBS.

Step 4: Create server startup JCL

(Job I200, Step 9515)

Described in the section *Configuring the Natural SQL Gateway Server*. See sample member NSBSTART on dataset NSB*vrs*.JOBS.

Step 9515 creates a startup procedure for the batch server.

Sample:

```
//         PROC SRV=SAGNSB
//NSB      EXEC PGM=NATRNSV,
// REGION=4000K,TIME=1440,PARM='POSIX(ON),TRAP(ON,NOSPIE)/&SRV'
//STEPLIB  DD   DISP=SHR,DSN=NSBvrs.LOAD
//         DD   DISP=SHR,DSN=SMA.LOAD
//SYSUDUMP DD   SYSOUT=X
//CEEDUMP  DD   SYSOUT=X
//CMPRINT  DD   SYSOUT=X
//STGCONFG DD   DISP=SHR,
//              DSN=NSB.CONFIG(&SRV)
//STGTRACE DD   SYSOUT=X
//STGSTDO  DD   SYSOUT=X
//STGSTDE  DD   SYSOUT=X
//SYSOUT   DD   SYSOUT=X
```

Note: The Natural SQL Gateway server account must be defined in the z/OS UNIX System Services (OE segment). If the server account is not defined, the server ends with U4093 and system message CEE5101C in the trace file.

Configuring the Natural SQL Gateway Server

This document describes how to configure a Natural SQL Gateway server.

The following topics are covered:

Configuration Requirements

A Natural SQL Gateway server requires the following z/OS language environment parameter configuration:

Parameter	Definition
`POSIX(ON)`	Enables a Natural SQL Gateway server to access the POSIX functionality of z/OS. If you start a Natural SQL Gateway server server with `POSIX(OFF)`, it terminates immediately with a user abend U4093 and the system message EDC5167. IBM supplies the default value `OFF`.
`TERMTHDACT(UADUMP)`	Defines the level of information that is produced in case of an abend. The option `UADUMP` generates a Language Environment CEEDUMP and system dump of the user address space. The CEEDUMP does not contain the Natural relevant storage areas. IBM supplies the default value `TRACE`.
`ENVAR(TZ=...)`	The `ENVAR` option enables you to set UNIX environment variables. The only environment variable applicable for the Natural SQL Gateway server is `TZ` (time zone). This variable allows you to adjust the timestamp within the Natural SQL Gateway server's trace file to your local time. Example: `ENVAR(TZ=CET-1DST) CET` - 1 hour daylight saving time

To set the z/OS language environment parameters, you have the following options:

- Use the `PARM` parameter specified in the `EXEC` card of the Natural SQL Gateway server startup job. The length of the options is limited by the maximum length of the `PARM` parameter.

- Assemble an LE/370 runtime option module `CEEUOPT` and link it to the Natural SQL Gateway server load module.
- As of z/OS Version 1.8, you can define the DD card for `CEEOPTS` to specify your LE options in a dataset.

Natural SQL Gateway Server Configuration File

A configuration file is allocated to the name `<serverid>C` (for example, `NSBS1C`) or `STGCONFG` alternatively.

The configuration file contains the server configuration parameters in the form of a keyword=value syntax. In addition, it may contain comments whose beginning is marked with a hash symbol (#).

See also the ***Natural SQL Gateway Server Configuration File Example*** shown below.

Natural SQL Gateway Server Configuration Parameters

The following Natural SQL Gateway server configuration parameters are available:

- FRONTEND_NAME
- HANDLE_ABEND
- HOST_NAME
- HTPMON_ADMIN_PSW
- HTPMON_PORT
- PORT_NUMBER
- TRACE_FILTER
- TRACE_LEVEL

FRONTEND_NAME

This configuration parameter specifies the name of the CXX server front-end to be used to communicate with the JDBC server. The front-end resides on the CXX load library.

Value	Explanation
frontend-name	Name of the CXX front-end to be used. Maximum length: 8 characters. The default value is `CXXNSERV`.

Example:

```
FRONTEND_NAME=CXXNSERV
```

HANDLE_ABEND

It is recommended that you leave this parameter on its default value in order to limit the impact of an abend to a single user. If you set the value of this parameter to NO, any abend in the server processing terminates the complete server processing. That is, it affects all users running on that server.

Value	Explanation
YES	Trap abends in the server processing, write a snap dump and abort the affected user. This is the default value.
NO	Suspend the server abend handling.

Example:

```
HANDLE_ABEND=NO
```

or

```
HANDLE_ABEND=NO
```

HOST_NAME

This optional configuration parameter is necessary only if the server host supports multiple TCP/IP stacks.

Value	Explanation
host-name	If HOST_NAME is specified, the server listens on the particular stack specified by HOST_NAME, otherwise the server listens on all stacks. No default value is provided.

Example:

```
HOST_NAME=node1
```

or

```
HOST_NAME=157.189.160.55
```

HTPMON_ADMIN_PSW

This configuration parameter defines the password required for some monitor activities (for example, `Terminate Server`) performed by the **HTML Monitor Client**.

Value	Explanation
character-string	The password (any character string) to be entered at the HTML Monitor Client for some monitor activities. No default value is provided.

Example:

```
HTPMON_ADMIN_PSW=GHAU129B
```

HTPMON_PORT

A Natural SQL Gateway server can be configured to host an HTTP monitor task which serves the **HTML Monitor Client** running in a web browser. It is not required to run this monitor task on each server. A single task allows you to monitor all servers running at one node.

This configuration parameter defines the TCP/IP port number under which the server monitor task can be connected from a web browser.

Value	Explanation
1 - 65535	The password to be entered at the HTML Monitor Client for some monitor activities. No default value is provided.

Example:

```
HTPMON_PORT=3141
```

PORT_NUMBER

This configuration parameter defines the TCP/IP port number under which the server can be connected.

Value	Explanation
1 - 65535	TCP/IP port number. No default value is provided.

Example:

```
PORT_NUMBER=3140
```

TRACE_FILTER

This optional configuration parameter enables you to restrict the trace by a logical filter in order to reduce the volume of the server trace output, for example:

```
TRACE_FILTER="Client=(XYZ P*)"
```

Each request of the user ID `XYZ` and each request of the user IDs starting with a `P` are traced.

See ***Trace Filter*** in the section ***Operating the Natural Gateway Server***.

TRACE_LEVEL

Value	Explanation
trace-level	See ***Trace Level*** in the section ***Operating the Natural Gateway Server***.
0	This is the default value.

Example:

```
TRACE_LEVEL=0x00000011
```

or alternatively

```
TRACE_LEVEL=31+27
```

The setting in the example switches on the TSW bits 31 and 27; see *Trace Level* in the section *Operating the Natural Gateway Server*.

Natural SQL Gateway Server Configuration File Example

For z/OS:

```
# This is a comment
FRONTEND_NAME=CXXNSERV       # and another comment
PORT_NUMBER=4811
TRACE_LEVEL=31+27
```

Natural SQL Gateway Server Datasets

The Natural SQL Gateway server requires the following datasets:

Dataset Name	Purpose
STGCONFG	Defines the server configuration file.
STGTRACE	The server trace output.
STGSTDO	The stdo dataset.
STGSTDE	The stde error output.

Alternatively, you can qualify each dataset name by the server ID.

Dataset Name	Purpose
NSBS1C	Defines the server configuration file for the server NSBS1.
NSBS1T	The server trace output for the server NSBS1.
NSBS1O	The stdo dataset for the server NSBS1.
NSBS1E	The stde error output for the server NSBS1.

Operating the Natural SQL Gateway Server

The following topics are covered below:

Starting the Natural SQL Gateway Server

Under z/OS:

The Natural SQL Gateway server can be started as a "started task":

```
//NSBSRV  PROC
//SRV      EXEC PGM=NATRNSV,REGION=4000K,TIME=1440,
// PARM=('POSIX(ON)/NSBSRV1')
//STEPLIB  DD DISP=SHR,DSN=NSBvrs.LOAD
//CMPRINT  DD SYSOUT=X
//STGCONFG DD DISP=SHR,DSN=NSBvrs.CONFIG(SRV1)
//STGTRACE DD SYSOUT=X
//STGSTDO  DD SYSOUT=X
//STGSTDE  DD SYSOUT=X
```

- where `NSB` is the product code and *`vrs`* is the version, release, system maintenance level number of the Natural SQL Gateway server.

Note: `PARM=('POSIX(ON)/NSBSRV1') - POSIX(ON)` is required for a proper LE370 initialization, and `NSBSRV1` is the name of the server for the communication with the monitor client.

The name of the started task must be defined under RACF and the z/OS UNIX System Services.

Monitoring the Natural SQL Gateway Server

To enable the administrator to monitor the status of the Natural SQL Gateway server, a monitor task is provided which is initialized automatically at server startup. Using the monitor commands described below, the administrator is able to perform functions such as control the server activities, cancel particular user sessions, terminate the entire server, etc.

The following topics are covered below:

- Monitor Commands

Monitor Communication

To communicate with the monitor

- Use the monitor client `NATMOPI`.

  See ***Monitor Client NATMOPI***.

  Or:

  Use the HTML Monitor Client that supports a standard web browser.

  See ***HTML Monitor Client***.

  Or:

  Under z/OS, you can alternatively use the operator command `MODIFY` to execute the monitor commands described below in the section ***Monitor Commands***.

  The output of the executed monitor command will be written to the system log.

  Example:

  ```
  F jobname,APPL=ping
  ```

  sends the command ping to the Natural SQL Gateway server running under the job *`jobname`*.

Monitor Commands

The Natural SQL Gateway server supports the following monitor commands:

Command Name	Action
`ping`	Verifies whether the server is active. The server responds and sends the string `I'm still up`
`terminate`	Terminates the server.
`abort`	Terminates the server immediately without releasing any resources.

Command Name	Action
`set configvariable value`	With the set command, you can modify server configuration settings. For example, to modify `TRACE_LEVEL`: `set TRACE_LEVEL 0x00000012`
`list sessions`	Returns a list of active Natural sessions within the server. For each session, the server returns information about the user who owns the session, the session initialization time, the last activity time and an internal session identifier (*`session-id`*).
`cancel session` *`session-id`*	Cancels a specific Natural session within the Natural SQL Gateway server. To obtain the session ID, use the monitor command `list sessions`.
`help`	Returns help information about the monitor commands supported.

Runtime Trace Facility

For debugging purposes, the server code has a built-in trace facility which can be switched on, if desired.

The following topics are covered below:

- Trace Medium
- Trace Configuration
- Trace Level
- Trace Filter

Trace Medium

Under z/OS, the Natural SQL Gateway server writes its runtime trace to the logical system file `STGTRACE`.

Trace Configuration

The trace is configured by a trace level which defines the details of the trace. Once a trace is switched on, it can be restricted to particular clients or client requests by specifying a trace filter, see also Natural SQL Gateway server configuration parameter `TRACE_FILTER`.

Every session is provided with a 32-bit trace status word (TSW) which defines the trace level for this session. The value of the TSW is set in the Natural SQL Gateway server configuration parameter `TRACE_LEVEL`. A value of zero (0) means that the trace is switched off.

Trace Level

Each bit of the TSW is responsible for certain trace information. Starting with the rightmost bit:

Trace Bit	Trace Information
31	Trace main events (server initialization/termination, client request/result).
30	Detailed functions (session allocation, rollin/rollout calls, detailed request processing).
29	Dump internal storage areas.
28	Session directory access.
27	Dump send/reply buffer.
26	Dump send/reply buffer short. Only the first 64 bytes are dumped.
25 - 16	Free.
15	Trace error situations only.
14	Apply trace filter definitions.
13 - 08	Free.
07 - 01	Free.
00	Reserved for trace-level extension.

Trace Filter

It is possible to restrict the trace by a logical filter in order to reduce the volume of the server trace output.

- The filter can be set with the configuration parameter `TRACE_FILTER`.
- The filter may consist of multiple *`keyword=filtervalue`* assignments separated by spaces.
- To activate the filter definition, the trace bit 14 in the trace status word (see ***Trace Level***) must be set.

The filter keyword is:

`Client`	Filters the trace output by specific clients.

The following rules apply:

- If a keyword is defined multiple times, the values are cumulated.
- The value must be enclosed in braces and can be a list of filter values separated by spaces.
- The values are not case sensitive.
- Asterisk notation is possible.

Example:

```
TRACE_FILTER="Client=(XYZ P*)"
```

Each request of the user ID `XYZ` and each request of the user IDs starting with a `P` are traced.

Monitor Client NATMOPI

Introduction

The Monitor Client `NATMOPI` is a character-based command interface for monitoring the various types of servers that are provided in a mainframe Natural environment. Each of these servers has its own set of monitor commands which is described in the corresponding server documentation. In addition, a set of directory commands is available which can be used independent of the server type. One `NATMOPI` can be used to monitor different server types.

Command Interface Syntax

Basically the syntax of the command interface consists of a list of options where each option can/must have a value. For example:

```
-s <server-id> -c help
```

where `-s` and `-c` are options and `<server-id>` and help are the option values.

It is possible to specify multiple options, but each option can have only one value assigned.

The command options available are listed below.

Command Options Available

Words enclosed in <> are user supplied values.

Command Option	Action
`-s <server-id>`	Specify a server ID for sending a **monitor command**. If the server ID is not unique in the server directory, `NATMOPI` prompts the user to select a server.
`-c <monitor command>`	Specify a **monitor command** to be sent to the server ID defined with the `-s` option
`-d <directory command>`	Specify a **directory command** to be executed.
`-a`	Suppress prompting for ambiguous server ID. Process all servers which apply to the specified server ID.
`-h`	Print `NATMOPI` help.

Monitor Commands

These are commands that are sent to a server for execution. The monitor commands available depend on the type of server, however, each server is able to support at least the commands `ping`, `terminate`, and `help`.

For further commands, refer to *Operating the Natural SQL Gateway Server* where the corresponding server commands are described.

Directory Commands

Directory commands are not executed by a server, but directly by the monitor client `NATMOPI`.

You can use the directory commands to browse through the existing server entries and to remove stuck entries.

The following directory commands are available. Words enclosed in <> are user supplied values and words enclosed in straight brackets `[]` are optional.

Directory Command	Action
`ls [<server-id>]`	List all servers from the server directory that apply to the specified server ID. The server list is in short form.
`ll [<server-id>]`	Same as `ls`, but the server list contains extended server information.
`rs [<server-id>]`	Remove server entries from server directory. **Note:** If you remove the entry of an active server, you will loose the ability to monitor this server process.
`cl [<server-id>]`	Clean up server directory. This command pings the specified server. If the server does not respond, its entry will be removed from the directory.

Directory Command	Action
ds	Dump the content of the server directory.
lm	List pending IPC messages.

Command Examples

Example: Ping a Server in Different Environments

Server in z/OS (started task or batch mode):

- Execute NATMOPI in batch job:

```
NATMOPI,PARM=('-sServerName -cPING')
```

  Sample job:

```
//SAGMOPI  JOB  SAG,CLASS=K,MSGCLASS=X
//NATEX EXEC PGM=NATMOPI,REGION=3000K,
// PARM=('-Sname -CPING')
//* PARM=('-H')
//STEPLIB  DD DISP=SHR,DSN=NATURAL.XXXvr.LE.LOAD
//         DD DISP=SHR,DSN=CEE.SCEERUN
//SYSOUT   DD   SYSOUT=X
//SYSPRINT DD   SYSOUT=X
//*
```

  Where *XXX* is the Natural SQL Gateway product code (NSB) and *vr* is the two-digit version number.

- Execute NATMOPI in TSO (Command):

```
NATMOPI -sServerName -cPING
```

  The NSB load library must be included in the steplib of TSO.

Further Command Examples:

natmopi -dls	List all servers registered in the directory in short format.
natmopi -dcl TST -ls TST	Clean up all servers with ID TST* (ping server and remove it, if it does not respond), and list all servers with ID TST* after cleanup.

`natmopi -sSRV1 -cping -sSRV2 -sSRV3 -cterminate`	Send command `ping` to `SRV1`. Send command `terminate` to `SRV2` and `SRV3`.
`natmopi -cterminate -sSRV1 -cping -sSRV2 -sSRV3`	Is equivalent to the previous example. That is, `NATMOPI` sends the command following the `-s` option to the server. If no `-c` option follows the `-s` option, the first `-c` option from the command line will be used.
`natmopi -sSRV1 -cterminate -a`	Send command `terminate` to `SRV1`. If `SRV1` is ambiguous in the server directory, send the command to all `SRV1` servers without prompting for selection.

HTML Monitor Client

Introduction

The HTML Monitor Client is a monitor interface that supports any web browser as a user interface for monitoring the various types of servers that are provided in a mainframe Natural environment. Each of these servers has its own set of monitor details which are described in the corresponding server documentation. The HTML Monitor Client enables you to list all existing servers and to select a server for monitoring.

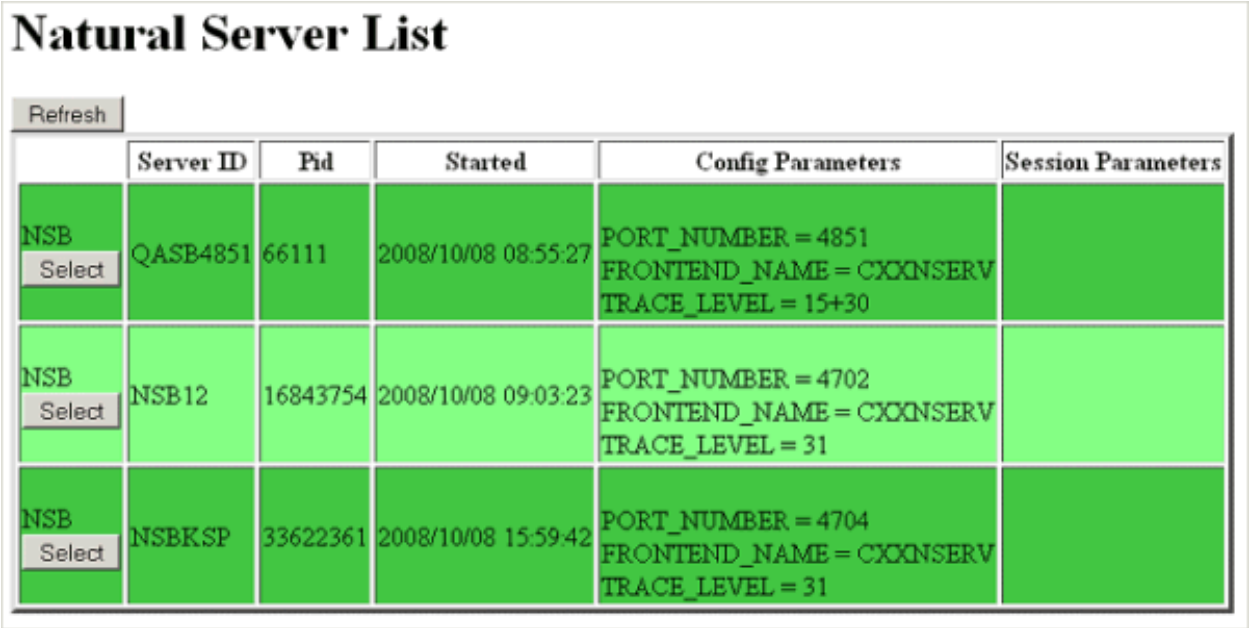
Prerequisites for HTML Monitor Client

To run the HTML Monitor Client, any server must host an HTTP Monitor Server. The HTTP Monitor Server is a subtask that can run in any Natural SQL Gateway server address space and is configured with the configuration parameter `HTPMON_PORT` and `HTPMON_ADMIN_PSW`. An HTTP Monitor Server is accessible through a TCP/IP port number and can monitor all servers running on the current node (for SMARTS: running within the current SMARTS). Although it is not necessary, you can run multiple HTTP Monitor Servers on one node. But each one needs an exclusive port number.

Server List

Open your web browser and connect the HTTP Monitor Server using the following url: `http://nodename:port`, where *nodename* is the name of the host on which the Natural SQL Gateway server hosting the monitor is running. And *port* is the port number the administrator has assigned as the monitor port in the configuration file.

Example:



Natural Server List

Refresh

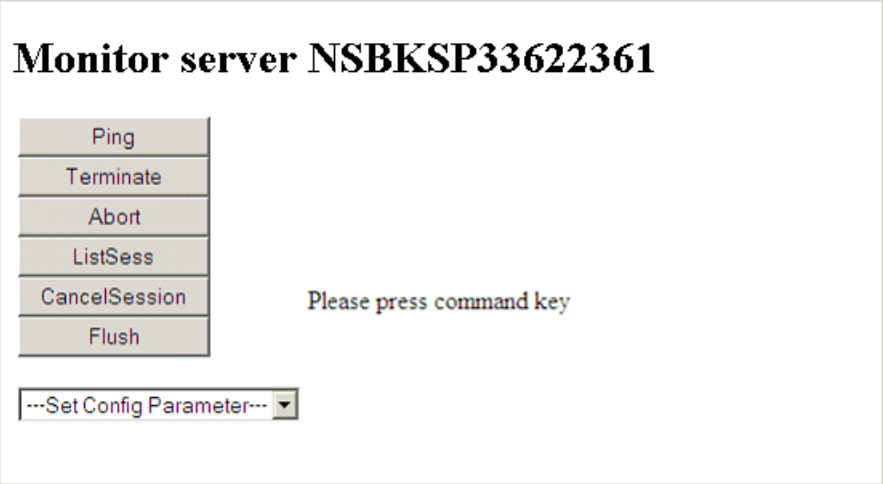
	Server ID	Pid	Started	Config Parameters	Session Parameters
NSB Select	QASB4851	66111	2008/10/08 08:55:27	PORT_NUMBER = 4851 FRONTEND_NAME = CXXNSERV TRACE_LEVEL = 15+30	
NSB Select	NSB12	16843754	2008/10/08 09:03:23	PORT_NUMBER = 4702 FRONTEND_NAME = CXXNSERV TRACE_LEVEL = 31	
NSB Select	NSBKSP	33622361	2008/10/08 15:59:42	PORT_NUMBER = 4704 FRONTEND_NAME = CXXNSERV TRACE_LEVEL = 31	

The server list consists of green and red entries. The red ones represent potentially dead server entries which can be deleted from the server directory by choosing the attached **Remove** button. The **Remove** button appears only for the red entries. “Potentially dead” means, that the HTTP Monitor Server “pinged” the server while assembling the server list, but the server did not answer within a 10 seconds timeout. Thus, even if you find a server entry marked red, it still might be active but could not respond to the ping. Choosing the **Remove** button does not terminate such a server but removes its reference in the monitor directory. Hence, it cannot be reached by the monitor anymore.

Choosing the **Select** button opens a window for monitoring the selected server.

Server Monitor

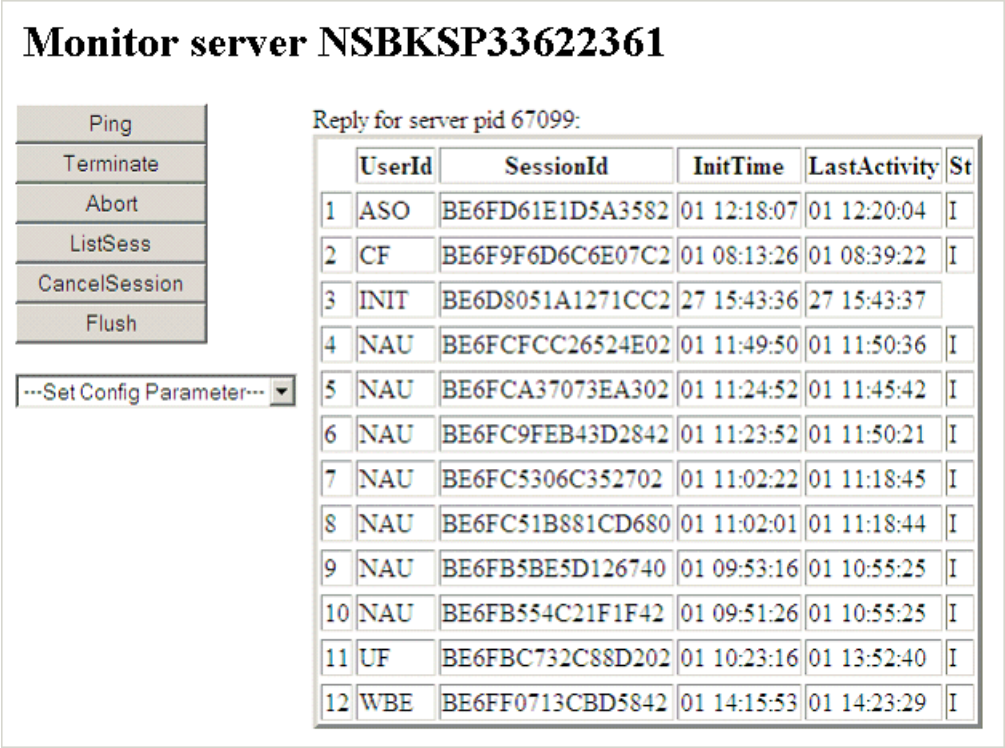
Example:



With the buttons, you can perform the labeled monitor commands.

The selection box allows you to modify the server configuration parameters. If you select a parameter for modification, it has a predefined value. This predefined value does not reflect the setting of the server. It is just a sample value.

If you choose the **ListSess** button, a list of all Natural sessions appears in the window, for example:



	UserId	SessionId	InitTime	LastActivity	St
1	ASO	BE6FD61E1D5A3582	01 12:18:07	01 12:20:04	I
2	CF	BE6F9F6D6C6E07C2	01 08:13:26	01 08:39:22	I
3	INIT	BE6D8051A1271CC2	27 15:43:36	27 15:43:37	
4	NAU	BE6FCFCC26524E02	01 11:49:50	01 11:50:36	I
5	NAU	BE6FCA37073EA302	01 11:24:52	01 11:45:42	I
6	NAU	BE6FC9FEB43D2842	01 11:23:52	01 11:50:21	I
7	NAU	BE6FC5306C352702	01 11:02:22	01 11:18:45	I
8	NAU	BE6FC51B881CD680	01 11:02:01	01 11:18:44	I
9	NAU	BE6FB5BE5D126740	01 09:53:16	01 10:55:25	I
10	NAU	BE6FB554C21F1F42	01 09:51:26	01 10:55:25	I
11	UF	BE6FBC732C88D202	01 10:23:16	01 13:52:40	I
12	WBE	BE6FF0713CBD5842	01 14:15:53	01 14:23:29	I

You can cancel sessions by selecting the session ID in the **SessionId** column and choosing the **CancelSession** button.

43 Natural for VSAM

This documentation describes the various aspects of Natural when used in a VSAM environment.

General Information	Special considerations on the environments supported by Natural for VSAM, known incompatibilities and constraints when using Natural for VSAM, terms used in this documentation, and on error messages related to Natural for VSAM.
Introduction to Natural for VSAM	Components of Natural for VSAM, structure of the Natural interface to VSAM.
Customizing Natural for VSAM	Description of the Natural for VSAM parameters, macros and I/O modules.
Installing Natural for VSAM	Installation of Natural for VSAM in the supported operating system and TP-monitor environments.
Operation	Information on operational aspects like how to invoke Natural for VSAM, `OPEN/CLOSE` processing, Natural file access, buffers for memory management, and application programming interfaces.
Natural Statements and Transaction Logic with VSAM	Special considerations on the use of Natural statements and system variables with VSAM. In addition, the Natural transaction logic with VSAM is discussed.
Using Natural with VSAM System Files	Usage and installation of Natural with VSAM system files.

Related Documentation

See also *Accessing Data in a Database* in the Natural *Programming Guide* for various aspects of accessing data in a database with Natural.

For a list of the abend codes of Natural for VSAM, refer to *Natural for VSAM Abend Codes* (in the Natural *Messages and Codes* documentation).

44 General Information

Purpose

With the Natural interface to VSAM, a Natural user can access data stored in VSAM files. As a prerequisite, the current version of Natural for Mainframes must be installed.

In general, there is no difference between using Natural with VSAM and using it with Adabas or any other supported database management system. The Natural interface to VSAM allows Natural programs to access VSAM data, using the same Natural DML statements that are available for Adabas. Therefore, programs written for VSAM can also be used to access, for example, Adabas databases.

All operations requiring interaction with VSAM are performed by the Natural interface to VSAM.

Environment-Specific Considerations

Natural for VSAM is fully ESA- and z/OS Parallel Sysplex-compliant. It runs in batch mode or under the online environments CICS, Com-plete and TSO. Under CICS, it also runs in conversational or pseudo-conversational mode.

Natural for VSAM supports the following types of VSAM file:

- KSDS,
- ESDS,
- RRDS,
- VRDS.

Under z/OS, Natural for VSAM supports the dataset access modes record-level sharing (RLS) and DFSMS Transactional VSAM Services (DFSMStvs).

The Natural system files `FNAT`, `FUSER`, `FDIC`, `FSPOOL` and `FSEC` can also be located on VSAM system files. For VSAM system files, Natural for VSAM uses the multi-fetch option to speed up the process of loading objects into the buffer pool.

For information on how to use and install Natural using VSAM files as system files, refer to the section ***Using Natural with VSAM System Files***.

Natural for VSAM supports local shared resources (LSR) under TSO and in z/OS and z/VSE batch modes. For CICS and Com-plete, the appropriate file definition tools must be used. The LSR option for VSAM files improves the performance of random access.

Natural for VSAM supports Create/Loading Mode for empty files under TSO as well as in batch mode.

Natural for VSAM supports the following types of Data Table under CICS z/OS:

- User-Maintained Data Tables (UMT),
- CICS-Maintained Data Tables (CMT),
- Coupling Facility Data Tables (CFDT).

It also supports dataset name sharing (DSN) under TSO, and batch-mode processing in z/OS and z/VSE, in particular to access datasets using a defined path.

Natural for VSAM supports extended-format datasets for all types of VSAM dataset organization. There are, however, restrictions for ESDS, RRDS and VRDS which result from the use of the Natural system variable `*ISN` (see *Database-Specific Information*) and its internal size limit of 4 bytes.

Natural for VSAM with Natural Security

Since Natural Security supports the `FSEC` system file as VSAM system file, the following restrictions must be considered:

- Generation of ETIDs is disabled.
- Logging of maintenance actions is disabled.
- Password history is disabled.
- Definition of utility profiles is disabled.

Integration with Predict

Predict, Software AG's open, operational data dictionary for fourth-generation-language development with Natural, is a central repository of application metadata and provides documentation and cross-reference features. Predict lets you automatically generate code from definitions, enhancing development and maintenance productivity.

Since Predict supports VSAM, direct access to VSAM files is possible via Predict and information from VSAM can be transferred to the Predict dictionary to be integrated with data definitions for other environments.

VSAM physical and logical views can be incorporated and compared, new VSAM views can be generated, and Natural views can be generated and compared. All VSAM-specific data types and the referential integrity of VSAM are supported. See the *Predict* documentation for details.

Terms Used in this Documentation

Term	Explanation
CFDT	Coupling Facility Data Tables
CMT	CICS-Maintained Data Tables
DDM	Natural data definition module
DFSM	Data Facility Storage Management Subsystem
DFSMStvs	DFSMS Transactional VSAM Services
Front-end	The `NATPARM` parameter module is called front-end in this documentation.
LSR	Local Shared Resources
NVS	This is the product code of Natural for VSAM. In this documentation the product code is often used as prefix in the names of datasets, modules, etc.
UMT	User-Maintained Data Tables

Messages Related to VSAM

The message number ranges of Natural system messages related to VSAM are 3500-3599.

For a list of the abend codes that may be issued by the Natural interface to VSAM, see *Natural for VSAM Interface Abend Codes* in the Natural *Messages and Codes* documentation.

45 Introduction to Natural for VSAM

This section describes the components and the structure of the Natural interface to VSAM.

Components of Natural for VSAM

The Natural interface to VSAM consists of the following components:

- The `NVSNUC` module, which is mandatory, environment-independent, and delivered as a load module only.
- The `NVSPARM` module, which is mandatory, contains Natural parameters specific to VSAM, and is delivered in source form only.
- The I/O module, which is mandatory, differs depending on the actual environment, and is delivered in source form only.
- The modules necessary when running with VSAM system files; they are optional and delivered as load modules only.
- The user exits.
- Callable system services.

Natural for VSAM is fully (E)LPA or SVA-compliant for multiple environments (for example, CICS, Com-plete and batch). The `NVSPARM` module and the appropriate I/O module must be linked to the `NATPARM` parameter module.

Structure of the Natural Interface to VSAM

Front End
TP Driver (Batch/CICS/ Com-plete/TSO)
. . .
`NATPARM`
`NVSPARM`
I/O Interface - `NVSMISC` - `NVSCICS`
`IGWARLS` (5)
User Exit defined with `NVMEXIT`

(E)LPA or SVA
NATSTUB
NATURAL
NATCONFG
. . .
NVSNUC
NVSFNAT (1)
NVSFSPO (2)
NVSFSEC (3)
NVSISPC (4)
NVSISPV (4)

(1) VSAM system-file handling for FNAT, FUSER and FDIC.

(2) VSAM system-file handling for FSPOOL.

(3) VSAM system-file handling for FSEC.

(4) VSAM system-file handling for Natural ISPF.

(5) IBM's record-level sharing (RLS) query routine to support RLS=CHECK, z/OS only (not CICS).

46 Customizing Natural for VSAM

The Natural parameters in a VSAM environment are defined in two locations:

- the Natural standard parameters, contained in the Natural parameter module `NATPARM`; see *Using a Natural Parameter Module* in the Natural *Operations* documentation,
- the Natural parameters specific to VSAM, contained in the source member `NVSPARM`.

Both are provided as source members only and can be edited to conform to your site standards, and then assembled and linked using the appropriate jobs (see ***Installing Natural for VSAM***).

Customizing NATPARM

To be able to run Natural in a VSAM environment, you must include the profile parameter `VSIZE` and the `NTDB` macro in your `NATPARM` parameter source (see the section ***Installation Procedure for z/OS and z/VSE***).

For an Adabas system file:

```
VSIZE=72,
NTDB VSAM,vsam-dbid
```

For a VSAM system file:

```
VSIZE=126,

FNAT=(vsam-dbid,fnr,dd-name),
FUSER=(vsam-dbid,fnr,dd-name),
FDIC=(vsam-dbid,fnr,dd-name),
FSPOOL=(vsam-dbid,fnr,dd-name),
FSEC=(vsam-dbid,fnr,dd-name)

NTDB VSAM,vsam-dbid
```

`dd-name` is the logical name (DD or DLBL) of the system file; see also *Installing Natural on VSAM Files* (z/OS), ***Step 9***, and *Installing Natural on VSAM Files* (z/VSE), ***Step 9***.

Note: If you use VSAM system files with Natural ISPF, see also the *Natural ISPF* documentation.

Below is information on:

- VSIZE Parameter

- NTDB Macro

VSIZE Parameter

VSIZE is a Natural profile parameter which can also be specified dynamically. It is used to specify the size of the Natural buffer area for VSAM and defines the maximum memory usage for the internal tables of the Natural interface to VSAM; the actual sizes of these tables depend on the values set in NVSPARM (see *Assembling the NVSPARM Parameter Module*). Possible values are 0, 1 - 512 KB.

If you use the default values specified in NVSPARM, the value of the VSIZE parameter must be at least 72 KB.

If VSIZE is set to 0, Natural for VSAM is not available and a corresponding error message is returned when trying to access VSAM files. Disabling Natural for VSAM leads to slight performance improvements because of skipping the initialization, relocation and roll efforts of the Natural interface to VSAM.

NTDB Macro

The NTDB macro is used to specify the database numbers that relate to VSAM files, which means the logical assignments available for Natural.

The value range of NTDB parameters is described in the Natural *Parameter Reference* documentation.

Note: Ensure that the DBIDs selected in the NTDB macro for VSAM do not conflict with DBIDs selected for other database management systems.

Assembling the NVSPARM Parameter Module

NVSPARM is delivered in source form only. If the default values supplied in the NVSPARM source do not meet your requirements, you can change the parameter values to suit your environment. The individual parameters contained in NVSPARM are described in the following section.

The NVSPARM module is created by assembling the macro:

- NVMPARM

and optionally one or more of the following macros:

- NVMLSR
- NVMEXIT
- NVMTVS

If more than one macro is specified, the NVMPARM macro must be specified first; further macros after the NVMPARM macro can be specified in any order.

The individual macros are:

- NVMPARM **Macro**
- NVMLSR **Macro**
- NVMEXIT **Macro**
- NVMTVS **Macro**

NVMPARM Macro

The NVMPARM macro contains the following parameters:

Parameter	Explanation
BTSUPP	Support of BACKOUT TRANSACTION statement.
CLSUPP	Support of CLOSE calls at session termination.
DDMCHECK	Support of DDM integrity.
DDSWITE	Maximum number of entries in DD/DLBL name switch buffer.
DFBE	Number of decoded format buffer entries.
DFBN	Number of fields in an entry of the decoded format buffer.
ENADIS	Enabling disabled files (CICS only).
ENAUNE	Enabling “unenabled” files (CICS only).
ETSUPP	Support of END TRANSACTION statement.
FORMAT	Support of record formatting for STORE and UPDATE statements.
KEYLGH	Length of VSAM keys used in I/O statements.
OPSUPP	Support of dynamic OPEN calls.
PATH	Support of path processing.
PSIGNF	Support of compiler option PSIGNF.
RETRY	Support of RETRY statement for ON ERROR clause.
RLS	Support of VSAM record-level sharing.
ROLLSIZ	Size of area for session status information.
SFILE	Support of VSAM system files.
TAFE	Maximum number of DDMs per Natural transaction.
TAFN	Average number of DDM fields.
TSAE	Maximum number of nested READ and FIND statements.
TIMEOUT	Timeout in minutes for non-RLS processing in a z/OS Parallel Sysplex environment.
TVS	Support of DFSMS Transactional VSAM Services (DFSMStvs).

Parameter	Explanation
UPDL	Size of update table.

BTSUPP - Support of BACKOUT TRANSACTION Statement

This parameter determines whether BACKOUT TRANSACTION statements are executed or not. It is applicable only in TP and DFSMStvs environments where VSAM logging is supported.

Possible value	Default value	Explanation
ON	ON	Each BACKOUT TRANSACTION is executed and translated into an appropriate ROLLBACK command.
OFF		BACKOUT TRANSACTION statements are ignored.

CLSUPP - Support of CLOSE Call at Session Termination

This parameter determines whether or not a CLOSE call is executed at session termination. If a CLOSE is executed, Natural for VSAM forces an END TRANSACTION only in TP and DFSMStvs environments where VSAM logging is supported.

Possible value	Default value	Explanation
ON	ON	Each CLOSE call is executed and translated into an appropriate SYNCPOINT command.
OFF		Each CLOSE call is ignored.

DDMCHECK - Support of DDM Integrity

This parameter checks whether the file layout and, in consequence, the DDM has changed. The check is performed after each program termination at the NEXT level, through the Natural buffer pool. The DDMCHECK parameter is only relevant for development environments where DDMs are modified. In production environments, disable this feature to improve performance.

Possible value	Default value	Explanation
ON		DDM check enabled.
OFF	OFF	DDM check disabled.

DDSWITE - Maximum Entries in DD/DLBL Name Switch Buffer

This parameter specifies the maximum number of entries in the DD/DLBL name switch buffer. For details on switching DD names, see the application programming interface USR1047N in the section *Operation*.

Possible values	Default value
0 up to the value of the TAFE parameter	0

DFBE - Number of Decoded Format Buffer Entries

This parameter specifies the initial number of entries in the table of decoded format buffers. For each active Natural I/O statement (FIND, READ, UPDATE, STORE) one entry is allocated in this table.

When increasing DFBE or DFBN, take into consideration that the allocated storage area size is obtained by multiplying these values and *not* by adding them.

Possible values	Default value
1 - 1000	10

DFBN - Number of Fields in Entry of Decoded Format Buffer

This parameter specifies the average number of fields contained in an entry of the decoded format buffer table. One entry is built for each Natural I/O statement (FIND, READ, UPDATE, STORE).

When increasing DFBE or DFBN, take into consideration that the allocated storage area size is obtained by multiplying these values and *not* by adding them.

Possible values	Default value
1 - 1000	50

ENADIS - Enabling Disabled Files

This parameter only applies to CICS environments and is only honored by the first file access performed in the current Natural session.

ENADIS is used to enable disabled files. If the parameter is set to OFF and the file has not been enabled, the NAT3516 error message must follow the first file access.

Possible value	Default value	Explanation
ON		For all disabled files accessed during the session, an EXEC CICS SET ENABLED command is executed.
OFF	OFF	All disabled files remain disabled.

ENAUNE - Enabling Unenabled Files

This parameter only applies to CICS environments and is only honored by the first file access performed in the current Natural session.

ENAUNE is used to enable "unenabled" files. If the parameter is set to OFF and the file has not been enabled, the NAT3539 error message must follow the first file access.

Possible value	Default value	Explanation
ON		For all unenabled files accessed during the session, an EXEC CICS SET ENABLED command is executed.
OFF	OFF	All unenabled files remain unenabled.

ETSUPP - Support of END TRANSACTION Statement

This parameter determines whether END TRANSACTION statements are executed or not. It is applicable only in TP and DFSMStvs environments where VSAM logging is supported.

Possible value	Default value	Explanation
ON	ON	Each END TRANSACTION is executed and translated into an appropriate SYNCPOINT command.
OFF		END TRANSACTION statements are ignored.

FORMAT- Support of Record Formatting for STORE and UPDATE Statements

This parameter supports the formatting of VSAM records referenced in a STORE or UPDATE statement. Record fields that are not referenced and, therefore, contain binary zeros are converted into a format that corresponds to the field type and record length defined in the relevant DDM.

Possible value	Default value	Explanation
ON	ON	VSAM records are formatted in accordance with the corresponding DDM definitions.
OFF		VSAM records are not formatted and fields that are not referenced contain binary zeros.

Natural for VSAM system file records are always formatted; this cannot be changed.

KEYLGH - Length of VSAM Keys used in I/O Statements

This parameter specifies the length of VSAM keys used in Natural I/O statements. The maximum key length for a VSAM file is 255 bytes. The value of this parameter is used to calculate the size of the **TSA** table (Table of Sequential Access).

If you use VSAM system files, specify at least:

- 87 bytes for the FNAT, FUSER, FDIC and FSPOOL files,
- 126 bytes for the FSEC and Natural ISPF system files.

Possible values	Default value
1 - 255 (bytes)	32

OPSUPP - Support of Dynamic OPEN Calls

This parameter is used to support multiple different OPEN calls within one session.

Possible value	Default value	Explanation
ON		Multiple different OPEN calls are supported by calling the application programming interface USR2008N (for further information, see the section *Operation*).
OFF	OFF	Multiple different OPEN calls are not supported within one session.

PATH - Support of Path Processing

This parameter is used to handle a secondary key as a path or as a native AIX file.

Possible value	Default value	Explanation
ON		All secondary keys defined in a DDM are handled as paths for AIX files.
OFF		All secondary keys are handled as AIX files.
CHECK	CHECK	Natural for VSAM checks whether the secondary keys are defined as paths or as AIXs in the VSAM catalog.

If you use the VSAM system files FSEC and/or FSPOOL, you must not specify ON: specify either OFF or CHECK.

Note: If PATH=CHECK is set under CICS and/or Com-plete in a z/VSE environment, the startup JCL job must contain the corresponding DLBL card(s).

PSIGNF - Support of Compiler Option PSIGNF

This parameter is used to handle the internal representation of positive signs of packed numbers.

Possible value	Default value	Explanation
ON		Natural for VSAM supports the compiler option PSIGN for a Natural object, the corresponding DDM description in the field ZONES is ignored.
OFF	OFF	Natural for VSAM uses the DDM description in field ZONES.

RETRY - Support of RETRY Statement for an ON ERROR Clause

This parameter is used to support the RETRY statement for the following Natural for VSAM error messages:

```
NAT3541     File :1:, control interval/record held by another user.

NAT3520     Held VSAM record modified by another user.
```

The first value of the RETRY parameter applies to NAT3541, the second to NAT3520.

Possible values	Default value
(ON/OFF, ON/OFF)	(OFF, OFF)

RLS - Support of Record-Level Sharing

Applies to z/OS only.

This parameter is used to support VSAM record-level sharing (RLS) under z/OS, DFSMS Version 1.6 or higher.

If TVS=ON is set (see TVS below) and no VSAM file has been defined in the NVMTVS macro (see below), set RLS=CHECK to verify that the corresponding VSAM file has been defined as recoverable dataset.

Possible value	Default value	Explanation
ON		All files are opened in RLS mode.
OFF	OFF	All files are opened in non-RLS mode (NSR, LSR).
CHECK		All files are checked whether they are defined as SMS-managed datasets with RLS options; if they are, the file is opened in RLS mode, if not in non-RLS mode.

ROLLSIZ - Size of Area for Session Status Information

This parameter is applicable in a thread environment only (CICS, Com-plete, Natural as a Server).

It specifies the size of the area used by Natural to save internal session status information when a Natural transaction is terminated due to the end of a TP-monitor task.

Possible values	Default value
0 - 10000 (bytes)	550

SFILE - Support of VSAM system files

This parameter is used to support VSAM system files.

Possible value	Default value	Explanation
ON		Support of VSAM system files
OFF	OFF	No support of VSAM system files.
CHECK		Checks whether the Natural system files FNAT, FUSER and FDIC files are defined as Natural for VSAM Version 4.2 VSAM system files with the required key length of 87.

Note: If SFILE=CHECK is set under CICS and/or Com-plete in a z/VSE environment, the startup JCL job must contain the corresponding DLBL card(s).

TAFE - Maximum Number of DDMs per Natural Session

This parameter specifies the maximum number of DDMs per Natural session.

Since it is possible to define several descriptors in one DDM, the TAFE parameter has impact on the sizes of the FCT, FWA, OPV and TAF buffers (see *Buffers for Memory Management*).

When increasing TAFE or TAFN, take into consideration that the allocated storage area size is obtained by multiplying these values and *not* by adding them.

Possible values	Default value
0 - 1000	10

TAFN - Average Number of DDM Fields

This parameter specifies the average number of DDM fields contained in each entry in the table of accessed VSAM files.

When increasing TAFE or TAFN, take into consideration that the allocated storage area size is obtained by multiplying these values and *not* by adding them.

Possible values	Default value
0 - 1000	50

TIMEOUT - Timeout in Seconds for an RLS Request

This parameter only applies to z/OS CICS Version 5.3 or higher.

This parameter is used to support an RLS/non-RLS-file mixed environment under z/OS CICS Version 5.3 or higher in a Natural for VSAM session. Natural and Natural for VSAM Version 6.2 are plex-enabled, that is, after a terminal I/O the Natural session can be continued by the workload manager on a different z/OS in a different CICS 5.3, provided the resources are plex-enabled. Since this is not the case with non-RLS files, the session must be run in conversational mode as soon as a VSAM file is opened in non-RLS mode.

With the `TIMEOUT` parameter, you can determine that non-RLS files are to be deleted from the Natural for VSAM FCT queue. When there are no further non-RLS FCT entries for the particular Natural for VSAM session, Natural for VSAM switches to non-conversational mode, which means that z/OS Parallel Sysplex processing is possible again.

Possible values	Default value
`0 - 10`	`0`

TSAE - Maximum Number of Nested READ and FIND Statements

This parameter is used to set the maximum number of all nested `READ` and `FIND` statements.

Possible values	Default value
`0 - 100`	`10`

TVS - Support of DFSMStvs

Applies to z/OS only.

This parameter is used to support DFSMS Transactional VSAM Services (DFSMStvs). If `TVS` is set to `ON`, the parameters `BTSUPP` and `ETSUPP` are forced to `ON`. The parameter `RLS` is only forced to `ON` if `RLS` has been set to `OFF` (`RLS=CHECK` is *not* forced to `ON`).

Possible values	Default value	Explanation
`ON`		Support of DFSMStvs.
`OFF`	`OFF`	No support of DFSMStvs.

UPDL - Size of Update Table

This parameter indicates the size of the table used by the Natural interface to VSAM to save the fields of records read for subsequent updating. Because these records are not read with hold by Natural to avoid deadlock conditions, the content of the UPDL table is used to check if any changes have been made before the update request by another user.

Possible values	Default value
0 - 500000 (bytes)	8192 or 32768 if SFILE=ON is set.

NVMLSR Macro

The NVMLSR macro is only required if VSAM files are used as local shared resources. Its purpose is to substantially increase the performance of TSO and batch runs, and, at the same time, decrease the VSAM I/O rate.

The NVMLSR macro is specified as follows:

```
NVMLSR DDNAME= dd-name,SHRPOOL= nn
```

Parameter	Explanation
DDNAME	Logical file name that corresponds to the one in your JCL startup job.
SHRPOOL	Specifies a pool number (ID) between 0 and 15 for z/VSE or between 0 and 255 for z/OS; see also the relevant IBM VSAM documentation.

Up to 200 logical files are possible.

If ERROR=YES is set in NVSMISC, all files defined with the NVMLSR macro must be defined via JCL at runtime; otherwise, an appropriate Natural initialization error message is returned.

If you have defined base clusters with NVMLSR which contain path entries, all paths must also be defined with NVMLSR.

For non-path environments the following applies: If the upgrade option is active in the VSAM catalog and if a VSAM file is defined with NVMLSR and contains references to an alternate index (AIX), all AIX files must also be defined with NVMLSR.

Natural for VSAM automatically calculates the optimum pool size by using the corresponding VSAM catalog information on the files involved, and then creates separate subpools for data and index components.

In batch mode under z/OS, Natural for VSAM allocates the pools as ESO hiperspace if the following conditions are met:

- All sizes in the VSAM catalog are at least specified as 4 KB or a multiple of this value (this is valid for both data and index components).
- The library from which Natural for VSAM was loaded is an APF-authorized library.
- This condition is necessary to define the address space as “non-swapable”, which is a prerequisite for ESO hiperspaces.

NVMEXIT Macro

Natural for VSAM provides the facility to define one or more user exits. For each VSAM file to be accessed, one user exit can be defined. The definition of a user exit is done by using the `NVMEXIT` macro.

`NVMEXIT` is specified as follows:

```
NVMEXIT DDNAME=dd-name,PGM=exit-name,WORK=nnnn
```

Parameter	Explanation
`DDNAME`	DD/DLBL/FCT name of the VSAM file to be accessed.
`PGM`	Specifies the name of the user exit.
`WORK`	Specifies the size of the user exit work area (in bytes). A minimum size of 72 bytes must be specified, which corresponds to the size of the IBM standard register saved area, that is 18 full words. The maximum size possible is 1024 bytes. The work area is allocated inside the Natural save area for VSAM, which has been previously initialized to `X'0'` by Natural.

All user exits must be linked to the front-end.

User Exit Linkage Conventions

When passing control to and from the user exit, standard IBM linkage conventions and standard linkage register notations are used.

Register	Usage
R1	Address pointer to the parameter address list. The parameter address list provides you with the addresses of the record, of LRECL, of the **current function** and of the work area.
R3	Address pointer to the VSAM control area (VCA).
R12	Address pointer to the Natural basic control block (BB).
R13	Address of 18-word save area.
R14	Return address.

Register	Usage
R15	Entry address/return code. A return code of 0 indicates a normal return of control. In all other cases, a Natural error message is returned.

The current function (see Register R1 above) indicates the way control has been passed to the user exit. Control can be passed either *before* or *after* a Natural call for VSAM (see also the `DCRREQCD` field in the `NVMDCR` macro delivered):

- With the `STORE` and `UPDATE` statements, control is passed before the call.
- With the `FIND`, `GET`, and `READ` statements, control is passed after the call.

Sample User Exit

A sample user exit `NVSEX01` is provided on the installation tape.

NVMTVS Macro

DFSMS Transactional VSAM Services (DFSMStvs) is activated by setting either the ACB parameter `RLSREAD` or the JCL parameter `RLS`. In general, Natural for VSAM opens all VSAM files for output by default.

The `NVMTVS` macro activates DFSMStvs by specifying the read integrity value of the ACB parameter `RLSREAD`. Specifying `RSLREAD` in `NVMTVS`, you do not have to adapt the JCL to activate DFSMStvs.

If you only set `TVS=ON` in the `NVSPARM` module without specifying the corresponding VSAM file in `NVMTVS`, to activate DFSMStvs, you need to modify the JCL as described below. In this case, you must specify `RLS=CHECK` in the `NVMPARM` module.

To activate DFSMStvs with NVMTVS

- Use the following specification:

```
NVMTVS DDNAME=dd-name,RLSREAD=[NRI/CR/CRE]
```

Parameter	Explanation
`DDNAME`	Logical file name that corresponds to the one in your JCL startup job.
`RLSREAD`	`NRI` No read integrity (dirty read). `CR` Consistent read. `CRE` Consistent read explicit.

To activate DFSMStvs in the JCL

- Set the `RLS` parameter to

```
RLS=NRI/CR/CRE
```

To activate DFSMStvs in Complete

- Set the `RLSREAD` parameter in the nFile utility to

```
RLSREAD=NRI/CR/CRE
```

Natural I/O Modules for VSAM

The Natural I/O module for VSAM depends on the actual environment in use.

All available I/O modules are delivered in source form so you can make site-specific modifications and use environment-specific macros and/or precompilers.

The I/O modules available are:

- NVSCICS Module
- NVSMISC Module

NVSCICS Module

The `NVSCICS` module is required for CICS under z/OS or z/VSE. The module contains the following parameter:

&FCTRELI - Indicator of Reliable Remote FCT Entries

The `&FCTRELI` parameter indicates whether the key length and record size of a remote file are correctly defined in the FCT entry of the Application Owning Region (AOR).

Possible values	Default value
0 or 1	0

When this parameter is set to 1, NVSCICS assumes a correct FCT entry.

When this parameter is set to 0, NVSCICS issues dummy commands to force opening of the file in the File Owning Region (FOR) region and then repeats inquiring for the real values.

If the FCT entry does not contain a key length definition, NVSCICS uses the key length of the corresponding VSAM DDM.

NVSMISC Module

The NVSMISC module is required in all environments except for CICS. The module mainly consists of the name of the relocatable module for z/VSE and the NVMMISC macro, which is used to generate the NVSMISC I/O interface according to your operating system and/or TP-monitor environment.

NVSMISC is specified as follows:

```
name  NVMMISC
      NONRLS=value
      TIMEOUT=value
      DSECTS=value
      DEFER=value
      COMMIT=value
      ERROR=value
      HFACTOR=value
      READINT=value
      SMARTS=value
      TVS=value
```

The *name* of the relocatable module must be 8 characters long; the default name is NVSMISCD (z/VSE only).

The individual parameters are described in the following section; specify these parameters according to your requirements.

NONRLS - Switch from RLS to Non-RLS Mode

This parameter is ignored under z/VSE.

When Natural for VSAM issues an RLS-OPEN for an RLS file and this file has already been opened in non-RLS mode in this z/OS session, this parameter specifies whether Natural for VSAM issues an open retry in a non-RLS mode, or whether an open error occurs.

Possible values	Default value
YES/NO	YES

TIMEOUT - Timeout in Seconds for an RLS Request

This parameter is ignored under z/VSE.

This parameter specifies the time in seconds Natural for VSAM is waiting to obtain a lock on a Natural for VSAM record when a lock on the record is already held by another user. For further details refer to the IBM manual z/OS DFSMS Version 1.6 or higher, *Macro Instructions for Datasets*.

Possible values	Default value
0 - 10	0

DEFER - Defer Writes in LSR Pools

This parameter only applies in batch mode and under TSO.

This parameter specifies whether write operations to disk are to be deferred in the LSR pool. If so and if the LSR pool becomes full, Natural for VSAM writes to disk those 5% of the pool area which have not been used for the longest time.

Possible values	Default value
YES/NO	NO

DSECTS - List VSAM System DSECTs

The DSECTS parameter specifies whether the VSAM system DSECTs are to be listed or not.

Possible values	Default value
YES/NO	NO

COMMIT - Support of Buffer Flush for LSR Pools

This parameter only applies in batch mode and under TSO.

The COMMIT parameter specifies whether all non-committed updates in any LSR pool are to be written to disk with each END TRANSACTION statement of a user program.

Possible values	Default value
YES/NO	NO

Note: The specification of COMMIT=YES increases the I/O rate considerably.

ERROR - Issue Initialization Error

This parameter issues a Natural initialization error if any DD or DLBL card is omitted in the runtime JCL (see also the macro NVMLSR).

Possible values	Default value
YES/NO	YES

If set to NO, processing is continued and Natural for VSAM will be initialized.

HFACTOR - Factor for Hiperspace Buffers

The HFACTOR parameter specifies a factor for the creation of ESO hiperspace buffers. When initializing such a hiperspace, the corresponding BLDVRP request may lead to a Natural error message, in which case the value of HFACTOR must be reduced.

Possible values	Default value
0 - a value where a corresponding Natural error message is returned	100

READINT - Read Integrity for Upgrade Set

The READINT parameter specifies whether read integrity for an upgrade set should be granted or not.

Possible values	Default value
YES/NO	NO

SMARTS - Support of SMARTS and Com-plete

The `SMARTS` parameter is required if installing Natural for VSAM under SMARTS and/or in a Complete environment.

Possible values	Default value
`YES/NO`	`NO`

TVS - Support of DFSMS Transactional VSAM Services (DFSMStvs)

This parameter is ignored under z/VSE. The TVS parameter specifies the support of DFSMStvs in a z/OS environment.

Possible values	Default value
`YES/NO`	`NO`

47 Installing Natural for VSAM

This section describes how to install Natural for VSAM in the various environments supported. The installation procedure depends on the TP monitor being used.

Notation vrs or vr: If used in the following document, the notation `vrs` or `vr` stands for the relevant version, release, system maintenance level numbers. For further information on product versions, see Version in the *Glossary*.

General Information

Below is information on:

Installation Jobs

The installation of Software AG products is performed by installation jobs. These jobs are either created manually or generated by System Maintenance Aid (SMA).

For each step of the **installation procedure under z/OS and z/VSE**, the job number of a job performing the respective task is indicated. This job number refers to an installation job generated by SMA. If you are not using SMA, an example installation job of the same number is provided in the job library on the Natural for VSAM installation tape; you must adapt this example job to your requirements. Note that the job numbers on the tape are preceded by the product code (for example, NVSI070).

In this document, Natural for VSAM is also referred to as NVS.

Using System Maintenance Aid

For information on using Software AG's System Maintenance Aid (SMA) for the installation process, refer to the System Maintenance Aid documentation.

Prerequisites

Products and versions are specified under *Natural and Other Software AG Products* and *Operating/Teleprocessing Systems Required* in the current Natural *Release Notes*.

Installation Tape - z/OS Systems

The installation tape contains the datasets listed in the table below. The sequence of the datasets is shown in the *Report of Tape Creation* which accompanies the installation tape.

Dataset Name	Contents
`NVSvrs.SRCE`	Natural for VSAM source modules.
`NVSvrs.LOAD`	Natural for VSAM load modules.
`NVSvrs.EXPL`	Natural for VSAM sample programs.
`NVSvrs.EMPL`	VSAM `EMPLOYEES` demo file.
`NVSvrs.JOBS`	Natural for VSAM installation jobs.

The notation *vrs* in dataset names represents the version number of the product.

Installation Tape - z/VSE Systems

The installation tape contains the datasets listed in the table below. The sequence of the datasets and the type and space they require on disk is shown in the *Report of Tape Creation* which accompanies the installation tape.

Dataset Name	Contents
`NVSvrs.LIBR`	Natural for VSAM source modules, macros and relocatable modules.
`NVSvrs.EXPL`	Natural for VSAM example programs.
`NVSvrs.EMPL`	VSAM `EMPLOYEES` demo file.

The notation *vrs* in dataset names represents the version number of the product.

Copying the Tape Contents to Disk

Copy the sublibrary containing the sample installation jobs from tape using the following JCL:

```
* $$ JOB JNM=NATJOBS,CLASS=0,DISP=D,LDEST=*,SYSID=1
* $$ LST CLASS=A,DISP=D
// JOB NATJOBS
// ASSGN SYS005,IGN
// ASSGN SYS006,cuu,VOL=Tnnnnn
// MTC REW,cuu
// MTC FSF,SYS006,nn
* Tape positioned at tape mark nn
*  *** NOW PROCESSING NVSvrs.LIBR - SUBLIBRARY NVSnnnJ ***
// EXEC LIBR,PARM='MSHP'
RESTORE SUBLIB=SAGLIB.NVSvrsJ:SAGLIB.NVSnnnJ -
TAPE=SYS006 -
LIST=YES -
REPLACE=NO
/*
// MTC REW,SYS006
/*
/&
* $$ EOJ
```

Notation:

cuu	represents the physical unit address of the tape drive.
nn	represents the file sequence number as shown in the *Report of Tape Creation*.
vrs	represents the version number of the product.

If you are not using System Maintenance Aid, adapt and run job `NVSTAPE` to copy the dataset from tape to disk. `NVSTAPE` is contained in sublibrary `NVSvrsJ` on the Natural installation tape.

The dataset type and the space it requires on disk are shown in the *Report of Tape Creation*.

Installation Procedure - z/OS and z/VSE

To install Natural for VSAM under the operating systems z/OS and z/VSE, perform the following steps:

Step 1: Define CICS RDO Definitions - Job I005

- Define CICS RDO Definitions for sample VSAM files.

Step 2: Prepare NVS Demo File - Job I008, Steps 1403 to 1407

- Load the VSAM demo file `EMPL` (dataset `NVS`*`vrs`*`.EMPL`). Define the alternate index path `EMPLX` for the file `EMPL`.

Step 3: Create NVS Parameter Module - Job I055, Steps 1400 and 1401

- Edit, assemble, and link the Natural for VSAM parameter module `NVSPARM`. See ***Assembling the NVSPARM Parameter Module*** in the section *Natural for VSAM Parameters*, for a description of the parameters which can be specified.

Step 4: Create NVS I/O Module - Job I055, Steps 1410 and 1411, or Job I070, Step 1400

- Assemble and link the Natural for VSAM I/O module.
  - If you install Natural for VSAM under CICS, use the I/O module `NVSCICS`; for this module, use Job NVSI070 (Step 1400).
  - If you install Natural for VSAM under Com-plete, the I/O module `NVSMISC` must be assembled by using the parameter `SMARTS=YES` (Steps 1415 and 1416). See also `SMARTS` in the section *Natural for VSAM Parameters*.
  - If you install Natural for VSAM in any other environment, use `NVSMISC`. See the description of the parameters which can be specified in `NVSMISC`.

  Note: Under CICS versions below 5.3, the precompile step receives Condition Code 12, since new `COMMAND` level options are used depending on the CICS version applied. The corresponding assembly step must be finished with Return Code 0. This is normal and can be ignored.

Step 5: Adapt all Natural Parameter Modules - Jobs I060, I080

- Modify the appropriate I060 and I080 jobs according to the TP monitor or batch modules you are relinking; for example, NATI060 for batch, NCOI080 for Com-plete and NCII080 for CICS. This applies also to ***Relink all Natural Nuclei*** below.

  Add the following parameter and macro call to your Natural parameter modules:

  ```
  VSIZE=72 NTDB VSAM, vsam-dbid
  ```

  The value for `VSIZE` depends on the values specified in `NVSPARM` (see also the ***VSIZE Parameter*** in the section *Natural for VSAM Parameters*).

Step 6: Relink all Natural Nuclei - Jobs I060, I080

- For information on the components and structure of the Natural interface to VSAM, see also ***Components of Natural for VSAM*** and ***Structure of the Natural Interface to VSAM*** in the section *General Information*.

  Add the following INCLUDE instruction in all links of the shared nucleus:

Platform	Instruction
z/OS	`INCLUDE NVSLIB(NVSNUC)`
z/VSE	`INCLUDE NVSNUC`

  Add the following `INCLUDE` instruction in all links of the front-end:

Platform	Instruction
z/OS	`INCLUDE SMALIB(NVSPARM)`
z/VSE	`INCLUDE NVSPARM`

  Add the following `INCLUDE` instruction in the link of the front-end in a CICS environment:

Platform	Instruction
z/OS	`INCLUDE SMALIB(NVSCICS)`
z/VSE	`INCLUDE NVSCICS`

  Add the following `INCLUDE` instruction in the link of the front-end in any other supported environment (except CICS):

Platform	Instruction
z/OS	`INCLUDE SMALIB(NVSMISC)`
z/VSE	`INCLUDE NVSMISCD`

  Add the following `INCLUDE` instruction in the link of the front-end under z/OS in any other supported environment (except CICS) if `RLS=CHECK` is specified in `NVSPARM`:

Platform	Instruction
z/OS	`INCLUDE CSSLIB(IGWARLS)`

The routine `IGWARLS` is a callable service to support RLS processing. It resides in the system library `SYS1.CSSLIB`. Add the corresponding DD statement to the link step.

Platform	Instruction
z/OS	Add the corresponding DD statements to the link step for Natural and link-edit the executable module.
z/VSE	Add the corresponding sublibrary for Natural for VSAM to the search chain for the linkage editor and link-edit the executable module.

Step 7: Load Examples - Job I061, Step 1400

- Use the system command INPL to load the Natural for VSAM example programs (dataset `NVS`*`vrs`*`.EXPL`) into the Natural system file.

Step 8: Customize your TP Monitor

-

TP Monitor	Instruction
CICS	Add the entries for the Natural for VSAM test files `EMPLVS` and `EMPLVX` to your RDO definition as described in ***Define CICS RDO Definitions*** above; you can find the CICS tables on the `JOBS` dataset as NVSI005.
Com-plete	Catalog all VSAM files to Com-plete using the `CA` function of the Com-plete utility `UFILE`. If you have specified `PATH=CHECK` in `NVSPARM`: 1. Catalog your front program to Com-plete using the `CA` function of the Com-plete utility `ULIB` with a region size of 40 KB if you have not changed the first default value of the `WPSIZE` parameter in the Natural parameter module. Under z/VSE, you must also catalog the front program as privileged. 2. Load the IBM routine `IGGOCLAO` either in the LPA or as resident program using the Com-plete utility `UCTRL` under z/OS.

TP Monitor	Instruction

TSO	Add the following `ALLOC` statements to your Natural CLIST:
	
	`ALLOC F(EMPLVS) DA('SAGLIB.VSAM.EMPL') SHR`
	`ALLOC F(EMPLVX) DA('SAGLIB.VSAM.EMPLX.PATH')SHR`

Installation Verification - z/OS and z/VSE

To verify whether the installation has been successfully performed, log on to the library `SYSEXNVS` and run the following programs:

- `NVSINST1`
- `NVSINST2`
- `NVSINST3`
- `NVSINST4`
- `NVSINST5`
- `NVSINST6`

If all these programs can be executed successfully, the installation of Natural for VSAM is completed and verified.

Note for z/OS batch mode: For verification in batch mode under z/OS you can run the job NVSI200 which executes the above programs.

48 Operation

This section provides information on various operational aspects of Natural for VSAM:

Invoking Natural for VSAM

If the Natural interface to VSAM is available, it is initialized when you start a Natural session. It can be switched off by setting the `VSIZE` parameter to `0` (see also the relevant description in the section *Natural for VSAM Parameters*).

OPEN/CLOSE Processing

In this section, VSAM files means both VSAM user files and VSAM Natural system files.

Database `OPEN/CLOSE` processing is controlled by the Natural parameter `OPRB`, which is described in *Profile Parameters* in the Natural *Parameter Reference* documentation.

Instead of using the `OPRB` parameter, you can also use the `NTOPRB` macro of the Natural parameter module, which is described in Parameter Modules in the Natural Parameter Reference documentation.

An `OPEN/CLOSE` error must be followed by the NAT3539 error message. In a TP environment, the NAT3516 error message can also occur during an active Natural session if the file is closed.

Note: For dynamic `OPEN` handling within a session, you can use the application programming interface **USR2008N**.

The section below covers the following topic:

- OPRB Parameter for VSAM Databases

OPRB Parameter for VSAM Databases

The `OPRB` parameter is not applicable under CICS or Com-plete, because in these environments, the TP monitor controls the `OPEN/CLOSE` processing of VSAM files.

By default, that is, without the `OPRB` parameter being specified, VSAM files are opened for input/output so that they can be read and/or updated.

If you want all used VSAM files to be opened for input only, you specify the `OPRB` parameter using the following syntax:

```
OPRB = (.ALL)
```

With this syntax, you specify an `OPEN` request for *all* VSAM files to be addressed. All files are opened for input only; individual files, however, are only opened when they are actually addressed by a given program.

Note: If you want all VSAM system files to be opened for input, you have to set the Natural profile parameter `ROSY=ON`; see also the relevant section in the Natural *Parameter Reference* documentation.

If you want to open VSAM files for input (`I`) or output (`O`) per DBID, use the following syntax:

```
OPRB = (DBID = nnn, { MODE = { I } [, string ; ...] } [, ...] )
                    {        { O }                  }
                    {        string ; ...            }
```

With `MODE`, you specify a global default handling for `DBID nnn`.

If you do not want to specify a default handling per DBID or if, for some VSAM files, you want an input/output handling other than the default one, you specify the *`string`* parameter in the appropriate way.

The DBID must be defined with the `NTDB` macro as a VSAM DBID, and *`string`* varies depending on the operating system (see below).

Important: If several strings are to be defined, a semicolon (;) must be specified as delimiter character. If not, the semicolon must be omitted.

Under z/OS

Under z/OS, you specify the *`string`* as follows:

```
{        FNR = nnn                  } { , O } { , B } [,R]
{                                   } { , I } { , A }
{ DD = dd-name , TYP = { K } }
{                      { E } }
{                      { R } }
{                      { P } }
```

The specified VSAM files must be defined as DDMs. However, instead of specifying the file number of the Natural DDM that corresponds to the VSAM file to be addressed, the *dd-name* and type (KSDS, ESDS, RRDS, or PATH) of this file can be specified directly, which saves you from having to look into the DDM first.

Individual files can be opened for output (option **O**), input (option **I**), opened **before** they are actually accessed (option **B**), or when they are accessed for the first time (option **A**), opened as reusable file (option **R**).

For performance reasons, it is sometimes desirable to modify the VSAM STRNO (string number) parameter to provide more index and data buffers. By default, Natural uses string number 3 for input processing and string number 5 for output processing. Since STRNO is specified in the JCL, both values can be modified with the AMP parameter in the corresponding DD card.

Under z/VSE

Under z/VSE, no string number can be specified in the JCS. Therefore, the syntax has been enhanced to be able to specify a string number with the OPRB parameter, where *nn* can be in the range from 1 to 10. Thus , *string* represents:

```
{        FNR = nnn        }   { K }   { , O }   { , B }   [,R]   [,STRNO
{                         } { E } } { , I } { , A }             = nn ]
{ DD = dd-name , TYP = { R } }
{                         } { P }
```

Sample OPRB Specification

The following OPRB example opens the specified files for input, while files not specified are opened for output by default:

```
OPRB=(DBID=254,MODE=I)
```

or

```
OPRB=(DBID=254,FNR=21,I,A;FNR=22,I,A)
```

The VSAM DBID and FNR as specified in the DDM are required. Option I specifies the corresponding FNR to be opened for input; option A specifies the corresponding FNR to be opened only if the file is accessed by a Natural program.

The corresponding NTOPRB macro example would be:

```
NTOPRB 254,'MODE=I'
```

or

```
NTOPRB 254,'FNR=21,I,A';'FNR=22,I,A'
```

Natural File Access

The Natural interface to VSAM supports VSAM entry-sequenced datasets (ESDS), key-sequenced datasets (KSDS), relative record datasets (RRDS), variable relative record datasets (VRDS), and paths for alternate indexes.

To enable Natural to access VSAM files, a Natural DDM is required for each VSAM file that is to be made accessible to Natural programs.

The section below covers the following topics:

Natural Data Definition Modules (DDMs)

A data definition module (DDM) must be set up for each file. DDMs are created and maintained with Predict (see the Predict documentation for details) or with the Natural utility `SYSDDM`; they are stored in the Natural dictionary system file (`FDIC`).

With VSAM, in addition to logical Natural DDMs, also VSAM user DDMs can be created from one physical DDM.

If you do not have Predict installed, use the `SYSDDM` utility to generate DDMs from VSAM files. The `SYSDDM` utility is described in the Natural *Editors* documentation; the parts of it relevant to VSAM are described in the following sections.

All DDMs used within a session are located in the Natural buffer pool. This increases performance and enables synchronization of DDM usage across multiple sessions.

SYSDDM Main Menu

The following functions on the main menu of the `SYSDDM` utility are relevant to Natural for VSAM:

Function	Explanation
Catalog DDM	The DDM currently in the work area is cataloged, making it available for use within Natural applications. The DDM must have previously been placed in the work area by a `READ` command, or have been entered by using the **Edit DDM** function described below. Below are further details about ***Catalog DDM***.
Edit DDM	Reads a DDM from the system file `FDIC` and into the `SYSDDM` work area, where it can be edited.
List DDMs	Displays a single DDM source (DDM editor *`not`* invoked) or a list of DDMs. The display format and options are identical to those of the `LIST DDM` command.
Copy DDM to Another FDIC File	One or all DDMs can be copied to a different Natural system file (`FDIC`) and/or to a different database. This is, for example, necessary during conversion of a Natural application from test to production status. In addition to the DDM name, DBID and FNR, with Natural for VSAM the file type `V` must be specified, as well as the DD/FCT name of the Natural system file `FDIC`, if the `FDIC` file is a VSAM file.
List DDMs with Additional Information	Displays a list of the DDMs stored in the specified `FDIC` system file. From the list, you can select individual DDMs for further processing. This function differs from the **List DDMs** function in that it displays additional items of information on the individual DDMs. The information displayed includes file name, DBID, file number, DDM length, security type (with Natural Security only), file type (that is, `LOG.DDM`, `PHY.FILE`, `LOG.FILE` or `USERDDM` for VSAM DDMs) and remarks as, for example, the VSAM file organization (KSDS, VRDS, RRDS, ESDS); see the section SYSDDM Utility in the Natural *Editors* documentation for details.
Delete DDM	Deletes a previously cataloged DDM from the Natural system file `FDIC`. The DDM remains in the work area. **Important:** If a DDM is deleted with `SYSDDM`, the corresponding Natural Security file profile is automatically deleted.

The following parameters relevant to Natural for VSAM can be specified for the various functions:

Parameter	Explanation
DDM Name	The name of the DDM to be processed.
FNR	The file number of the DDM to be processed.
DBID	The database which contains the DDM to be processed.
Replace	If Y is entered, DDMs which are being copied or cataloged and which are already existent are replaced. If N is entered, such DDMs are not replaced.
FDIC Type	The type of the system file FDIC.
DDM Type	The type of the DDM. For VSAM, the type must be V.
DBID Type	The type of the DDM. For VSAM, the type is V.

Catalog DDM

A DDM can be cataloged by either using function code C in the SYSDDM main menu or entering the CATALOG command in the **Command** line of the DDM maintenance editor.

File name and file number are required for this function. With Natural for VSAM, a DBID assigned to VSAM must be specified. If no DBID is entered, it is assumed to be 0 and is generated dynamically at execution time based on the DBID of the Natural user system file (FUSER) in use (see also the description of the UDB parameter in the section *Profile Parameters* in the Natural *Parameter Reference* documentation).

If a DBID assigned to VSAM is specified (and V for VSAM in the field **Type of this DDM**), SYSDDM prompts you for additional information.

Note: The actual DBID assignments for VSAM is made with NTDB macros when assembling NATPARM; see ***Installation Procedure for z/OS and z/VSE*** for details.

Additional Options for VSAM Files

If the DDM is to access a VSAM file, an additional screen, requiring the entry of additional VSAM options, is displayed:

```
11:24:04           ***** NATURAL SYSDDM UTILITY *****                2006-05-25
                         - Catalog a VSAM file/DDM -

        DBID 254   FNR  12    DDM AUTOMOBILES-VS                  Def seq
      ----------------------------------------
     VSAM file information

     VSAM file name ............ AUTO
     VSAM View ...........(Y/N) N
     Logical related to FNR ....
```

```
User defined prefix .......

VSAM file organization

KSDS, ESDS, RRDS, VRDS (K,E,R,V) .. K

Compress file ........(Y/N) N
Zones X'0C' / X'0F' (C/F) F
```

The additional options for VSAM files consist of two parts: **VSAM File Information** and **VSAM File Organization**.

VSAM File Information Options

Option	Explanation	
VSAM file name	The DDNAME/FCT entry as defined to the TP monitor or when using batch mode, for example: `//PERSON DD ...` where PERSON would be entered under **VSAM file name**.	
VSAM View (DDM)	Indicates whether this DDM represents a logical user DDM or a physical DDM.	
	`Y`	Indicates that the DDM represents a logical DDM, which means that it does not necessarily correspond to the physical layout of the VSAM file. A logical DDM must use the same file number as the physical DDM from which it is derived, and the corresponding physical DDM must exist at the time the user DDM is invoked during execution. The short names of the logical DDM must be identical to those defined in the physical DDM. The sequence of fields within the DDM can be different from the physical sequence. The primary-key field must not be deleted from the DDM. Since the logical DDM is a subset of the physical DDM, the corresponding subsets of the underlying VSAM file appear to the user as independent files with different record layouts. When processing a logical DDM, the user obtains records only from the corresponding subset and not from any other subset contained in the same physical VSAM file.
	`N`	Indicates that the DDM represents a physical DDM. Only one DDM with a given file number can be used as the physical DDM for a VSAM file. This physical DDM is used internally by Natural to calculate field offsets.

Logical DDMs are used to define different record types in a physical VSAM file. At DDM generation, these record types are identified by specifying a prefix for the primary key.

If a logical DDM is read, only records whose key begins with the specified prefix are returned from the VSAM file. Records beginning with any other prefix are ignored. If not specified otherwise, the prefix corresponds to the logical file number.

A different prefix must be assigned to each logical DDM. Natural automatically links the prefix with the logical key. The field layout in the logical DDM need not be the same as in the physical DDM.

The following two options are used only if the DDM represents a logical file which is to be derived from a physical VSAM file.

Option	Explanation
Logical related to FNR	This option is used to enter the file number of the physical DDM from which the logical file or DDM is derived. A logical DDM corresponds to a record type which is controlled by a prefix. Several logical record types can be contained in a physical VSAM file. The record types are distinguished by a prefix which determines which records are to be processed. See the **example** below.
User defined prefix	The prefix value which is to be assigned for the logical file. The default prefix value is the logical file number (length 3).

Example of Logical Related to FNR

Physical Dataset			
Key			
{ X1234 X2345 X3456 }	DDM1	PREFIX = X	FNR = 10
{ Z1234 Z1209 Z9000 }	DDM2	PREFIX = Z	FNR = 11
Read DDM1 with key			
Display key			
results in:			
	Key 1234 2345 3456		

VSAM File Organization Options

Option	Explanation	
KSDS, ESDS, RRDS, VRDS	The type of VSAM file:	
	K	KSDS file (default)
	E	ESDS file
	R	RRDS file
	V	VRDS file
Compress file	Specifies whether the file is to be compressed or not. The default is .	
	N	Indicates that the file is not to be compressed. The file is written in the maximum length (that is, the length of all fields within this file) as defined in SYSDDM or Predict.
	Y	Indicates that the file is to be written in variable record length. During compression, the record is scanned backwards for default values, which are blank for alphanumeric fields, low values for binary fields, low values with a zone for packed fields and X'F0' for numeric fields. Compression stops as soon as the first non-default value is detected or the first descriptor is found. The new computed length is used to write the record to the file; this applies to KSDS and ESDS files only.

Option	Explanation
	Compression of trailing null values in VSAM records minimizes the space required for VSAM records. The application programming interface `USR0100N` in the library `SYSEXT` is provided to be able to maintain the logical record length by a Natural program.
Zones X'0C' / X'0F'	In Adabas all positive packed values have `X'0F'` as a zone. This value could be different in VSAM. `F` Indicates that all packed data are written to the VSAM file with the zone `X'0F'`. This is the default. `C` Indicates that all packed values are written to the VSAM file with the zone `X'0C'`.

Edit DDM

To edit the DDM currently loaded in the work area, you can use the DDM editor of the `SYSDDM` utility. If no DDM has been read into the work area, an empty screen is displayed, allowing the manual entry of a DDM definition.

Instead of entering a complete DDM manually, you can read an existing DDM definition into the work area, by entering `EDIT` *`ddm-name`* in the DDM editor **Command** line. This DDM can be modified and cataloged under a different name.

Note: When you modify a DDM, all objects which reference this DDM have to be cataloged again.

DDM Editor

Example:

```
11:26:09                  ***** EDIT DDM (VSAM) *****                2007-02-25
DDM Name EMPLOYEES-VS                      Def.Seq.        DBID   254 FNR     1
Command
I T L DB Name                             F Leng  S D Remark
- - - -- -------------- top ------------- - ----- - - ------------------------
    1 AA PERSONNEL-ID                     A 8.0     P
  *      CNNNNNNN
  *      C=COUNTRY
  G 1 AB FULL-NAME
    2 AC FIRST-NAME                       A 20.0  N
    2 AD MIDDLE-NAME                      A 20.0  N
    2 AE NAME                             A 20.0    A
    1 AF MAR-STAT                         A 1.0   F
  *      M=MARRIED
  *      S=SINGLE
  *      D=DIVORCED
```

```
*       W=WIDOWED
  1 AG SEX                              A 1.0   F
  1 AH BIRTH                            N 6.0
G 1 A1 FULL-ADDRESS
M 2 AI ADDRESS-LINE                     A 20.0  N
  2 AJ CITY                             A 20.0  N
```

If you enter the HELP command or a question mark (?) in the **Command** line, the editor help information is displayed.

The header information of the DDM editor is:

DDM Name	The name used to reference the DDM in a Natural program. The name must be unique within the specified Natural system file.
Def. Seq.	The default sequence by which the file is read when it is accessed with a READ LOGICAL statement in a Natural program.
DBID	The database in which the file to be accessed with the DDM is contained. With Natural for VSAM, a DBID assigned to VSAM must be specified. If 0 is specified, the default DBID for the Natural user system file (FUSER) as defined in the Natural parameter module is used. **Note:** The actual DBID assignments for VSAM are made with NTDB macros when assembling NATPARM; see ***Installation Procedure for z/OS and z/VSE*** in the section Installation for details.
FNR	The number of the file being referenced. The specified file number is used internally by Natural for VSAM.

The DDM itself comprises the following field definition attributes which can be entered or modified:

Attribute	Explanation
I	Line indicator. This field is used by the DDM editor to mark lines. E Lines containing an error detected during execution of the CHECK command. S Lines containing a scanned value. X/Y Lines selected for copy/move operation.
T	Field Type: G Group header. M Multiple-value field. P Periodic group header. * Comment line. *blank* Elementary field.

Attribute	Explanation
L	Level number assigned to the field. Valid level numbers are 1 - 7. Level numbers have to be specified in consecutive ascending order.
DB	For VSAM files, the two-character code which is used in VSAM.
Name	A 3- to 32-character external field name. This is the field name used in Natural programs to reference the field.
F	Field format. For valid formats, refer to User-Defined Variables, Format and Length of User-Defined Variables (in the Natural Programming Guide).
Leng	Standard field length. This length can be overridden in a Natural program. For numeric fields (format N), the length is specified as `nn.m`, where `nn` represents the number of digits before the decimal point and `m` represents the number of digits after the decimal point.
S	This attribute is not applicable to Natural for VSAM.
D	Descriptor Option. `A` Indicates that the field is an alternate index for a VSAM file. `P` Indicates that the field is a primary key. `S` Indicates that the field is a primary subdescriptor or superdescriptor; that is, a primary key for a VSAM file. `X` Indicates that the field is an alternate subdescriptor or superdescriptor; that is, an alternate index for a VSAM file.
Remark	A comment which applies to a field and/or the DDM.

Most of the editor and line commands available with the Natural program editor also apply to the Natural DDM editor. Special commands, such as `PROFILE`, `RENUMBER`, `SET`, `SHIFT`, etc. and some line commands are not available. Refer to the section *SYSDDM Utility* in the Natural *Editors* documentation and to the section *Program Editor* in the Natural *Editors* documentation for more details on editor commands.

Extended Editing at Field Level

The DDM editor can also be used to enter or modify DDM definitions at field level.

Extended editing mode is used to specify field headers and edit masks to be applied when the field is used in a `DISPLAY` or `INPUT` statement, as well as further specifications for VSAM DDM definitions. All the other information specific to the field (field type, length, name, format, remarks) can also be modified at this point.

The extended editing mode is invoked by entering the line command `.E` in the first positions of the line containing the field.

A range of field definitions can be selected for editing by entering `.Ennn` where `nnn` is the number of fields to be selected.

The field level editing mode is terminated when you press Enter with or without having made any modifications.

The **Extended Field Editing** screen displays special attributes of the field definition if the edited DDM is a VSAM DDM:

```
11:25:26                 ***** EDIT DDM (VSAM) *****                 2007-02-25
                          - Extended Field Editing -
DDM Name AUTOMOBILES-VS                    Def.Seq.        DBID   254 FNR    12

I T L DB Name                              F Leng  S D Remark
- - - -- -------------- top ------------- - ----- - - ------------------------
    1 GA OWNER-PERSONNEL-NUMBER            N 8.0     A SECONDARY KEY
-------------------------------------------------------------------------------

Field Header .......... OWNER/NUMBER_____________________________________
Field Edit Mask ....... ________________________________________________

Alternate Index Name .. AUTOY___

Maximum Occurrence ....   1

Upgrade Flag .......... _ (X)
Unique Key Flag ....... _ (X)
Null Flag ............ _ (X)

Field GA redefines field __ with offset   0
```

The following attributes can be specified:

Attribute	Explanation
Alternate Index Name	If the field references a VSAM alternate index or a path (denoted by an `A` in column **D**), the index or path name must be entered here.
Maximum Occurrence	The number of occurrences for a multiple-value field or a periodic group (denoted by an `M` or `P` in column **T**).
The following flags only apply to alternate indexes and not to paths:	
Upgrade Flag	Since Natural does not use VSAM paths, upgrading can be performed either by Natural or by VSAM when using a KSDS or ESDS file with alternate indices defined. A blank value indicates that upgrading the alternate index is to be done by VSAM, which is the default. If VSAM is to perform the upgrading, define the VSAM file using IDCAMS with `UPGRADE`. If you enter an `X`, upgrading of the alternate index is performed by Natural. If so, the AIX must be defined with the `NONUPGRADE` option.

Attribute	Explanation
	Note: For LSR handling, it is recommended that you specify this option. Under CICS, the FCT entry must also contain the `VARIABLE` option.
Sort Flag	If this option is marked with an `X`, the alternate index is to be read in ascending or descending value order. This option only takes effect if the **Upgrade Flag** option is specified, too.
Unique Key Flag	If this option is marked with an `X`, Natural ensures that the values of the alternate index field are unique. An attempt to update with a non-unique value results in an error message. The default value is a blank. This option only takes effect if the **Upgrade Flag** option is also specified.
Null Flag	A value of `S` indicates that null values for the alternate index field are suppressed. The default value is a blank. This option only takes effect if the **Upgrade Flag** option is also specified.

Note: For all DDMs cataloged with Natural which contain alternate indexes and any specifications for the above flags, all flags are nullified during runtime as soon as path processing is activated for these DDMs.

The last two fields on the screen are used to define sub-/superdescriptors for a VSAM file. For example, to define the field `S1` as superdescriptor beginning in field `BA` and ending in field `BB`, the following would be entered:

```
S1 redefines BA with offset 0
```

The field `S1` must have been defined to VSAM as a primary or secondary key.

VSAM superdescriptors can only be constructed from fields which are contiguous. To define the field `S2` as a superdescriptor which begins in the 11th position of field `BA` and ends with the first two positions of field `BB`, the following would be entered:

```
S2 redefines BA with offset 10
```

In addition, the length of `S2` would have to be set to `7`. As mentioned above, `S2` must have been defined as a primary or alternate index to VSAM.

Restrictions with DDM Generation as Compared to Adabas

- No keys can be defined within periodic groups.
- Descriptors that contain multiple-value fields are not allowed with VSAM.
- Natural DDMs for VSAM cannot contain multiple-value fields or periodic groups *within* periodic groups.
- The same field cannot be defined more than once in the same DDM. A data definition as in the following example would lead to unpredictable results when used with VSAM:

Example:

```
...
G 01 AB FULL-NAME
        02 AC FIRST-NAMEA 20.0  N
        02 AD MIDDLE-I                  A  1.0 N   /* duplicate short name
        02 AE NAME                      A 20.0
        01 AD MIDDLE-NAME               A 20.0 N   /* duplicate short name
...
```

Natural would treat the field `MIDDLE-I` not as a redefinition of `MIDDLE-NAME` but as a separate field.

Buffers for Memory Management

The `VSIZE` parameter is suballocated into ten different areas whose sizes are determined by the assembly of `NVSPARM`. The different VSAM areas are split into fixed and variable buffer types. If there is insufficient space in the `VSIZE` buffer for all `NVSPARM` areas, you receive error message NAT3592 during initialization. At runtime, error message NAT3513 can occur for fixed buffer types. In this case, you must adapt the corresponding `NVSPARM` value. Variable buffers are increased during runtime, NAT3513 does not occur. Some buffer sizes depend on the use of VSAM system files. The relevant buffers are FCT, FWA, TSA and UPD.

The `VSIZE` parameter is suballocated as follows:

- FCT - File Control Table
- FWA - File Work Area
- OPV - Open Table
- SFT - System File Table
- SWT - Switch Table
- TAF - Table of Accessed Files
- ROLL - Table of Session Status Information
- DFB - Table of Decoded Format Buffers
- TSA - Table of Sequential Access
- UPD - Table of Update Records

- VCA - Natural Control Area for VSAM

FCT - File Control Table

FCT contains file-specific information and is a fixed buffer type.

FCT also contains the complete VSAM access control block (ACB), information on existing user exits, and information on the application programming interface `USR0100N`.

The size of the table is determined by using the following formula and then rounding up to a double-word boundary:

(72 + *ACB-length*) (TAFE * 2) + 80

Without VSAM system files, the default setting is:

(72 + 76) (10 * 2) + 80 = 3040

With VSAM system files, the default setting is:

(72 + 76) (26 * 2) + 80 = 7776

FCT and **SWT** (see below) share a common buffer area.

FWA - File Work Area

FWA contains information on a VSAM request and is a fixed buffer type.

FWA also contains information on the VSAM request parameter list (RPL).

The size of the table is determined by using the following formula and then rounding up to a double-word boundary.

(40 + *RPL-length*) (TAFE * 2) + 80

Without VSAM system files the default setting is:

(40 + 76) (10 * 2) + 80 = 2400

With VSAM system files the default setting is:

(40 + (76*4)) (26 * 2) + 80 = 17968

FWA and OPV (see below) share a common buffer area.

OPV - Open Table

OPV contains information on an `OPRB` string and is a fixed buffer type.

The size of the table is determined by using the following formula and then rounding up to a double-word boundary:

24 * (TAFE * 2) + 48

The default setting is :

24 * (10 * 2) + 48 = 528

OPV and **FWA** share a common buffer area.

SFT - System File Table

This table is only active if VSAM system files are defined. The buffer type is fixed.

This area contains the description of the VSAM system files `FNAT`, `FUSER`, `FDIC`, `FSEC` and `FSPOOL` as well as the system file used by Natural ISPF, if available.

The size of the area is 8192 for `SFILE=ON`. The default setting is 0.

SWT - Switch Table

SWT contains information necessary for the application programming interface `USR1047N` for dynamic DD/DLBL modification. SWT is allocated only if the value specified for the parameter `DDSWITE` in `NVSPARM` is greater than 0.

The SWT buffer type is fixed.

The size of the table is determined by using the following formula and then rounding up to a double-word boundary:

24 * DDSWITE + 48

The default setting is 0.

SWT and **FCT** (see above) share a common buffer area.

TAF - Table of Accessed Files

This area describes the record layout for each file accessed by Natural; it is created by reading the physical or logical DDM for the file. Each TAF entry consists of a header entry and an entry for each field in the DDM. The header entry describes the type of file, file name, primary key, etc. The field entries describe the format, offset, and length of every field in the file. The layouts for the header and field entries are described in the macros NVMTAF and NVMFLD respectively.

The TAF buffer type is fixed.

The size of the table is determined by using the following formula and then rounding up to a double-word boundary:

(((32 * TAFN) + 112) * TAFE) + 80

The default setting is:

(((32 * 50) + 112) * 10) + 80 = 17200

ROLL - Table of Session Status Information

This table is used to keep track of the position within a file for every active `FIND` or `READ` statement; it is identified by the CID. This allows Natural to release all VSAM resources during a ROLLOUT operation and then reposition itself correctly after a ROLLIN operation.

The ROLL buffer type is fixed.

The size of this area is determined by the parameter `ROLLSIZ` in the `NVSPARM` module, rounded up to a double-word boundary:

TAXSIZE + 80

The default setting is:

550 + 80 = 632

DFB - Table of Decoded Format Buffers

The table is suballocated into two areas, one for global format IDs (GFIDs) and one for command IDs (CIDs).

For any given I/O request, this area describes which fields from the VSAM record area are returned to the Natural record buffer. Each DFB (decoded format buffer) entry consists of one header, identified by the CID or the GFID of the I/O request, plus an entry for each field to be returned to Natural. Each field entry in the DFB contains the format, offset, and length of the field as derived from the associated TAF entry for the file. The layouts of the header and field entries are described in the macros `NVMDFB` and `NVMDFF` respectively.

The DFB buffer type is fixed. If the no-space-condition occurs for GFID-oriented entries, the oldest entries are deleted.

The size of the TDFB area is determined by using the following formula and then rounding up to a double-word boundary:

(16 * DFBN * 2 + 36) * DFBE * 2 + 128

The default setting is:

(16 * 50 * 2 + 36) * 10 * 2 + 128 = 32848

TSA - Table of Sequential Access

The TSA is used to keep important pointers and information on each `READ` or `FIND` statement. There is one TSA entry for each active `READ` and `FIND` statement, and each entry is identified by the CID. The layout of the TSA is described in the macro `NVMTSA`.

The TSA buffer type is variable.

The size of the area is determined by using the following formula and then rounding up to a double-word boundary:

(104 + KEYLGH) * TSAE + 80

The default setting is:

(104 + 32) * 10 + 80 = 1440

UPD - Table of Update Records

This area contains an entry for every `READ` or `FIND` loop that contains an `UPDATE` or `DELETE` statement. These entries are released when an `END TRANSACTION` or `BACKOUT TRANSACTION` statement is executed. Each entry contains control information about the record and the values of all the fields that might be updated within the loop. The layout of each UPD entry is described in the macro `NVMUPD`.

The UPD buffer type is variable.

The size of the UPD area is determined by the parameter UPDL in the `NVSPARM` module, rounded up to a double-word boundary.

The default setting is 8272 without VSAM system files and 32848 with VSAM system files.

VCA - Natural Control Area for VSAM

VCA is a fixed length area which contains pointers, addresses, flags, and work areas that are important to a Natural environment for VSAM. The layout for this area is described in the macro `NVMCA`. Within a Natural environment for VSAM, R3 always points to this area.

The size of this area is 6600 bytes.

Application Programming Interfaces

Natural for VSAM provides the following application programming interfaces (APIs) in the Natural system library `SYSEXT`:

API	Function
`USR0100N`	Controls the VSAM variable record length (LRECL).
`USR1047N`	Supports dynamic switching of DD/DLBL names defined in a DDM.
`USR2008N`	Supports dynamic `OPEN` calls for VSAM datasets.

A short description of the APIs is provided in the following section; for more detailed information, log on to the library `SYSEXT` and display the text members (`USRxxxxT`) of the API(s) desired.

The section below contains information on the following APIs:

- USR0100N
- USR1047N
- USR2008N

USR0100N

The API `USR0100N` controls the record length of variable VSAM files.

The API is invoked as follows (a sample program called `USR0100P` is provided in the library `SYSEXT`):

```
CALLNAT 'USR0100N' parm1 parm2 parm3 parm4 parm5
```

The parameters are described in the following table:

Parameter	Format/Length	Explanation
parm1	A1	Specifies either of the following function codes: G For retrieval statements; the current record length is determined for *parm5*. P For update/store statements; the length specified in *parm5* becomes the current record length.
parm2	A8	Specifies the DD/DLBL name for the current file (optional); if specified, *parm5* is only valid for this file.
parm3	N5	Specifies the DBID taken from the DDM (optional); is used instead of the DD/DLBL name and only in conjunction with *parm4*.
parm4	N5	Specifies the FNR taken from the DDM (optional).
parm5	N5	Specifies or returns the record length depending on the setting of *parm1*.

Note: If neither *parm2* nor *parm3* and *parm4* are specified, *parm5* is valid for all files.

USR1047N

The API USR1047N enables dynamic modification of DD/DLBL names within a Natural program if the DDSWITE parameter is specified in NVSPARM. It can be used if data are spread over several VSAM files which have different DD/DLBL names, but the same record structure.

The API is invoked as follows (a sample program called USR1047P is provided in the library SYSEXT):

```
CALLNAT 'USR1047N' parm1 parm2 parm3 parm4
```

The various parameters are described in the following table:

Parameter	Format/Length	Explanation
parm1	A1	Specifies either of the following function codes: S For switching of DD names with the next following database calls. R For resetting of DD names; the switch table entry of function S has been deleted (see ***SWT - Switch Table***).
parm2	A8	Specifies the old DD name taken from the DDM.
parm3	A8	Specifies the new DD name for the next database calls.
parm4	P4	Return code of Natural for VSAM.

The parameter *parm4* can contain the following response codes:

Code	Explanation
0	Normal return.
4	The switch table (SWT) is too small; increase the DDSWITE parameter.
8	The switch table entry has not been found; program error.
12	Invalid function code.
16	The switch table is not allocated; that is, the DDSWITE parameter is set to 0.

USR2008N

This API is not applicable under Com-plete and CICS.

USR2008N supports dynamic OPEN calls during a Natural session if OPSUPP=ON is specified in NVSPARM (see also OPSUPP in the section *Natural for VSAM Parameters*).

The API is invoked as follows (a sample program called USR2008P is provided in the library SYSEXT):

```
CALLNAT 'USR2008N' parm1 parm2 parm3 parm4 parm5 parm6
```

The parameters are described in the following table:

Parameter	Format/Length	Explanation
parm1	N5	Specifies the DBID taken from the NTDB macro definition; see ***NTDB Macro*** in the section *Natural for VSAM Parameters*.
parm2	A1	Specifies the global OPEN MODE; see ***OPEN/CLOSE Processing***.
parm3	A4	Specifies the data management type, for example, VSAM.
parm4	A40/16	Specifies the valid OPRB syntax and/or DDM long name instead of the DD= or FNR= definitions.
parm5	P4	Returns the Natural for VSAM error number.
parm6	A50	Returns the Natural for VSAM error text.

49 Natural Statements and Transaction Logic with VSAM

This section describes special considerations on Natural statements and Natural transaction logic when used with VSAM.

The Natural statements used to access VSAM files are a subset of those provided with the Natural language. No new statements are needed to access a VSAM file, since each Natural statement performs the same function regardless of the database management system or access method used. Therefore, programs written for VSAM files can also be used to access Adabas databases.

The Natural interface to VSAM has no built-in transaction logic and uses the one of the environment it is running in. This leads to different results depending on the environment.

Natural Statements with VSAM

This section mainly consists of information also contained in the Natural Statements documentation, where each Natural statement is described in detail, including notes on VSAM usage where applicable. Summarized below are the particular points a programmer has to bear in mind when using Natural statements with VSAM.

Note: Since the Natural compiler does not check if a program adheres to the restrictions imposed by the Natural interface to VSAM, VSAM-specific programming errors concerning the use of Natural statements only occur when the program is executed.

Any Natural statement not mentioned in this section can be used with VSAM without restrictions.

- BACKOUT TRANSACTION
- DELETE
- END TRANSACTION
- FIND
- GET
- GET SAME
- GET TRANSACTION DATA
- HISTOGRAM
- READ
- STORE

- UPDATE

BACKOUT TRANSACTION

The `BACKOUT TRANSACTION` statement is used to back out all database updates performed during the current user logical transaction. This statement also releases all records held during the transaction.

If used with Natural for VSAM, the `BACKOUT TRANSACTION` statement releases records held in the UPD table. It does not back out transactions unless Natural is running under a TP monitor or DFSMStvs which supports dynamic transaction backout (for example, CICS). In this case, a `ROLLBACK` to the last `SYNCPOINT` is issued.

DELETE

The `DELETE` statement is used to delete a record from a VSAM file.

The use of the `DELETE` statement places each record selected in the corresponding `FIND` or `READ` statement in hold status.

The `DELETE` statement is not valid for VSAM entry-sequenced data sets (ESDS).

END TRANSACTION

The `END TRANSACTION` statement is used to indicate the end of a logical transaction. A logical transaction is the smallest logical unit of work (as defined by the user) which must be performed in its entirety to ensure that the information contained in the VSAM file is logically consistent.

The `END TRANSACTION` statement also releases all records placed in hold status during the transaction.

An `END TRANSACTION` only releases records held in the UPD table unless Natural is running under a TP monitor or DFSMStvs which supports dynamic transaction backout (for example, CICS). In this case, an `END TRANSACTION` statement causes a `SYNCPOINT` to be issued.

FIND

The `FIND` statement is used to select a set of records from the VSAM file based on a search criterion consisting of fields defined as descriptors (keys).

The `WITH` clause is used to specify the search criterion consisting of key fields (descriptors) defined in the VSAM file.

Only VSAM key fields can be used.

The number of records to be selected as a result of a WITH clause can be limited by specifying the keyword LIMIT together with a limit value (*`operand 1`*) expressed as a numeric constant or a user-

defined variable. The limit value is enclosed within parentheses. If the number of records selected exceeds the limit value, the program is terminated with an error message.

The descriptor must be defined in a VSAM file as a VSAM key field. In a DDM, it is marked with `P` for primary key, `S` for primary sub/superdescriptor, `X` for alternate sub/superdescriptor or `A` for alternate key (see ***Edit DDM*** in the section *Operation*, and the *SYSDDM Utility* as described in the Natural *Editors* documentation).

The formats of the descriptor and the search value must be compatible.

The following Natural system variables are available with the `FIND` statement:

Variable	Content
`*ISN`	The system variable `*ISN` contains the relative byte address of the record currently being processed (ESDS files only). This variable is not available for the `FIND NUMBER` and `FIND FIRST` statements.
`*NUMBER`	The system variable `*NUMBER` contains the number of records which satisfied the basic search criterion specified in the `WITH` clause, and before evaluation of any `WHERE` criterion. `*NUMBER` only contains a meaningful value if the `EQUAL TO` operator is used in the search criterion. With any other operator, `*NUMBER` will be `0` if no records have been found; any other value indicates that records have been found, but the value will have no relation to the number of records actually found. The same applies to `*NUMBER` with the `FIND NUMBER` statement.
`*COUNTER`	The system variable `*COUNTER` contains the number of times the processing loop has been entered. This system variable is not available for the `FIND NUMBER` statement.

The `FIND` statement is only valid for key-sequenced (KSDS) and entry-sequenced (ESDS) VSAM datasets. For ESDS, an alternate index or a path for an alternate index must be defined. Relative record datasets (RRDS) are not allowed, since they do not contain any key fields (descriptors).

GET

The `GET` statement is used to read a record with a given VSAM record number. For an ESDS file, the record number (ISN) would be the relative byte address (RBA); for RRDS and VRDS files, it would be the relative record number (RRN). The `GET` statement does not initiate a processing loop. As a result, a subsequent `UPDATE` or `DELETE` statement will not be processed and Natural returns a corresponding error message.

For ESDS, the RBA must be contained in a user-defined variable (numeric format) or specified as an integer constant. The same rules apply for RRDS and VRDS with the exception that the RRN must be provided instead of the RBA.

GET SAME

The `GET SAME` statement applies to VSAM ESDS, RRDS, and VRDS only (see also the `GET` statement above).

GET TRANSACTION DATA

The `GET TRANSACTION DATA` statement is not applicable to the Natural interface to VSAM.

HISTOGRAM

The `HISTOGRAM` statement is used to read the values of a field which is defined as a descriptor, subdescriptor, or superdescriptor.

The `HISTOGRAM` statement initiates a processing loop, but does not provide access to any fields other than the field specified in the statement.

Only VSAM key fields can be used as descriptors.

The following Natural system variable is available with the `HISTOGRAM` statement:

Variable	Content
`*NUMBER`	When used in conjunction with a KSDS primary key or a unique alternate index, `*NUMBER` is always 1.

Note: The `*ISN` system variable is not available for the Natural interface to VSAM.

When used with VSAM, the `HISTOGRAM` statement is only valid for KSDS and ESDS datasets. For ESDS, an alternate index or a path for an alternate index must be defined.

The values are read directly from the VSAM index and are returned in ascending or descending value sequence.

READ

The `READ` statement is used to read records from a VSAM file. The records can be retrieved in the value sequence (ascending or descending) of a descriptor (key) field. The `READ` sequence initiates a processing loop.

`IN LOGICAL SEQUENCE` is used to read records in the order of the values of a descriptor (key). If `LOGICAL` is specified with a descriptor, the records are read in the value sequence of the descriptor. A descriptor can be used for sequence control. A descriptor within a periodic group cannot be used. If `LOGICAL` is specified without a descriptor, the records are read in the default descriptor sequence, as defined in the DDM.

WITH REPOSITION can be used for skip-sequential processing inside the active loop, the new position must be defined as the new start value for the loop and must reset the system variable *COUNTER.

IN LOGICAL SEQUENCE is only valid for KSDS with primary and alternate keys defined and ESDS with alternate keys defined. A subdescriptor or superdescriptor can be used for sequence control, too.

The following Natural system variables are available with the READ statement:

Variable	Content
*ISN	The system variable *ISN contains either the RRN (for RRDS or VRDS) or the RBA (for ESDS) of the current record.
*COUNTER	This system variable contains the number of times the processing loop has been entered.

Records can also be retrieved IN PHYSICAL SEQUENCE, which is used to read records in the order in which they are physically stored in a database. It is only valid for VSAM ESDS, RRDS and VRDS. This is the default sequence.

STARTING WITH ISN can be used as start value for the loop in ascending or descending physical sequence.

BY ISN is used to read records in RBA and RRN order for ESDS, RRDS and VRDS files, respectively.

STORE

The STORE statement is used to add a record to a database.

A unique value for the primary-key field or the alternate-index field must be provided if the dataset is defined with a primary key or a unique alternate index.

The USING/GIVING NUMBER clause is only valid for RRDS or VRDS, in which case the ISN corresponds to the relative record number.

USING/GIVING NUMBER is used to store a record with a user-supplied RRN. If a record with the specified RRN already exists, an error message is returned and the execution of the program is terminated, unless ON ERROR processing was specified.

The Natural system variable *ISN contains the RRN assigned to the new record as a result of the STORE

statement execution. A subsequent reference to *ISN must include the statement number of the related STORE statement. *ISN is available for RRDS or VRDS files only.

UPDATE

The `UPDATE` statement is used to update one or more fields of a record in a database. The record to be updated must have been previously selected using a `FIND` or `READ` statement.

The primary key cannot be updated.

Natural Transaction Logic with VSAM

Natural for VSAM uses the transaction logic of the environment it is running in. Thus, the results of the Natural `END TRANSACTION` and `BACKOUT TRANSACTION` statements (see also the relevant sections in Natural Statements with VSAM) differ depending on the actual environment:

- With Native VSAM
- Under CICS
- Under DFSMStvs

With Native VSAM

Since VSAM itself has no transaction logic, there is no transaction logic available if Natural is working in a native VSAM environment. This is the case under Com-plete, TSO, and in batch mode, which means when `NVSMISC` is the I/O module in use.

With `NVSMISC`, `END TRANSACTION` and `BACKOUT TRANSACTION` statements do not return any error messages, but are ignored by the Natural interface to VSAM.

Under CICS

Under CICS, VSAM files can be defined as “recoverable resources” or for RLS as “recoverable sphere”, all of which are synchronized by CICS using the concept of “logical units of work” (LUWs). An LUW ends if a `SYNCPOINT` command is issued or if the CICS task is terminated. For details, refer to the relevant IBM literature on CICS.

Below is information on:

- NVSCICS Module
- Conversational Tasks

- Pseudo-Conversational Tasks

NVSCICS Module

For CICS, the I/O module `NVSCICS` is a normal command-level application program. It transfers `END TRANSACTION` and `BACKOUT TRANSACTION` statements to the `NATCICS` driver which issues the `EXEC CICS SYNCPOINT` and `EXEC CICS ROLLBACK` commands. If an error occurs in a Natural session with uncommitted updates and no error transaction is supplied, Natural itself triggers the interface to VSAM to issue a `ROLLBACK` command.

If a `SYNCPOINT` or `ROLLBACK` command fails (for example, when CICS answers with a `ROLLEDBACK` condition to a `SYNCPOINT` request), error messages NAT3544 or NAT3545 are returned.

Conversational Tasks

If the Natural session runs in CICS conversational mode, the LUW is not ended by a terminal I/O. Natural runs in conversational mode if either the Natural parameter `PSEUDO=OFF` has been specified or Natural itself has determined that pseudo-conversational processing is not possible.

Since terminal I/Os do not disturb the transaction logic of an application as long as Natural is running in conversational mode, a program like the following one would work without problems:

Example:

```
READ vsam-file
 UPDATE
 INPUT ...
END-READ
BACKOUT TRANSACTION
```

Pseudo-Conversational Tasks

If the Natural session is running in pseudo-conversational mode, each terminal I/O terminates the CICS task, thus implicitly performing a `SYNCPOINT`. Therefore, the impact of a `BACKOUT TRANSACTION` statement, that is of an `EXEC CICS SYNCPOINT ROLLBACK` command, only goes back to the most recent terminal I/O. The example program above would, therefore, end with error message NAT3548, because it is not possible to roll back all the updates.

Note: Keep in mind that all messages of the Natural interface to VSAM are issued at runtime only, since the Natural compiler is not able to detect this kind of logical error.

Under DFSMStvs

DFSMS Transactional VSAM Services (DFSMStvs) provides the same features CICS provides: forward and backward recovery logging, backout processing and a two-phase commit process. An LUW ends if the RRS (Resource Recovery Service) call `SRRCMIT` or `SRRBACK` is issued (`END TRANSACTION` or `BACKOUT TRANSACTION`). For details, refer to the relevant IBM literature on DFSMStvs and RRS.

50 Using Natural with VSAM System Files

The Natural system files FNAT, FUSER, FDIC, FSEC and FSPOOL can also be located on VSAM files.

To support the locking of source objects a separate FLOCK file and related paths are necessary.

This section covers the following topics:

Prerequisites

See the ***Prerequisites*** under *Installing Natural for VSAM* in the *Installation* section.

For the installation of Natural ISPF on VSAM system files, refer to the Natural ISPF *Installation* documentation. Be sure that you use the relevant module (NVSISPV) provided on the Natural for VSAM installation tape.

Installing Natural on VSAM System Files - z/OS

This section describes step by step how to install Natural under the operating system z/OS using VSAM system files. The information given is basically a combination of the installation descriptions for both base Natural and Natural for VSAM (product code NVS), plus some points specific to VSAM system files.

Installation Tape

To install Natural with VSAM system files, you need the datasets for both base Natural and Natural for VSAM. The required datasets are listed in the table below:

Dataset Name	Contents
NAT*vrs*.ERRN	Natural error messages.
NAT*vrs*.LOAD	Natural load modules.
NAT*vrs*.SRCE	Natural source modules and macros.
NAT*vrs*.JOBS	Example installation jobs.
NAT*vrs*.INPL	Natural system programs.
NAT*vrs*.EXPL	Natural example programs.
NVS*vrs*.LOAD	Natural for VSAM load modules.
NVS*vrs*.SRCE	Natural for VSAM source modules.
NVS*vrs*.EMPL	Natural for VSAM example file.
NVS*vrs*.EXPL	Natural for VSAM example programs.
NVS*vrs*.LINI	Natural for VSAM Locking Source Objects.

Dataset Name	Contents
NVS*vrs*.VINI	Natural for VSAM FDIC initialization file.

The notation *vrs* in dataset names represents the version number of the product. The sequence of the datasets is shown in the *Report of Tape Creation* which accompanies the installation tape.

Copying the Tape Contents to a z/OS Disk

If you are using SMA, refer to the *System Maintenance Aid* documentation (included in the current edition of the Natural documentation CD).

If you are *not* using SMA, follow the instructions below.

This section explains how to:

- Copy dataset COPY.JOB from tape to disk.
- Modify this dataset to conform to your local naming conventions.

The JCL in this dataset is then used to copy all datasets from tape to disk.

If the datasets for more than one product are delivered on the tape, the dataset COPY.JOB contains the JCL to unload the datasets for all delivered products from the tape to your disk.

After that, you will have to perform the individual install procedure for each component.

- Step 1 - Copy Dataset COPY.JOB from Tape to Disk
- Step 2 - Modify COPY.JOB on Your Disk
- Step 3 - Submit COPY.JOB

Step 1 - Copy Dataset COPY.JOB from Tape to Disk

The dataset COPY.JOB (Label 2) contains the JCL to unload all other existing datasets from tape to disk. To unload COPY.JOB, use the following sample JCL:

```
//SAGTAPE JOB SAG,CLASS=1,MSGCLASS=X
//* --------------------------------
//COPY EXEC PGM=IEBGENER
//SYSUT1 DD DSN=COPY.JOB,
// DISP=(OLD,PASS),
// UNIT=(CASS,,DEFER),
// VOL=(,RETAIN,SER=tape-volume),
// LABEL=(2,SL)
//SYSUT2 DD DSN=hilev.COPY.JOB,
// DISP=(NEW,CATLG,DELETE),
// UNIT=3390,VOL=SER=volume,
// SPACE=(TRK,(1,1),RLSE),
```

```
// DCB=*.SYSUT1
//SYSPRINT DD SYSOUT=*
//SYSIN DD DUMMY
//
```

where:

hilev is a valid high level qualifier
tape-volume is the tape volume name, for example: T12345
volume is the disk volume name

Step 2 - Modify COPY.JOB on Your Disk

Modify the COPY.JOB on your disk to conform to your local naming conventions and set the disk space parameters before submitting this job:

- Set HILEV to a valid high level qualifier.
- Set LOCATION to a storage location.
- Set EXPDT to a valid expiration date.

Step 3 - Submit COPY.JOB

Submit COPY.JOB to unload all other datasets from the tape to your disk.

Installation Procedure

Under z/OS, the installation procedure for Natural with VSAM system files consists of the following steps:

- Step 1: Prepare NVS Demo File - Job NVSI008, Steps 1403 to 1407
- Step 2: Prepare VSAM Clusters System Files - Job VSAMI008, Steps 1420 to 1446
- Step 3: Prepare VSAM Cluster for the Spool File - Job VSAMI008, Steps 0300 to 0309
- Step 4: Prepare VSAM Cluster for the Security File - Job VSAMI008, Steps 9900 to 9907
- Step 5: Prepare VSAM Cluster for Scratch-Pad File - (Dataset NVSnnn.VINI)
- Step 6: Prepare VSAM Cluster for Source locking File FLOCK - Job VSAMI008, Step 1460 and 1461
- Step 7: Assemble Natural z/OS Interface Module - Job NATI055, Steps 0100 and 0102
- Step 8: Create NVS Parameter Module - Job NVSI055, Steps 1400 and 1401
- Step 9: Create NVS I/O Module - Job NVSI055, Steps 1410 and 1411
- Step 10: Create Natural Batch Parameter Module - Job VSAMI060, Steps 0010
- Step 11: Link Natural Batch Nucleus - Job VSAMI060, Step 0020
- Step 12: Load System Programs - Job VSAMI061, Step 0100
- Step 13: Load Error Messages - Job VSAMI061, Steps 0102
- Step 14: Load Examples - Job VSAMI061, Steps 0103 and 1400
- Step 15: Reorganize FNAT System File
- Step 16: Create NVS I/O Module for CICS - Job NVSI070, Step 1400
- Step 17: Install Online Natural

- Step 18: Customize your TP Monitor

Step 1: Prepare NVS Demo File - Job NVSI008, Steps 1403 to 1407

Load the VSAM demo file `EMPL` and define the alternate index path `EMPLX` for the file `EMPL`.

Step 2: Prepare VSAM Clusters System Files - Job VSAMI008, Steps 1420 to 1446

Define three VSAM clusters to be used as system files for Natural (`FNAT`, `FUSER` and `FDIC`), an alternate index and a path for the alternate index for `FDIC`.

It is strongly recommended that you keep these three system files on separate VSAM clusters.

Step 3: Prepare VSAM Cluster for the Spool File - Job VSAMI008, Steps 0300 to 0309

This step must only be performed if you have Natural Advanced Facilities installed and want your spool file to be a VSAM file, too.

Define an additional VSAM cluster to be used as spool file (`FSPOOL`) and five alternate indices.

Note: Path processing is **not** supported for `FSPOOL`.

Step 4: Prepare VSAM Cluster for the Security File - Job VSAMI008, Steps 9900 to 9907

This step must only be performed if you have Natural Security installed and want your security file to be a VSAM file, too.

Define an additional VSAM cluster to be used as security file (`FSEC`) and three alternate indices.

Note: Path processing is **not** supported for `FSEC`.

Step 5: Prepare VSAM Cluster for Scratch-Pad File - (Dataset NVSnnn.VINI)

- Allocate VSAM SCRATCH PAD File - Job VSAMI008, Step 1450
- Initialization VSAM SCRATCH PAD File - Job VSAMI008, Step 1451

This step must only be performed if you want to use a scratch-pad file; that is, if you want to use read-only system files (ROSY=ON); see also the parameter ROSY and the macro `NTLFILE` (described in the Natural *Parameter Reference* documentation).

Define an additional VSAM cluster to be used as scratch-pad file.

For the optional scratch-pad file inclusion, the following NATPARM parameters must be added or, if already present, updated with:

```
NTLFILE 212,dbid,nt-file-number,dd-name-scratch-pad-file
ROSY=ON
```

If you want your system file(s) to be opened for input, adapt your Natural parameter module as follows:

```
FNAT=(dbid,fnr,filename,,RO),
FUSER=(dbid,fnr,filename,,RO),
FSEC=(dbid,fnr,filename,,RO),
```

Step 6: Prepare VSAM Cluster for Source locking File FLOCK - Job VSAMI008, Step 1460 and 1461

This step must only be performed if you want to use a locking of source objects on VSAM system file (SLOCK=PRE); see also the parameter SLOCK and the macro NTLFILE (described in the Natural *Parameter Reference* documentation).

Define an additional VSAM cluster to be used as source locking file.

For the optional source locking file inclusion, the following NATPARM parameters must be added or, if already present, updated with:

```
NTLFILE 002,dbid,nt-file-number,dd-name-source-locking-file,,PATH
SLOCK=PRE
```

The default dd-name is FLOCK, the related default pathes are FLOCKA, FLOCKB and FLOCKC.

- Allocate and Define VSAM Source Locking File - Job VSAMI008, Step 1460
- Printing Data Records VSAM Source Locking File - Job VSAMI008, Step 1461

This step must only be performed if you want to use a VSAM Source Locking File; that is, if you want to use VSAM Source Locking parameter SLOCK - Source Locking (described in the Natural *Parameter Reference* documentation).

Step 7: Assemble Natural z/OS Interface Module - Job NATI055, Steps 0100 and 0102

Assemble and link the Natural z/OS interface module `NATOS` contained in dataset `NAT`*`nnn`*`.SRCE`.

Step 8: Create NVS Parameter Module - Job NVSI055, Steps 1400 and 1401

Edit, assemble and link the Natural for VSAM parameter module `NVSPARM`. For a description of the parameters which can be specified, see ***Assembling the NVSPARM Parameter Module*** in the section *Natural for VSAM Parameters*.

Step 9: Create NVS I/O Module - Job NVSI055, Steps 1410 and 1411

Assemble and link the Natural for VSAM I/O module `NVSMISC` with the LSR options:

```
DEFER=YES
COMMIT=NO
READINT=NO
```

See a description of the parameters which can be specified in `NVSMISC` (see the section *Natural for VSAM Parameters*).

Step 10: Create Natural Batch Parameter Module - Job VSAMI060, Steps 0010

Create the Natural batch parameter module.

To install Natural with VSAM system files, in addition to the `VSIZE` and `NTDB` specification, you must modify the parameters `FNAT`, `FUSER` and `FDIC` as follows:

```
VSIZE=126,
FNAT=(vsam-dbid,fnr-fnat,dd-name-fnat),
FUSER=(vsam-dbid,fnr-fuser,dd-name-fuser),
FDIC=(vsam-dbid,fnr-fdic,dd-name-fdic),
NTDB VSAM,vsam-dbid
```

`vsam-dbid` must have the same value in all four entries.

It is recommended to use different files and different file numbers for `FNAT` and `FUSER`. The `FDIC` file *must* be a file different from `FNAT` and `FUSER`. Therefore, the `FDIC` parameter must not be omitted.

The DD names are the logical names of the system files; each DD name can be up to seven characters long. The DD name for the `FDIC` path is created by appending an `X` to the DD name of the `FDIC` file.

If you have Natural Advanced Facilities installed and want your spool file to be a VSAM file, modify the FSPOOL parameter accordingly:

```
FSPOOL=(vsam-dbid,fnr-fspool,dd-name-fspool)
```

If you have Natural Security installed and want your security file to be a VSAM file, modify the FSEC parameter accordingly:

```
FSEC=(vsam-dbid,fnr-fsec,dd-name-fsec)
```

The FSEC file must be a file different from FNAT.

Step 11: Link Natural Batch Nucleus - Job VSAMI060, Step 0020

For information on the components and structure of the Natural interface to VSAM, see also *Components of Natural for VSAM* and *Structure of the Natural Interface to VSAM*.

With the INCLUDE instruction for the parameter module, specify the name of the Natural parameter module created in Step 8.

Add the following INCLUDE instructions to the link of the Natural batch nucleus:

```
INCLUDE NVSLIB(NVSNUC)
INCLUDE NVSLIB(NVSFNAT)
INCLUDE NVSLIB(NVSFSPO)
INCLUDE NVSLIB(NVSFSEC)
INCLUDE SMALIB(NVSFLOCK)
INCLUDE SMALIB(NVSPARM)
INCLUDE SMALIB(NVSMISC)
```

The module NVSFSPO is only required if you have Natural Advanced Facilities installed and want your spool file to be a VSAM file, too.

The module NVSFSEC is only required if you have Natural Security installed and want your security file to be a VSAM file, too.

The module NVSFLOCK is only required if you want locking for source objects on VSAM system files FUSER/FNAT.

If your front-end is *not* linked to your Natural nucleus, NVSPARM and NVSMISC must be linked to NATPARM instead.

Add the corresponding DD statements to the link step for Natural and link-edit the executable module.

Link the executable batch Natural nucleus.

Step 12: Load System Programs - Job VSAMI061, Step 0100

Use the Natural system command INPL (see the *Natural System Command Reference* documentation) to load the Natural system programs (dataset `NAT`*`nnn`*`.INPL`) into the Natural system files.

Ensure that the DD names specified in `NATPARM` are specified in the `INPL` job, too. In addition, an alternate index DD name (*`dd-name-fdic`*`X`) must be specified for `FDIC`.

Note: If you want to install any other Software AG products that require `INPL` steps, ensure that these `INPL` steps are adapted according to the VSAMI061 job.

Step 13: Load Error Messages - Job VSAMI061, Steps 0102

Load the Natural error messages file (dataset `NAT`*`nnn`*`.ERRN`) using the program `ERRLODUS` as described in the Natural *SYSERR Utility* documentation.

Ensure that the DD names specified in `NATPARM` are specified in the `ERRLODUS` job, too.

Step 14: Load Examples - Job VSAMI061, Steps 0103 and 1400

Use the system command `INPL` to load the Natural example programs (dataset `NAT`*`nnn`*`.EXPL`) and the Natural for VSAM example programs (dataset `NVS`*`nnn`*`.EXPL`) into the Natural system file.

Ensure that the DD names specified in `NATPARM` are specified in the `INPL` job, too. In addition, a path DD name (*`dd-name-fdic`*`X`) must be specified for `FDIC`.

Step 15: Reorganize FNAT System File

Reorganize the `FNAT` system file using the VSAM facility AMS REPRO to unload and reload the file.

Step 16: Create NVS I/O Module for CICS - Job NVSI070, Step 1400

This step must only be performed if you wish to install Natural for VSAM under CICS.

If Natural for VSAM is to be installed under CICS, assemble and link the module `NVSCICS`.

Step 17: Install Online Natural

Proceed with the specific installation steps for Natural required under your TP monitor (see the relevant sections in the Natural *Installation* documentation), taking into account the following additions:

- Modify your Natural online parameter modules according to Step 8.
- Add the following INCLUDE instructions to all links of the online Natural nucleus:

```
INCLUDE NVSLIB(NVSNUC)
INCLUDE NVSLIB(NVSFNAT)
INCLUDE NVSLIB(NVSFSPO)
INCLUDE NVSLIB(NVSFSEC)
INCLUDE NVSLIB(NVSFLOCK)
```

  The module `NVSFSPO` is only required if you have Natural Advanced Facilities installed and want your spool file to be a VSAM file, too. The online environment for Natural Advanced Facilities must be a CICS environment, and the VSAM spool files must be defined in the CICS FCT. The module `NVSFSEC` is only required if you have Natural Security installed and want your security file to be a VSAM file, too. The VSAM security files must be defined in the CICS FCT. The module `NVSFLOCK` is only required if you want locking for source objects on VSAM system files `FUSER`/`FNAT`. The VSAM locking files must be defined in the CICS FCT.

- Add the following `INCLUDE` instructions to the link of the front-end in a CICS environment:

```
INCLUDE SMALIB(NVSPARM)
INCLUDE SMALIB(NVSCICS)
```

- Add the following `INCLUDE` instructions to the link of the front-end in any other supported environment:

```
INCLUDE SMALIB(NVSPARM)
INCLUDE SMALIB(NVSMISC)
```

Before starting Natural, ensure that the DD and DSN names of the VSAM system files are known in your respective batch and online environments.

Step 18: Customize your TP Monitor

TP Monitor	Instruction
Com-plete	Catalog the VSAM system files FNAT, FUSER, FDIC and FDICX to Com-plete using the CA function of the Com-plete utility UFILE. If Natural Security is installed, catalog the VSAM security files FSEC, FSECA, FSECB and FSECC to Com-plete using the CA function of the Com-plete utility UFILE. If locking of source objects for VSAM system files FUSER/FNAT is desired, catalog the VSAM locking files FLOCK, FLOCKA, FLOCKB and FLOCKC to Com-plete using the CA function of the Com-plete utility UFILE. If you have specified PATH=CHECK in NVSPARM, catalog your front program to **Com-plete** using the CA function of the Com-plete utility ULIB with a region size of 36 KB, if you have not changed the first default value for the WPSIZE parameter in the Natural parameter module.
CICS	Add the following entries to your FCT: ■ the Natural for VSAM system files FNAT, FUSER, FDIC and FDICX; ■ the Natural for VSAM test files EMPLVS and EMPLVX; ■ the Natural Security files FSEC, FSECA, FSECB and FSECC (if you have Natural Security installed). ■ the locking files FLOCK, FLOCKA, FLOCKB and FLOCKC (if you want locking of source objects for VSAM system files FUSER/FNAT). Refer to the job VSAMI005 for examples. You can add DD statements for these datasets to your CICS startup job, too.

TSO	Add the following statements to your Natural CLIST:
	
	`ALLOC F(FNAT) DA('SAGLIB.VSAM.FNAT') SHR`
	`ALLOC F(FUSER) DA('SAGLIB.VSAM.FUSER') SHR`
	`ALLOC F(FDIC) DA('SAGLIB.VSAM.FDIC') SHR`
	`ALLOC F(FDICX) DA('SAGLIB.VSAM.FDIC.PATH') SHR`
	`ALLOC F(FSEC) DA('SAGLIB.VSAM.FSEC') SHR`
	`ALLOC F(FSECA) DA('SAGLIB.VSAM.FSEC.AIXA') SHR`
	`ALLOC F(FSECB) DA('SAGLIB.VSAM.FSEC.AIXB') SHR`
	`ALLOC F(FSECC) DA('SAGLIB.VSAM.FSEC.AIXC') SHR`
	`ALLOC F(FLOCK) DA('SAGLIB.VSAM.FLOCK') SHR`
	`ALLOC F(FLOCKA) DA('SAGLIB.VSAM.FLOCK.PATHA') SHR`
	`ALLOC F(FLOCKB) DA('SAGLIB.VSAM.FLOCK.PATHB') SHR`
	`ALLOC F(FLOCKC) DA('SAGLIB.VSAM.FLOCK.PATHC') SHR`
	`ALLOC F(EMPLVS) DA('SAGLIB.VSAM.EMPLVS') SHR`
	`ALLOC F(EMPLVX) DA('SAGLIB.VSAM.EMPLVX.PATH') SHR`

Installing Natural on VSAM System Files - z/VSE

This section describes step by step how to install Natural under the operating system z/VSE using VSAM system files. The information given is basically a combination of the installation descriptions for both base Natural and Natural for VSAM (product code: NVS), plus some points specific to VSAM system files.

Installation Tape

To install Natural with VSAM system files, you need the datasets for both base Natural and Natural for VSAM. The required datasets are listed in the table below:

Dataset Name	Contents
NAT*nnn*.LIBR	Natural source modules, macros, relocatable modules and sample installation jobs.
NAT*nnn*.INPL	Natural system programs.
NAT*nnn*.EXPL	Natural example programs.
NAT*nnn*.ERRN	Natural error messages.
NVS*nnn*.LIBR	Natural for VSAM source modules, macros and relocatable modules.
NVS*nnn*.EMPL	Natural for VSAM example file.
NVS*nnn*.EXPL	Natural for VSAM example programs.
NVS*nnn*.LINI	Natural for VSAM Locking Source Objects.
NVS*nnn*.VINI	Natural for VSAM FDIC initialization file.

The notation *nnn* in dataset names represents the version number of the product. The sequence of the datasets, their type and the space each dataset requires on disk are shown in the *Report of Tape Creation* which accompanies the installation tape.

Copying the Tape Contents to Disk

The sample JCS supplied on tape for the installation of Natural assumes one library, which has installation sublibraries per Software AG product library. In addition to these sublibraries, you need a work sublibrary and a sublibrary for sample installation jobs for Natural. It is recommended that you create this library and the work sublibrary now.

Then copy the sublibrary containing the sample installation jobs from tape using the following JCS:

```
* $$ JOB JNM=NATJOBS,CLASS=0,DISP=D,LDEST=*,SYSID=1
* $$ LST CLASS=A,DISP=D
// JOB NATJOBS
// ASSGN SYS005,IGN
// ASSGN SYS006,cuu,VOL=NVSnnn
// MTC REW,SYS006
// MTC FSF,SYS006,nn
*  Tape positioned at file ?, tape mark nn
*  *** Now process NVSnnn.LIBR - JOBS ***
// EXEC LIBR,PARM='MSHP'
 RESTORE SUBLIB=SAGLIB.NVSnnnJ:SAGLIB.NVSnnnJ -
                TAPE=SYS006 -
                LIST=YES -
                REPLACE=NO
/*
// MTC REW,SYS006
/*
/&
* $$ EOJ
```

The notation *cuu* represents the physical unit address of the tape drive.

The notation *nn* represents the file sequence number given by "(3 * *file-no*) - 2", as shown on the *Report of Tape Creation*. Leave out the `// MTC FSF ...` instructions if your library is the first dataset on the tape.

The notation *nnn* represents the version number of the product.

Now use jobs `NATTAPE` and `NVSTAPE` from this job library to restore the Natural sublibrary from tape and make Natural known to MSHP.

All further datasets will be directly used from tape by the installation jobs.

Installation Procedure

Under z/VSE, the installation procedure for Natural with VSAM system files consists of the following steps:

- Step 1: Prepare NVS Demo File - Job NVSI008, Steps 1403 to 1407
- Step 2: Prepare VSAM Clusters for System Files - Job VSAMI008, Steps 1420 to 1446
- Step 3: Prepare VSAM Cluster for Spool File - Job VSAMI008, Steps 0300 to 0309
- Step 4: Prepare VSAM Cluster for Security File - VSAMI008, Steps 9900 to 9907
- Step 5: Prepare VSAM Cluster for Scratch-Pad File (Dataset NVSnnn.VINI)
- Step 6: Prepare VSAM Cluster for Source locking File FLOCK - Job VSAMI008, Step 1460 and 1461
- Step 7: Assemble Natural z/VSE Interface Module - Job NATI055, Step 0100
- Step 8: Create NVS Parameter Module - Job NVSI055, Step 1400

Step 1: Prepare NVS Demo File - Job NVSI008, Steps 1403 to 1407

Load the VSAM demo file `EMPL` and define the alternate index path `EMPLX` for the file `EMPL`.

Step 2: Prepare VSAM Clusters for System Files - Job VSAMI008, Steps 1420 to 1446

Define three VSAM clusters to be used as system files for Natural (`FNAT`, `FUSER` and `FDIC`) and a path for `FDIC`.

It is strongly recommended that you keep these three system files on separate VSAM clusters.

Step 3: Prepare VSAM Cluster for Spool File - Job VSAMI008, Steps 0300 to 0309

This step must only be performed if you have Natural Advanced Facilities installed and want your spool file to be a VSAM file, too.

Define an additional VSAM cluster to be used as spool file (`FSPOOL`) and five alternate indices.

Note: Path processing is *not* supported for `FSPOOL`.

Step 4: Prepare VSAM Cluster for Security File - VSAMI008, Steps 9900 to 9907

This step must only be performed if you have Natural Security installed and want your security file to be a VSAM file, too.

Define an additional VSAM cluster to be used as security file (`FSEC`) and three alternate indices.

Note: Path processing is *not* supported for `FSEC`.

Step 5: Prepare VSAM Cluster for Scratch-Pad File (Dataset NVSnnn.VINI)

- Allocate VSAM SCRATCH PAD File - Job VSAMI008, Step 1450
- Initialization VSAM SCRATCH PAD File - Job VSAMI008, Step 1451

This step must only be performed if you want to use a scratch-pad file; that is, if you want to use read-only system files (`ROSY=ON`); see also the parameter `ROSY` and the macro `NTFILE` in the section *Profile Parameters* in the Natural *Parameter Reference* documentation.

Define an additional VSAM cluster to be used as scratch-pad file.

For the optional scratch-pad file inclusion, the following `NATPARM` parameters must be added or, if already present, updated with:

```
NTFILE ID=212,DBID=dbid,FNR=nt-file-number,PASSWD=dd-name-scratch-pad-file
ROSY=ON
```

If you want your system file(s) to be opened for input, adapt your Natural parameter module as follows:

```
FNAT=(dbid,fnr,filename,,RO),
FUSER=(dbid,fnr, filename,,RO),
FSEC=(dbid,fnr,filename,, RO),
```

Step 6: Prepare VSAM Cluster for Source locking File FLOCK - Job VSAMI008, Step 1460 and 1461

This step must only be performed if you want to use a locking of source objects on VSAM system file (`SLOCK=PRE`); see also the parameter `SLOCK`and the macro `NTFILE` (described in the Natural *Parameter Reference* documentation).

Define an additional VSAM cluster to be used as source locking file.

- Allocate and Define VSAM Source Locking File - Job VSAMI008, Step 1460
- Printing Data Records VSAM Source Locking File - Job VSAMI008, Step 1461

For the optional source locking file inclusion, the following `NATPARM` parameters must be added or, if already present, updated with:

```
NTLFILE 002,dbid,nt-file-number,dd-name-source-locking-file,,PATH
SLOCK=PRE
```

The default dd-name is FLOCK, the related default pathes are FLOCKA, FLOCKB and FLOCKC.

Step 7: Assemble Natural z/VSE Interface Module - Job NATI055, Step 0100

Set the parameters in the source of the module NATVSE to suit your requirements. The NATVSE generation parameters are described in the section *Running Natural in Batch under z/VSE* (*Natural in Batch Mode*) in the Natural *Operations* documentation.

Assemble and link the Natural z/VSE interface module NATVSE contained in dataset NAT*nnn*.LIBR.

Step 8: Create NVS Parameter Module - Job NVSI055, Step 1400

Edit, assemble and link the Natural for VSAM parameter module NVSPARM. For a description of the parameters which can be specified, see the section ***Assembling the NVSPARM Parameter Module***.

For a quick installation, use the Natural for VSAM LSR feature and specify the following NVMLSR definitions in NVSPARM (see also ***NVMLSR Macro*** in the section *Natural for VSAM Parameters*):

```
NVMLSR DDNAME=fnat-dd-name,SHRPOOL=1
NVMLSR DDNAME=fuser-dd-name,SHRPOOL=2
NVMLSR DDNAME=fdic-dd-name,SHRPOOL=3
NVMLSR DDNAME=fdicx-dd-name,SHRPOOL=3
```

If you want to use FSEC system files:

```
NVMLSR DDNAME=fsec-dd-name,SHRPOOL=4
NVMLSR DDNAME=fseca-dd-name,SHRPOOL=4
NVMLSR DDNAME=fsecb-dd-name,SHRPOOL=4
NVMLSR DDNAME=fsecc-dd-name,SHRPOOL=4
```

Step 9: Create NVS I/O Module - Job NVSI055, Step 1410

Assemble and link the Natural for VSAM I/O module NVSMISC with the LSR options:

```
DEFER=YES
COMMIT=NO
READINT=NO
```

See the description of the parameters which can be specified in NVSMISC (see the section *Natural for VSAM Parameters*).

Step 10: Create Natural Batch Parameter Module - Job VSAMI060, Steps 0010, 0015

Create the Natural batch parameter module.

To be able to install Natural with VSAM system files, in addition to the `VSIZE` and `NTDB` specification, modify the parameters `FNAT`, `FUSER` and `FDIC` as follows:

```
VSIZE=126,
FNAT=(vsam-dbid,fnr-fnat,dlbl-name-fnat),
FUSER=(vsam-dbid,fnr-fuser,dlbl-name-fuser),
FDIC=(vsam-dbid,fnr-fdic,dlbl-name-fdic),
NTDB VSAM,vsam-dbid
```

`vsam-dbid` must have the same value in all four entries.

It is recommended to use different files and different file numbers for `FNAT` and `FUSER`. The `FDIC` file *must* be a file different from `FNAT` and `FUSER`. Therefore, the `FDIC` parameter must not be omitted.

The DD names are the logical names of the system files; each DD name can be up to seven characters long. The DLBL name for `FDIC` is created by appending an `X` to the DLBL name for the `FDIC` file.

If you have Natural Advanced Facilities installed and want your spool file to be a VSAM file, modify the `FSPOOL` parameter accordingly:

```
FSPOOL=(vsam-dbid,fnr-fspool,dd-name-fspool)
```

Assemble and link the parameter module.

If you have Natural Security installed and want your security file to be a VSAM file, modify the `FSEC` parameter accordingly:

```
FSEC=(vsam-dbid,fnr-fsec,dd-name-fsec)
```

The FSEC file must be a file different from FNAT.

Step 11: Link Natural Batch Nucleus - Job VSAMI060, Step 0020

For information on the components and structure of the Natural interface to VSAM, see also ***Components of Natural for VSAM*** and ***Structure of the Natural Interface to VSAM***.

With the `INCLUDE` instruction for the parameter module, specify the name of the Natural parameter module created in Step 8.

Add the following INCLUDE instructions to the link of the Natural batch nucleus:

```
INCLUDE NVSNUC
INCLUDE NVSFNAT
INCLUDE NVSFSPO
INCLUDE NVSFSEC
INCLUDE NVSFLOCK
INCLUDE NVSPARM
INCLUDE NVSMISCD
```

The module NVSFSPO is only required if you have Natural Advanced Facilities installed and want your spool file to be a VSAM file, too.

The module NVSFSEC is only required if you have Natural Security installed and want your security file to be a VSAM file, too.

The module NVSFLOCK is only required if you want locking for source objects on VSAM system files FUSER/FNAT.

If your front-end is *not* linked to your Natural nucleus, NVSPARM and NVSMISCD must be linked to NATPARM instead.

Add the corresponding sublibrary for Natural for VSAM to the search chain for the linkage editor and link-edit the executable module.

Link the executable batch Natural nucleus.

Step 12: Load System Programs - Job VSAMI061, Step 0100

Use the Natural system command INPL to load the Natural system programs (dataset NAT*nnn*.INPL) into the Natural system files.

Ensure that the DLBL names specified in NATPARM (Step 8) are specified in the INPL job, too. In addition, a path DLBL name (*dlbl-name-fdic*X) must be specified for FDIC.

Note: If you want to install any other Software AG products that require INPL steps, ensure that these INPL steps are adapted according to the VSAMI061 job.

Step 13: Load Error Messages - Job VSAMI061, Steps 0102

Load the Natural error messages file (dataset `NAT`*`nnn`*`.ERRN`) using the `ERRLODUS` utility (which is described in the Natural *SYSERR Utility* documentation).

Ensure that the DLBL names specified in `NATPARM` (Step 8) are specified in the `ERRLODUS` job, too.

Step 14: Load Examples - Job VSAMI061, Step 0103

Use the system command `INPL` to load the Natural example programs (dataset `NAT`*`nnn`*`.EXPL`) and the Natural for VSAM example programs (dataset `NVS`*`nnn`*`.EXPL`) into the Natural system file.

Ensure that the DLBL names specified in `NATPARM` (Step 8) are specified in the `INPL` job, too. In addition, a path DLBL name (*`dlbl-name-fdic`*`X`) must be specified for `FDIC`.

Step 15: Reorganize the FNAT System File

Reorganize the FNAT system file using the VSAM facility AMS REPRO to unload and reload the file.

Step 16: Create NVS I/O Module for CICS - Job NVSI070, Step 1400

This step must only be performed if you wish to install Natural for VSAM under CICS.

If Natural for VSAM is to be installed under CICS, assemble and link the module `NVSCICS`.

Step 17: Install Online Natural

Proceed with the specific installation steps for Natural required under your TP monitor (see the relevant sections in the *Natural Installation* documentation), taking into account the following additions:

- Modify your Natural online parameter modules according to Step 8.
- Add the following `INCLUDE` instructions to all links of the online Natural nucleus:

```
INCLUDE NVSNUC
INCLUDE NVSFNAT
INCLUDE NVSFSPO
INCLUDE NVSFSEC
INCLUDE NVSFLOCK
```

  The module `NVSFSPO` is only required if you have Natural Advanced Facilities installed and want your spool file to be a VSAM file, too. The online environment for Natural Advanced Facilities must be a CICS environment, and the VSAM spool files must be defined in the CICS FCT. The module `NVSFSEC` is only required if you have Natural Security installed and want your security file to be a VSAM file, too. The VSAM security files must be defined in the CICS FCT.

The module NVSFLOCK is only required if you want locking for source objects on VSAM system files FUSER/FNAT. The VSAM locking files must be defined in the CICS FCT.

- Add the following INCLUDE instructions to the link of the front-end in a CICS environment:

```
INCLUDE NVSPARM
INCLUDE NVSCICS
```

- Add the following INCLUDE instructions to the link of the front-end in a Com-plete environment:

```
INCLUDE NVSPARM
INCLUDE NVSMISCD
```

- Add the corresponding sublibrary for Natural for VSAM to the search chain for the linkage editor and link-edit the executable module. Before starting Natural, ensure that the DLBL names of the VSAM system files are known in your batch and online environments.

Step 18: Customize your TP Monitor

TP Monitor	Instruction

Com-plete	Add the following DLBL statements to your Com-plete startup job:
	
	`// DLBL FNAT, 'DSN=SAGLIB.VSAM.FNAT',,VSAM,CAT=xxxx`
	`// DLBL FUSER, 'DSN=SAGLIB.VSAM.FUSER',,VSAM,CAT=xxxx`
	`// DLBL FDIC, 'DSN=SAGLIB.VSAM.FDIC',,VSAM,CAT=xxxx`
	`// DLBL FDICX, 'DSN=SAGLIB.VSAM.FDIC.PATH',,VSAM,CAT=xxxx`
	`// DLBL EMPLVS, 'DSN=SAGLIB.VSAM.EMPLVS',,VSAM,CAT=xxxx`
	`// DLBL EMPLVX, 'DSN=SAGLIB.VSAM.EMPLVX.PATH',,VSAM,CAT=xxxx`
	
	If Natural Security is installed, add the following DLBL statements to your Com-plete startup job:
	
	`// DLBL FSEC, 'DSN=SAGLIB.VSAM.FSEC',,VSAM,CAT=xxxx`
	`// DLBL FSECA, 'DSN=SAGLIB.VSAM.FSEC.AIXA',,VSAM,CAT=xxxx`
	`// DLBL FSECB, 'DSN=SAGLIB.VSAM.FSEC.AIXB',,VSAM,CAT=xxxx`
	`// DLBL FSECC, 'DSN=SAGLIB.VSAM.FSEC.AIXC',,VSAM,CAT=xxxx`

TP Monitor	Instruction

	If you want locking of source objects for VSAM system files FUSER/FNAT, add the following DLBL statements to your Com-plete startup job:
	
	// DLBL FLOCK, 'DSN=SAGLIB.VSAM.FLOCK',,VSAM,CAT=xxxx
	// DLBL FLOCKA, 'DSN=SAGLIB.VSAM.FLOCK.PATHA',,VSAM,CAT=xxxx
	// DLBL FLOCKB, 'DSN=SAGLIB.VSAM.FLOCK.PATHB',,VSAM,CAT=xxxx
	// DLBL FLOCKC, 'DSN=SAGLIB.VSAM.FLOCK.PATHC',,VSAM,CAT=xxxx
	
	If you have specified PATH=CHECK in NVSPARM, catalog your front program to **Com-plete** using the CA function of the Com-plete utility ULIB with a region size of 36 KB, if you have not changed the first default value for the WPSIZE parameter in the Natural parameter module.

CICS	Add the following entries to your FCT: ■ the Natural for VSAM system files FNAT, FUSER, FDIC and FDICX; ■ the Natural for VSAM test files EMPLVS and EMPLVX; ■ the Natural Security files FSEC, FSECA, FSECB and FSECC (if you have Natural Security installed). ■ the locking files FLOCK, FLOCKA, FLOCKB and FLOCKC (if you want locking of source objects for VSAM system files FUSER/FNAT). Refer to the job VSAMI005 for examples. You can add DLBL statements for these datasets to your CICS startup job, too.

Installation Verification with VSAM System Files

Under z/OS and z/VSE

To verify whether the installation has been successfully performed, log on to the library SYSEXNVS and run the following programs:

- NVSINST1
- NVSINST2
- NVSINST3
- NVSINST4
- NVSINST5
- NVSINST6

If all these programs can be executed successfully, the installation of Natural on VSAM system files is completed and verified.

Note for z/OS batch mode:

For verification in batch mode under z/OS, you can run the job VSAMI200 which executes the above programs.

Restrictions

The Natural VSAM system files `FSEC` and `FSPOOL` cannot be used for record-level sharing (RLS), as the related AIX files cannot be accessed using a path definition. The reason is that null values are not suppressed during VSAM upgrade handling for AIX keys. The record length of AIX files related to `FSEC` and `FSPOOL` would be exceeded for AIX keys filled with blanks or binary zeros. This would cause problems under CICS, as the record length supported is limited to 32 KB only. Natural for VSAM supports null-value suppression for AIX keys and the upgrade handling for AIX files.

51 Natural for DL/I

This documentation provides information on Natural in a DL/I environment. It describes the installation and operation of Natural for DL/I, as well as special considerations on Natural statements when used with DL/I.

This documentation covers:

General Information	Brief information on features.
Accessing DL/I Data	How to enable access to DL/I databases using Natural statements.
Natural Parameter Modifications for DL/I	Parameters contained in `NDLPARM`, storage estimates, and Natural for DL/I in z/OS environments.
Installing Natural for DL/I	How to install Natural for DL/I.
Operation	Describes the procedures `NATPSB`, `NATDBD`, `NATUDF`, and the generation of DDMs from DL/I segment types.
System File Structure	Describes the database structure, the segment data and the processing intent of an application.
Natural Batch Utilities	Describes the system file transfer of NDBs, NSBs and UDFs from one `FDIC` and the use of the batch utility `NDUDFGEN` to generate Natural data areas.
Execution	Describes PSB scheduling, the `CALLNAT` interface, support of IMS TM-specific features, fast path and GSAM, and CICS mode processing under IMS TM.
Programming Language Considerations	Natural versus third generation languages, Natural statements with DL/I, Natural system variables with DL/I.
Problem Determination Guide	Actions required to correct a given problem.
Performance Considerations	How to increase the performance of Natural in a DL/I environment.

DL/I Services	Terminology and maintenance of NDBs and NSBs.

Related Documentation

See also *Accessing Data in a Database* for various aspects of accessing data in a database with Natural.

For a list of DL/I status codes and abend codes (under CICS only), refer to *Status Codes and Abend Codes* (in the Natural *Messages and Codes* documentation).

52 General Information

With Natural for DL/I, a Natural user can access and update data stored in a DL/I database. The Natural user can be executing in batch mode or under the control of the TP monitor CICS or IMS TM.

A DL/I database is represented to Natural as a set of files, each file representing one database segment type. Each file or segment type must have an associated DDM generated and stored on the Natural system file `FDIC`.

Since Natural for DL/I is an extension to Natural, nearly all of the information contained in the Natural documentation applies to its use in the DL/I environment as well as in the Adabas environment.

The Natural statements used to access DL/I databases are a subset of those provided with the Natural language. No new statements are needed to access a DL/I database.

Applications developed using Natural for DL/I operate as standard DL/I applications. This means that all access to DL/I databases performed by Natural follows the DL/I product conventions. For an online Natural session or batch Natural program to issue a DL/I database call, a PSB must first be scheduled. The PCB in use must have segment sensitivity and the appropriate `PROCOPT` parameter must be specified for Natural, to be able to perform a segment update. Only standard DL/I database calls are issued by Natural.

53 Accessing DL/I Data

Natural for DL/I allows Natural programs to access DL/I databases using Natural statements.

To access DL/I data, Natural requires certain information on these data. This information mainly consists of four types of control blocks:

- the original database descriptions (DBDs) and program specification blocks (PSBs) which are required by DL/I itself;
- suitable copies of DL/I DBDs and PSBs for Natural, called NDBs and NSBs;
- user-defined fields (UDFs);
- Natural DDMs generated from NDBs and UDFs.

All information required by Natural to access DL/I databases is stored and maintained in the Natural system file `FDIC`. The Natural system file `FDIC` can be an Adabas file (if Adabas is installed), or a VSAM file (only in CICS environments).

As is the case with any DL/I application, a DL/I DBDGEN and PSBGEN must be performed to define the data structure the Natural application is to have access to, and the processing intent this application has on these data. This same information, which is contained in the DBD and PSB source statements, must also be defined to Natural.

The Natural batch procedures `NATDBD` and `NATPSB` are used to add this information to the Natural `FDIC` system file. They generate NDBs and NSBs from the respective DBDs and PSBs, using the DBDGEN and PSBGEN source respectively, as input.

It is the administrator's responsibility to ensure that the contents of the DL/I DBDLIB and PSBLIB and the Natural system file `FDIC` are compatible. It is therefore recommended that the DL/I procedures DBDGEN and PSBGEN and the Natural procedures `NATDBD` and `NATPSB` always be executed as a pair.

The DBDGEN source usually does not define all fields within a segment. Additional segment fields, called user-defined fields (UDFs), can be entered as part of creating the DDMs. UDFs in

Natural are added by using either the batch utility `NATUDF`, the ***Edit an NDB Segment Description*** facility of the `SYSDDM` utility, or Predict.

Once all the necessary information has been stored on the Natural system file `FDIC`, Natural DDMs defining the DL/I database segment types can be created.

54 Natural Parameter Modifications for DL/I

Natural parameter default values for DL/I can be changed to meet your particular requirements. The object module NDLPARM, which is used for Natural static parameter assignment in a DL/I environment, must then be appropriately modified and reassembled.

This section covers the following topics:

Parameters in NDLPARM

The following parameters are contained in NDLPARM:

- DFBNUM - Maximum Entries in Translated Format Buffer
- DFFNUM - Maximum Fields in Single Entry of Translated Format Buffer
- FLBNUM - Number of Entries in Fast Locate Buffer
- INGSIZE - Initial Size of Buffer to Copy Parameter List
- INGOSIZ - Initial Size of I/O Area for DL/I Calls
- INITCAL - Issues INIT Call at Transaction Start
- PCBLEV - Maximum Number of PCB Levels
- PCBNUM - Maximum Number of PCBs in a PSB
- RELEVNT - Requests Relocation Event
- RESINDB - NDB Resident in Buffer Pool
- RESINSB - NSB Resident in Buffer Pool
- RESIUDF - UDF Resident in Buffer Pool
- SASIZE - Size of Natural Save Area for DL/I
- SEQNUM - Maximum Number of Nested Sequential Accesses
- SEQSSA - Maximum Size of an SSA
- THCSIZE - Table Size to Save Natural Field Values
- TRACE - Trace Options
- TYPCHCK - Numeric/Packed Data Check
- TYPWARN - Issues Data Check Warning
- WORKLGH - Size of Work Areas

DFBNUM - Maximum Entries in Translated Format Buffer

Possible Values	Default Value
5 - 200	25

This parameter is used to indicate the maximum number of entries in the table of translated format buffers.

An entry in this table is created for each active Natural input/output statement (FIND, READ, UPDATE, STORE).

When increasing DFBNUM or DFFNUM, take into consideration that the allocated storage area size is obtained by multiplying these values and *not* by adding them.

DFFNUM - Maximum Fields in Single Entry of Translated Format Buffer

Possible Values	Default Value
5 - 1000	10

This parameter is used to indicate the average number of fields contained in each single entry of the table of translated format buffers.

A field entry in this table is created for each field referenced in a Natural input/output statement (FIND, READ, UPDATE, STORE).

When increasing DFFNUM or DFBNUM, take into consideration that the allocated storage area size is obtained by multiplying these values and *not* by adding them.

FLBNUM - Number of Entries in Fast Locate Buffer

Possible Values	Default Value
0 - 32767	50

This parameter is used to indicate the number of entries in the Fast Locate Buffer. This buffer holds absolute addresses of Natural for DL/I objects (that is, NDBs, NSBs, UDFs) in the buffer pool.

The addresses are stored in wrap-around technique.

This buffer is especially useful if Natural for DL/I objects have been marked as “resident” in the buffer pool (see the related parameters RESINDB, RESINSB, RESIUDF).

It allows Natural for DL/I to use the Fast Locate algorithm of the Natural buffer pool manager when locating objects.

INGSIZE - Initial Size of Buffer to Copy Parameter List

Possible Values	Default Value
1000 - 32767 (bytes)	1000

This parameter is used to indicate the initial size of the buffer which is used to copy the DL/I call parameter list and the call parameters below 16 MB if Natural operates in a z/OS environment. If the initial size is not sufficient, Natural automatically increases the size of this buffer accordingly.

INGOSIZ - Initial Size of I/O Area for DL/I Calls

Possible Values	Default Value
1000 - 32767 (bytes)	1000

This parameter is used to indicate the initial size of the I/O area for DL/I calls. This area is re-used for subsequent DL/I calls if no GET HOLD call has been issued.

If the initial size is not sufficient, Natural automatically increases the size of this buffer accordingly.

INITCAL - Issues INIT Call at Transaction Start

Possible Values	Default Value
NO/YES	NO

This parameter is used to inform IMS TM that Natural is prepared to accept status codes BA or BB regarding data unavailability.

The setting of this parameter only applies if Natural runs in a BMP or MPP region.

PCBLEV - Maximum Number of PCB Levels

Possible Values	Default Value
1 - 15	10

This parameter is used to indicate the maximum number of PCB levels which can be processed by Natural.

When increasing PCBLEV, take into consideration that the allocated storage area size is obtained by multiplying these values and *not* by adding them.

PCBNUM - Maximum Number of PCBs in a PSB

Possible Values	Default Value
1 - 255	25

This parameter is used to indicate the maximum number of PCBs which can be contained within a single PSB.

When increasing PCBNUM, take into consideration that the allocated storage area size is obtained by multiplying these values and *not* by adding them.

RELEVNT - Requests Relocation Event

Possible Values	Default Value
NO/YES	NO

This parameter is used to inform the Natural nucleus whether or not Natural for DL/I requests relocation events.

With RELEVNT=YES, Natural for DL/I is called for relocation on every relocation event, that is, even if no DL/I call has been issued since the last relocation event.

With RELEVNT=NO, Natural for DL/I is not called for relocation. Instead, it checks itself whether relocation is required before a DL/I call is issued.

RESINDB - NDB Resident in Buffer Pool

Possible Values	Default Value
NO/YES	YES

This parameter is used to indicate whether NDBs are to be kept resident in the buffer pool.

RESINSB - NSB Resident in Buffer Pool

Possible Values	Default Value
NO/YES	YES

This parameter is used to indicate whether NSBs are to be kept resident in the buffer pool.

RESIUDF - UDF Resident in Buffer Pool

Possible Values	Default Value
NO/YES	YES

This parameter is used to indicate whether UDFs are to be kept resident in the buffer pool.

SASIZE - Size of Natural Save Area for DL/I

Possible Values	Default Value
1000 - 3000 (bytes)	1000

This parameter is used to indicate the size of the save area.

Do not increase the default value, unless you receive an error message which indicates that a save area overflow has occurred.

SEQNUM - Maximum Number of Nested Sequential Accesses

Possible Values	Default Value
5 - 100	20

This parameter is used to indicate the maximum number of nested sequential accesses which can be processed by Natural.

When increasing the values for the SEQNUM and SEQSSA parameters, remember that the storage area allocated is dependent on the product of these areas, *not* their sum.

SEQSSA - Maximum Size of an SSA

Possible Values	Default Value
10 - 500 (bytes)	50

This parameter is used to indicate the maximum size of an SSA related to sequential access.

When increasing the values for the SEQNUM and SEQSSA parameters, remember that the storage area allocated is dependent on the product of these areas, *not* their sum.

THCSIZE - Table Size to Save Natural Field Values

Possible Values	Default Value
2000 - 32000 (bytes)	3000

This parameter only applies under IMS TM or under CICS in pseudo-conversational mode.

This parameter is used to indicate the size of the table which is used to save field values in hold status when running under IMS TM or under CICS in pseudo-conversational mode.

TRACE - Trace Options

Possible Values	Explanation
ALL	Trace all modules
CMD	Trace command execution
REQ	Trace request modules
ROU	Trace routines
SER	Trace service modules
OFF	Trace is not active. Default value.

This parameter is used to indicate whether Natural trace information is to be created and printed or not.

The options CMD, REQ, SER and ROU can be combined.

TYPCHCK - Numeric/Packed Data Check

Possible Values	Default Value
NO/YES	NO

This parameter is used to indicate whether numeric or packed segment fields from DL/I are to be checked for valid data and repaired, if necessary.

With TYPCHCK=NO, no data check is performed. Natural for DL/I would abend with data exception if, for example, a packed field contained blanks.

With TYPCHCK=YES, a data check is performed. If the field does not contain format compatible data, it is filled with zeroes. In addition, a message is issued, depending on the setting of the parameter TYPWARN (see below).

TYPWARN - Issues Data Check Warning

Possible Values	Default Value
NO/YES	NO

This parameter only applies if TYPCHCK has been specified (see above).

This parameter is used to indicate whether a message is to be issued if a data check and repair has been performed.

With TYPWARN=NO, no message is issued if a data repair has been performed.

With TYPWARN=YES, a message is issued if a data repair has been performed. This message displays the short name of the field in error. The message is issued as a warning (only), which means that:

- The message is not issued via the Natural error exit but is directly inserted into the page buffer.
- The message(s) is (are) only issued when the page buffer is full.
- There is no backout transaction.
- The program flow is not interrupted.

WORKLGH - Size of Work Areas

Possible Values	Default Value
1000 - 3000	1000

This parameter is used to indicate the size of the work areas. Natural allocates six work areas of this size.

Do not increase the default value, unless you receive an error message which indicates that a work area overflow has occurred.

Storage Estimates

The memory size required by Natural for DL/I is determined by the following items:

1. Object code: 90 KB.
2. Save areas: 3 KB.
3. Work areas: 6 KB.
4. Fast Locate Buffer: 12 bytes for each entry.
5. XRST buffer: 2 KB.
6. Internal tables: the amount of storage allocated depends on parameters specified in the module NDLPARM. The following formula can be used to compute the amount of storage required for initial table allocation:

   Amount of Storage =

```
SEQNUM * (SEQSSA + 64) + 32 +
DFBNUM * (28 + (DFFNUM * 12)) + 20 +
PCBNUM * (24 + 12 + (PCBLEVL * 5)) + 20 +
TCHSIZE
```

The above formula can be described as follows:

Term	Computational Expression
Sequential Access Table	SEQNUM * (SEQSSA + 64) + 32
Field Table	DFBNUM * (28 + (DFFNUM * 12)) + 20
PCB Map	PCBNUM * (24 + 12 + (PCBLEVL * 5)) + 20
Table of Fields in Hold	TCHSIZE

If the standard values of these `NDLPARM` parameters are used in the above formula, 14 KB of storage is allocated.

7. Segment I/O areas are to be added on additionally.

Note: The object code is shared among all Natural sessions. There is a copy of all other areas for each active Natural session.

The storage required for save areas, work areas, Fast Locate Buffer, XRST buffer and internal tables is allocated from the thread at the initialization of the Natural session. Six GETMAINs are performed, the sizes of which are determined by the values of the parameters in the `NDLPARM` module. If the default values of the `NDLPARM` parameters are used, the total size required is 27 KB.

The total size available is determined by the profile parameter `DLISIZE` in the Natural parameter module (`NATPARM`); see the Natural *Parameter Reference* documentation.

The `BUS` (Buffer Usage Statistics) command can be used to obtain information on the sizes of the buffers allocated by Natural for DL/I. The following information is provided:

Buffer	Content
`DLISIZE0`	contains the Fast Locate Buffer, the XRST buffer, and the save areas.
`DLISIZE1`	contains the work areas.
`DLISIZE2`	contains the sequential access table.
`DLISIZE3`	contains the field table .
`DLISIZE4`	contains the PCB map .
`DLISIZE5`	contains the table of fields in hold status.

Natural for DL/I in z/OS Environments

Before Natural issues a DL/I call in a z/OS environment, it checks whether the call parameter list or any of the call parameters reside above the 16 MB line. This is the case if the Natural threads have been placed above this line. If so, the parameter list and all parameters are copied into a buffer which has been allocated below the line via GETMAIN. The pointers in the parameter list are modified accordingly to point to the new parameters.

The initial size of this buffer is set by the `INGSIZE` parameter of `NDLPARM`. If the initial size is not sufficient, Natural automatically increases the size of this buffer accordingly.

This overhead is required because DL/I terminates programs abnormally if parameter addresses passed in DL/I calls do not refer to code or storage areas below the 16 MB line.

55 Installing Natural for DL/I

This section describes step by step how to install Natural for DL/I.

Notation vrs or vr: If used in the following document, the notation *vrs* or *vr* stands for the relevant version, release, system maintenance level numbers. For further information on product versions, see *Version* in the *Glossary*.

Prerequisites

Products and versions are specified under *Natural and Other Software AG Products* in and *Operating/Teleprocessing Systems Required* in the current Natural *Release Notes*.

Installation Tape - z/OS Systems

The installation tape contains the datasets listed in the table below. The sequence of the datasets is shown in the *Report of Tape Creation* which accompanies the installation tape.

Dataset Name	Contents
NDL*vrs*.LOAD	Natural executable modules necessary for the linkage editor.
NDL*vrs*.SRCE	Macros and sources for the parameter module NDLPARM and for the batch procedures NATDBD/NATPSB.
NDL*vrs*.JOBS	Example installation jobs.

The notation *vrs* in dataset names represents the version number of the product.

Copying the Tape Contents to a z/OS Disk

If you are using SMA, refer to the *System Maintenance Aid* documentation (included in the current edition of the Natural documentation CD).

If you are *not* using SMA, follow the instructions below.

This section explains how to:

- Copy dataset COPY.JOB from tape to disk.
- Modify this dataset to conform to your local naming conventions.

The JCL in this dataset is then used to copy all datasets from tape to disk.

If the datasets for more than one product are delivered on the tape, the dataset `COPY.JOB` contains the JCL to unload the datasets for all delivered products from the tape to your disk.

After that, you will have to perform the individual install procedure for each component.

- Step 1 - Copy Dataset COPY.JOB from Tape to Disk
- Step 2 - Modify COPY.JOB on Your Disk
- Step 3 - Submit COPY.JOB

Step 1 - Copy Dataset COPY.JOB from Tape to Disk

The dataset `COPY.JOB` (Label 2) contains the JCL to unload all other existing datasets from tape to disk. To unload `COPY.JOB`, use the following sample JCL:

```
//SAGTAPE JOB SAG,CLASS=1,MSGCLASS=X
//* ---------------------------------
//COPY EXEC PGM=IEBGENER
//SYSUT1 DD DSN=COPY.JOB,
// DISP=(OLD,PASS),
// UNIT=(CASS,,DEFER),
// VOL=(,RETAIN,SER=tape-volume),
// LABEL=(2,SL)
//SYSUT2 DD DSN=hilev.COPY.JOB,
// DISP=(NEW,CATLG,DELETE),
// UNIT=3390,VOL=SER=volume,
// SPACE=(TRK,(1,1),RLSE),
// DCB=*.SYSUT1
//SYSPRINT DD SYSOUT=*
//SYSIN DD DUMMY
//
```

where:

`hilev` is a valid high level qualifier
`tape-volume` is the tape volume name, for example: T12345
`volume` is the disk volume name

Step 2 - Modify COPY.JOB on Your Disk

Modify the `COPY.JOB` on your disk to conform to your local naming conventions and set the disk space parameters before submitting this job:

- Set `HILEV` to a valid high level qualifier.
- Set `LOCATION` to a storage location.
- Set `EXPDT` to a valid expiration date.

Step 3 - Submit COPY.JOB

Submit `COPY.JOB` to unload all other datasets from the tape to your disk.

Installation Tape - z/VSE Systems

The installation tape contains the datasets listed in the table below. The sequence of the datasets is shown in the *Report of Tape Creation* which accompanies the installation tape.

Dataset Name	Contents
`NDL`*`vrs`*`.LIBR`	`LIBR` backup file

The notation *`vrs`* in dataset names represents the version number of the product.

Copying the Tape Contents to a z/VSE Disk

If you are using SMA, refer to the *System Maintenance Aid* documentation (included in the current edition of the Natural documentation CD).

If you are *not* using SMA, follow the instructions below.

This section explains how to:

- Copy dataset `COPYTAPE.JOB` from tape to disk.
- Modify this dataset to confom with your local naming conventions.

The JCL in this member is then used to copy all datasets from tape to disk.

If the datasets for more than one product are delivered on the tape, the member `COPYTAPE.JOB` contains the JCL to unload the datasets for all delivered products from the tape to your disk, except the datasets that you can directly install from tape, for example, Natural `INPL` objects.

After that, you will have to perform the individual install procedure for each component.

- Step 1 - Copy Dataset COPYTAPE.JOB from Tape to Disk
- Step 2 - Modify COPYTAPE.JOB
- Step 3 - Submit COPYTAPE.JOB

Step 1 - Copy Dataset COPYTAPE.JOB from Tape to Disk

The dataset `COPYTAPE.JOB` contains the JCL to unload all other existing datasets from tape to disk. To unload `COPYTAPE.JOB`, use the following sample JCL:

```
* $$ JOB JNM=LIBRCAT,CLASS=0,                                          +
* $$ DISP=D,LDEST=(*,UID),SYSID=1
* $$ LST CLASS=A,DISP=D
// JOB LIBRCAT
* ****************************************
*     CATALOG COPYTAPE.JOB TO LIBRARY
* ****************************************
// ASSGN SYS004,nnn                                <------  tape address
// MTC REW,SYS004
// MTC FSF,SYS004,4
ASSGN SYSIPT,SYS004
// TLBL IJSYSIN,'COPYTAPE.JOB'
// EXEC LIBR,PARM='MSHP; ACC S=lib.sublib'         <------- for catalog
/*
// MTC REW,SYS004

ASSGN SYSIPT,FEC
/*
/&
* $$ EOJ
```

where:

nnn is the tape address
lib.sublib is the library and sublibrary of the catalog

Step 2 - Modify COPYTAPE.JOB

Modify `COPYTAPE.JOB` to conform to your local naming conventions and set the disk space parameters before submitting this job.

Step 3 - Submit COPYTAPE.JOB

Submit `COPYTAPE.JOB` to unload all other datasets from the tape to your disk.

Installation Procedure

The Natural for DL/I installation procedure consists of the following steps:

Step 1: Create the NDL Parameter Module - Job I055, Step 1500

Modify the Natural for DL/I parameter module `NDLPARM` as described in the section ***Natural Parameter Modifications for DL/I***.

Assemble and link/catalog NDLPARM.

Step 2: Modify the Natural Parameter Modules - Jobs I060 and I080

Modify the appropriate I060 and I080 jobs according to the TP monitor or batch modules you are relinking; for example, NATI060 for batch and NCII080 for CICS. This applies also to Step 3 below.

Add the parameter `DLISIZE` and specify `DLISIZE=27`. This value applies if the default values of the `NDLPARM` parameters are used.

Add an `NTDB` macro specifying the database identification list (DBID list) that relates to DL/I segment types. The numbers specified in this DBID list must be in the range from 1 to 254. They indicate which DBIDs are reserved for DL/I segment types. Up to 254 entries can be specified. All Natural DDMs that refer to a DL/I segment type are cataloged with a DBID from this list. The number with the lowest value in this list is the default DBID for DL/I segment types.

Examples:

```
NTDB DLI,(250,253,252)
NTDB DLI,250
```

Note: Values for DL/I database IDs above 255 are not possible.

Step 3: Link the Natural Nucleus - Job I060 and I080

Under z/OS: Add the following `INCLUDE` instructions and the corresponding DD statements to the link step for Natural and link-edit the executable module:

CICS	IMS TM	Batch Mode
`INCLUDE NDLLIB(NDLNUC)`	`INCLUDE NDLLIB(NDLNUC)`	`INCLUDE NDLLIB(NDLNUC)`
`INCLUDE NDLLIB(NDLSIOCX)`	`INCLUDE NDLLIB(NDLSIOBA)`	`INCLUDE NDLLIB(NDLSIOBA)`
`INCLUDE SMALIB(NDLPARM)`	`INCLUDE SMALIB(NDLPARM)`	`INCLUDE SMALIB(NDLPARM)`
`INCLUDE TPSLIB(ASMTDLI)`	`INCLUDE DLILIB(ASMTDLI)`	`INCLUDE DLILIB(ASMTDLI)`

Under z/VSE: Add the following `INCLUDE` instructions and the corresponding sublibraries for Natural for DL/I to the search chain for the linkage editor and link-edit the executable module:

CICS	Batch Mode
`INCLUDE NDLNUC`	`INCLUDE NDLNUC`
`INCLUDE NDLSIOCX`	`INCLUDE NDLSIOBA`
`INCLUDE NDLPARM`	`INCLUDE NDLPARM`
`INCLUDE ASMTDLI`	`INCLUDE ASMTDLI`

Under CICS, the link-edit of the load module that contains Natural for DL/I can be done in any of the following ways:

- Include all Natural for DL/I modules (that is, `NDLNUC`, `NDLPARM` and `NDLSIOCX`) and the DL/I module `ASMTDLI` in the link-edit of Natural.
- Include all Natural for DL/I modules (that is, `NDLNUC`, `NDLPARM` and `NDLSIOCX`) and the DL/I module `ASMTDLI` in the link-edit of the Natural TP driver. This way of link-editing only applies if the Natural TP driver runs separately from the Natural nucleus.
- Link-edit all Natural for DL/I modules (that is, `NDLNUC`, `NDLPARM` and `NDLSIOCX`), the DL/I module `ASMTDLI` and an alternate Natural parameter module as a separate module with the mandatory *`entry`* name `CMPRMTB`. The *`name`* of the resulting module is optional. This way of link-editing only applies if an alternate parameter module (`PARM=`) is used. If so, under CICS, an additional CICS PPT entry with `PROGRAM=`*`name`* is required.
- Link-edit all Natural for DL/I modules (that is, `NDLNUC`, `NDLPARM` and `NDLSIOCX`) and the DL/I module `ASMTDLI` as a separate module with the mandatory *`entry`* name `NATGWDLI`. The *`name`* of the resulting module is optional. If it is different from `NATGWDLI`, however, it must be specified as an alias name in an `NTALIAS` macro entry of the Natural parameter module. This way of link-editing only applies if the Natural Resolve CSTATIC Addresses feature (RCA) is used. If so, under CICS, an additional CICS PPT entry with `PROGRAM=`*`name`* is required.

- Include all environment-independent Natural for DL/I modules (that is, NDLNUC and NDLPARM) in the link-edit of Natural Include the environment-dependent Natural for DL/I I/O module (NDLSIOCX) in the link-edit of the Natural TP driver. This way of link-editing only applies if a shared nucleus is created.

Step 4: Establish a Natural Environment for DL/I

To verify the installation of Natural for DL/I with a sample database rather than with existing databases, you perform the following steps:

1. Allocate VSAM spaces for the sample database (Job I008, Steps 1500 to 1502).
2. Create the DBDs, PSBs and ACB, and perform the initial load (Job I053, Steps 1500 to 1560). Creation of an ACB only applies to z/VSE.
3. Execute procedures NATPSB and NATDBD for the sample database (Job I075, Steps 1500 and 1510).

   To enable Natural to access DL/I databases, additional data must be added to the FDIC system file. To do so, the procedures NATPSB and NATDBD must be executed for each PSB/DBD to be used.

   If you are not using System Maintenance Aid (SMA) the following applies: When executing modules NDPBNDB0 or NDPBNSB0 in an LE370 enabled batch Natural to store an NDB or NSB into the FDIC system file, the following Natural error message may be issued:

   ```
   SYSDLI 3970 Error when loading NDB/NSB
   ```

   The step ends with Condition Code 8 in this case.

   To prevent this error, the NDB or NSB load module must be link-edited with AMODE(31). The binder step will then end with Return Code 4 due to the following warning message:

   ```
   IEW2651W 511C ESD AMODE 24 CONFLICTS WITH USER-SPECIFIED AMODE 31
   ```

   This return code must be ignored in the following step by means of a COND=(8,LE) keyword.

Installation Verification

To verify the installation of Natural for DL/I

1 Invoke online Natural.

2 Invoke the Natural utility SYSDDM by entering the following system command: SYSDDM

3 On the SYSDDM menu, enter function code D to invoke the DL/I Services function.

4 On the resulting screen, enter function code D to invoke the **NDB Maintenance** function.

5 On the resulting screen, enter function code `S` to select the NDB which was created in substep 3 of Step 4.

6 On the resulting screen, enter function code `L` to list the NDB segments.

7 On the resulting screen, enter function code `A` to assign DBID and FNR to the segments.

8 On the same screen, enter function code `G` to generate a DDM from the segment description.

9 Catalog the generated DDM.

10 Only if running under CICS: Enter `NATPSB ON psbname` in the Command line.

11 Edit and run the following program:

```
DEFINE DATA LOCAL
01 COURSE VIEW OF DPQA03-COURSE
  02 COURSEN
  02 TITLE
  02 DESCRIPN

                                        /* End of DPQA03-COURSE View
END-DEFINE
READ (100) COURSE BY COURSEN
  DISPLAY COURSEN TITLE DESCRIPN
END
```

56 Operation

Natural for DL/I operates as a standard DL/I application.

Prior to running a Natural application, a PSB must be scheduled. The method for scheduling PSBs varies depending on the actual environment (see the relevant sections under ***PSB Scheduling***), but as for any other DL/I application, PSB scheduling is a requirement.

This section covers the following topics:

Procedure NATPSB

Every PSB required by DL/I to accommodate Natural requests must be processed by the Natural batch utility `NDPBNSB0`. This utility stores DL/I PSB information, in a form suitable for Natural, on the `FDIC` system file. This information is referred to as NSB control block. A batch procedure called `NATPSB` has been established for this purpose.

A sample `NATPSB` job has been included in the source library from the installation tape. The information used to create NSB control blocks comes from the actual PSBGEN source. It is essential that the same input is used for the `NATPSB` procedure as was used for the DL/I PSBGEN. Otherwise, unpredictable results are likely.

The `NATPSB` job is a three step procedure:

- The first step executes the normal DL/I PSBGEN procedure. This step is included to guarantee compatibility between DL/I and Natural.
- The second step performs another assembly and link of the PSBGEN source, this time using macros supplied by Natural.
- The final step executes the Natural batch utility `NDPBNSB0`, which uses the linked PSB module from the previous step to create NSB control blocks which are stored on the `FDIC` system file. `NDPBNSB0` dynamically loads the Natural module `NDLB0002`, which therefore must be present in an allocated load library.

Natural requires one or more PSBs for batch and/or online processing. Depending on application requirements, the PSB can be switched during a Natural session. Each PSB describes all user views that can be used to access DL/I databases from Natural programs if this PSB is active. A PSB must contain one or more program communication blocks (PCBs) for each DBD to be accessed. Since Natural only uses the single positioning option on PCBs, Natural programs that maintain two or more independent positions in a database require a PCB (of the appropriate type) for each separate position.

If this requirement is not fulfilled, Natural for DL/I issues the runtime error message:

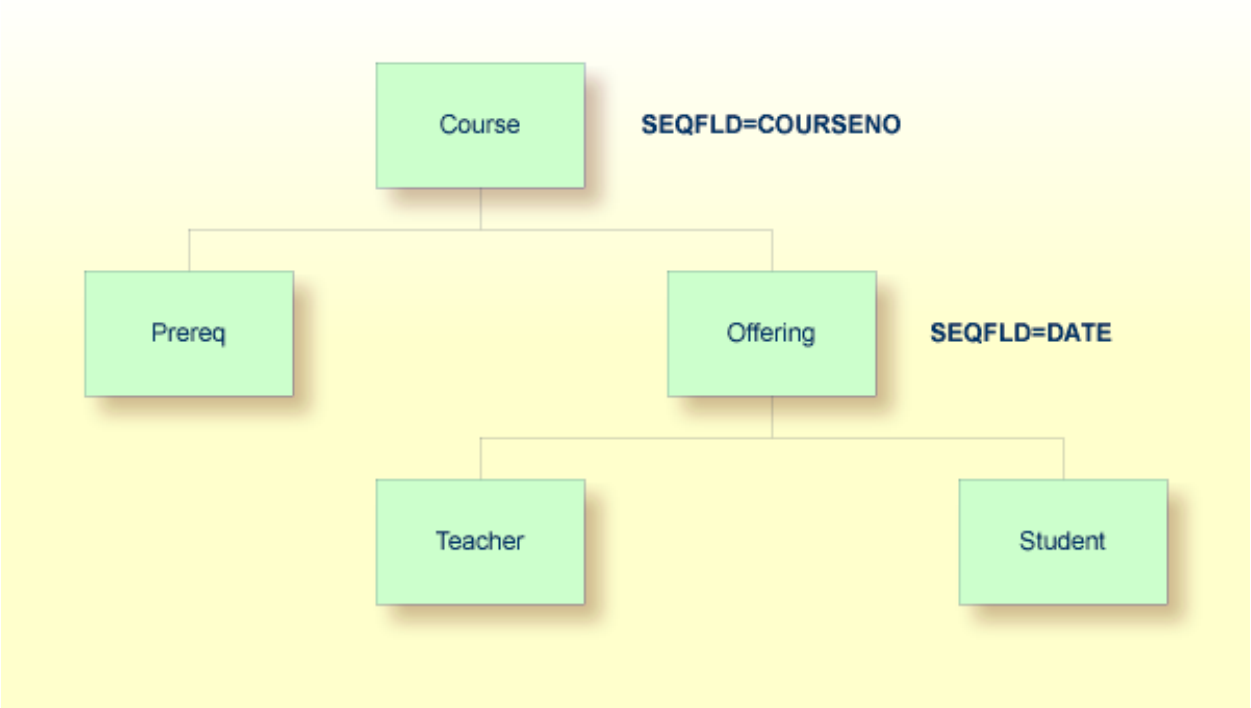
```
NAT3789 Active PSB contains too few PCBs for program execution
```

The PCB in use must have segment sensitivity and the appropriate `PROCOPT` parameter specified for Natural, to be able to perform a segment update.

Nested I/O loops (`FIND` or `READ`) in Natural programs frequently require separate positions in the same database to be maintained. To reduce the number of PCBs needed, as many I/O loops as possible should be closed before opening subsequent I/O loops.

Consider the following sample DL/I database:

Sample Education Database ED00DBD:



The following Natural program based on the above database requires two PCBs:

```
READ ED00DBD-COURSE BY COURSENO
   FIND ED00DBD-PREREQ WITH COURSENO-COURSE = COURSENO
     FIND ED00DBD-OFFERING WITH COURSENO-COURSE = COURSENO
     LOOP
   LOOP
LOOP
END
```

The first PCB is used to maintain position on the `COURSE` and `PREREQ` segments. A second PCB is required for the `OFFERING` segment since the `FIND` loop has not been terminated for the `PREREQ` segment prior to invoking a `FIND` on the `OFFERING` segment. By closing the first `FIND` loop prior to opening the second one, this program would only require one PCB.

Natural selects the PCB to be used for a database request in the following manner:

1. Natural selects the first PCB in the PSB with the correct DBD name and the appropriate `PROCSEQ` parameter (if applicable).
2. Natural then determines if the PCB can be used for the request or if there is a conflict due to current database positioning.
3. If there was a positioning conflict or the PCB did not contain the correct DBD name or `PROCSEQ` parameter, Natural would continue scanning the PSB.

4. If the database search request refers to a secondary index, Natural attempts to use a PCB with the corresponding PROCSEQ parameter. If there is no PCB of this type in the PSB, Natural tries to use a PCB without the PROCSEQ parameter. In this case, it is assumed that the INDICES parameter has been coded in the appropriate SENSEQ statement.
5. If no eligible PCB could be found, an error message would be generated.

In general, PCBs for use by Natural can have different PROCOPT parameters. However, if there are two or more PCBs in the PSB referring to the same DBD, these PCBs must appear consecutively in the PSB source and they must specify the same SENSEG statements and same PROCOPT parameters. They can, however, have different PROCSEQ parameters.

When locating an eligible PCB, Natural disregards the PROCOPT parameter of the PCB. The first free PCB is selected independently of the PROCOPT parameter, so that if the chosen PCB has a PROCOPT that does not support the request, an error message that corresponds to a DL/I status code is returned.

Natural assumes that all PCBs with the same DBD name and the same PROCSEQ parameter contain the same SENSEG statements as the first PCB. If this is not true and a PCB is selected that does not contain a SENSEG statement for the segment being referenced, an error message that corresponds to a DL/I status code is returned.

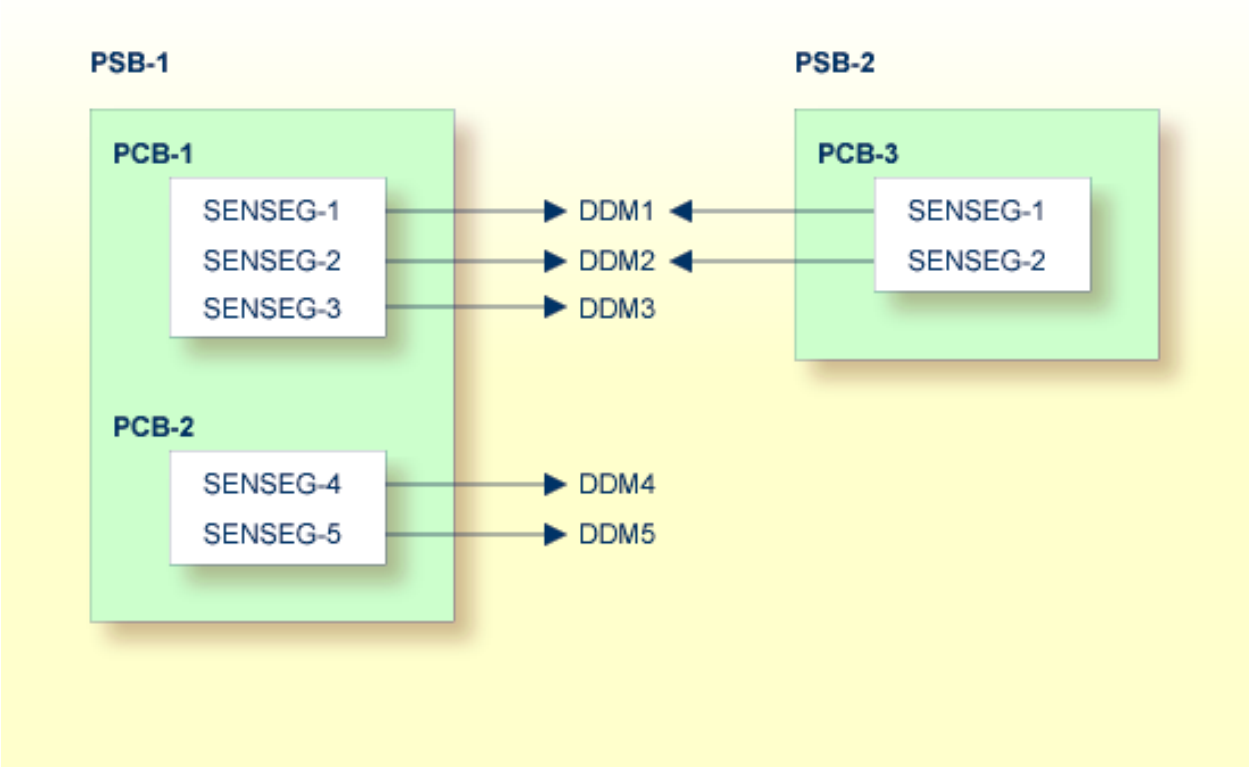
The following example PSB and Natural program demonstrate that the sequence of the PCBs, referring to the same DBD, may affect Natural programs if the PROCOPT parameters are different:

```
PCB    TYPE=DB,DBDNAME=EDOODBD,PROCOPT=GO,...
SENSEG NAME=COURSE
SENSEG NAME=OFFERING,PARENT=COURSE
PCB    TYPE=DB,DBDNAME=EDOODBD,PROCOPT=A,...
SENSEG NAME=COURSE
```

The following program requires two PCBs: the first PCB is used for the READ loop (which reads all COURSE segments) and the second nested FIND loop (which finds one offering to a given course); the second PCB is used for the first FIND loop (which updates a specific COURSE segment). The program does not work if the order of the two PCBs is reversed.

```
READ COURSE BY COURSENO
   FIND (1) COURSE WITH COURSENO = '120'
      UPDATE WITH TITLE = 'Natural'
   LOOP
   FIND (1) OFFERING WITH COURSENO-COURSE = COURSENO (0010)
      DISPLAY COURSENO-COURSE
   LOOP
LOOP
END
```

The following figure shows the logical connections between DL/I PSBs, PCBs, sensitive segment types and Natural DDMs:



Natural DDMs which are derived from segment descriptions in the DBD correspond to DL/I segment types.

Since each DL/I application program requires the specification of its sensitive segment types, an appropriate PSB must be scheduled before Natural program execution. A PSB can be scheduled at the start of a Natural session or at any time during the session.

If, in the configuration shown in the diagram above, PSB-2 has been scheduled, only the DDMs DDM1 and DDM2 are accessible to Natural application programs. If an attempt is made to use DDM5, for example, Natural for DL/I returns the error message:

```
NAT3768 PCB with requested DBD not found in NSB
```

Procedure NATDBD

Every DL/I database structure, both physical and logical, which is supposed to be used by Natural, must be processed by the Natural batch utility NDPBNDB0.

This utility stores DL/I database information on the FDIC system file, in a form suitable for Natural. This information is referred to as *NDB control block*. A batch procedure called NATDBD has been established for this purpose.

A sample NATDBD job has been included in the source library from the installation tape. The information used to create NDB control blocks comes from the actual DBDGEN source. It is essential that the same input is used for the NATDBD procedure as was used for the DL/I DBDGEN. Otherwise, unpredictable results are likely.

The NATDBD job is a three step procedure:

- The first step executes the normal DL/I DBDGEN procedure. This step is included to guarantee compatibility between DL/I and Natural.
- The second step performs another assembly and link of the DBDGEN source, this time using macros supplied by Natural.
- The final step executes the Natural batch utility NDPBNDB0, which uses the linked DBD module from the previous step to create NDB control blocks which are stored on the FDIC system file. NDPBNDB0 dynamically loads the Natural module NDLB0001, which therefore must be present in an allocated load library.

The NATDBD procedure assigns a short name of two bytes to each DL/I field; that is, to each field defined in the DBD. All field short names are generated in the range from NA to Z9, which means that up to 13 * (26 + 10) = 468 DL/I fields can be managed per DBD. DL/I short names are generated uniquely within an NDB.

When replacing an NDB, NATDBD reassigns short names in a consistent way; that is, the same short name to the same field name. In addition, the UDFs are maintained, where the new NDB contains the new DL/I layout followed by the old UDF layout, which means that UDFs are not deleted by NATDBD. It is the administrator's responsibility to edit the segment description after NATDBD has been executed, in order to modify the UDFs accordingly.

Using Logical Databases with Natural

The following information must be considered when using logical databases with Natural:

- Execute the `NATDBD` procedure for a logical database only after successful execution of the procedure for the physical databases referred to. In other words, if the input DBD is a "logical" DBD, the NDBs generated from the "physical" DBDs must already be stored in the Natural `FDIC` system file to correctly generate the NDB control blocks related to this segment.
- When a segment specifying the `SOURCE=`*`keyword`* is processed by the `NATDBD` procedure, the related "physical" DBD must already be stored in the Natural `FDIC` system file.

  If the `SOURCE=`*`keyword`* is specified (in one or more segments) in a "physical" DBD, which means that one or more logical virtual child segments are involved (recursively or not), the NATDBD procedure run against this DBD stores the NDB structure on the Natural FDIC system file even if one or more physical DBDs referred to by the `SOURCE=`*`keyword`* specifications have not already been stored.

  In this case, the logical virtual child segments whose source DBD is not yet in the Natural FDIC system file as well as their descendants are not accessible to the user since Natural has marked these segments as inhibited. An appropriate Natural error message is issued indicating the name(s) of the related physical DBD(s) that need to be stored into the Natural system file.

  If the logical relationship is the result of a recursive database structure, the `NATDBD` procedure for the physical DBD must be run at least twice: the first time, the NDB is stored on the Natural system file with the undefined segment marked as inhibited; the second time, the reference to the `SOURCE` segment is resolved.

  If multiple physical databases are logically related, the `NATDBD` procedure must be run for each of these physical databases and then rerun for any database that contained logical child segments marked as inhibited.
- If the `SOURCE=`*`keyword`* is specified in a "logical" DBD and one or more source DBDs are not found in the Natural `FDIC` system file while running the `NATDBD` procedure, the NDB structure is not stored and an appropriate error message is returned.
- If an attempt is made to generate a DDM for a segment whose NDB control blocks are not in the Natural `FDIC` system file, a Natural error message is returned.

Using Index Databases with Natural

The following information must be considered when using index databases with Natural:

- To access a secondary index database as data, the secondary index database must be defined as an independent physical database to both DL/I and Natural.
- The NATDBD procedure need not be executed for primary or secondary index DBDs.

Procedure NATUDF

The DBDGEN source usually does not define all fields within a segment. Additional segment fields called User-Defined Fields (UDFs) can be entered as part of creating the DDMs. UDFs define the additional data in the segment that can be referenced by a Natural program. UDFs can be generated online using Predict or the Natural *SYSDDM Utility*, or they can be generated in batch mode using the `NATUDF` procedure.

The `NATUDF` procedure invokes the batch utility `NDPBCUDF`, which stores segment description layout information on an `FDIC` system file.

Important: Before `NDPBCUDF` can be executed, the DL/I DBD must have been stored as an NDB on the `FDIC` system file, and a DBID and FNR must have been assigned (with Predict or `SYSDDM`) to each segment concerned. Otherwise, `NDPBCUDF` cannot read the segments concerned.

The input for this utility is provided by the segment description read from a work file. This work file contains segment identification statements and segment field descriptions.

You can format data by using either delimiter mode (`IM=D`) or forms mode (`IM=F`); see also the `IM` profile parameter in the Natural *Parameter Reference* documentation. In delimiter mode, the delimiter character can be used. In forms mode (for example, if input is passed from other programs), input data fields are assumed to be in contiguous storage and must be filled up to the internally defined full length.

One line is required for the segment identification statement, and two lines are required for each segment field description.

The section below covers the following topics:

- Segment Identification Statement

- Segment Field Description

Segment Identification Statement

One line has to be supplied for each segment being defined. The following syntax is used (the parameters must be specified in the sequence shown below):

```
FUNC=(function),DBD=dbd-name,SEGM=segment-name
```

function	Function to be applied to the segment: ADD to create a new segment layout; REP to replace an existing segment layout; MOD to add or modify fields without deleting existing fields not present in the input file; END to indicate termination of the UDF redefinition.
dbd-name	A 1 to 8 character alphanumeric DBD name; that is, the name of the DL/I DBD which owns the segment to be defined.
segment-name	A 1 to 8 character alphanumeric name of the DL/I segment to be defined.

Segment Field Description

The segment identification statement has to be followed by at least one segment field description. The following syntax is used for each field to be defined (the parameters must be specified in the sequence shown below):

```
FUNC=FLD,NAME=fnam,TYPE=type,LEVEL=lev,LENGTH=lgh,MAXOCC=moc,VAR=var
FUNC=STR,BEGIN=begin
```

After each FLD card, a STR card must be coded, except for the last FLD card, which is specified with four dollar signs ($$$$) in the field name. After this last FLD card, an END card must be coded.

fnam	The name of the field being defined. This must be an alphanumeric value of 1 to 19 bytes. The value $$$$ closes the definition of the current segment.
type	The UDF field format (1 character). The following formats can be specified: A, B, F, P, U, N, S.
lev	The field level (1 digit).
lgh	The field length (4 digits).
moc	The maximum occurrence (3 digits) of the field (only applicable for a multiple-value field or a periodic group).
var	Possible values:

	`V` variable field length `N` fixed field length
`begin`	The starting position of the field being redefined. This can be specified either in terms of bytes relative to the beginning of the segment or as a field name of the DL/I field being redefined. The value must be alphanumeric and 1 to 19 characters long (32 bytes in forms mode, as the field is 32 characters long in this mode).

The short name is automatically assigned by the utility in the range from `AA` to `G9`, excluding `EA` to `E9`. The range from `HA` to `M9` is reserved for UDFs of logical child segments. Thus, up to 216 fields can be provided as input, which is the maximum number of UDF fields.

For further information on UDF field parameters, please refer to ***DL/I Services***.

Delimiter Mode (IM=D) Example:

```
FUNC=REP,DBD=EDO2DBD,SEGM=COURSE
FUNC=FLD,NAME=GENG1,TYPE=N,LEVEL=1,LENGTH=5
FUNC=STR,BEGIN=11
FUNC=FLD,NAME=DUM1,TYPE=A,LEVEL=1,LENGTH=6
FUNC=STR,BEGIN=TITLE
FUNC=FLD,NAME=DUM2,TYPE=A,LEVEL=1,LENGTH=6
FUNC=STR,BEGIN=DESCRIPN
FUNC=FLD,NAME=GENG3,LEVEL=1,MAXOCC=2
FUNC=STR,BEGIN=GENG1
FUNC=FLD,NAME=GRU21,TYPE=N,LEVEL=2,LENGTH=1
FUNC=STR
FUNC=FLD,NAME=GRU22,TYPE=A,LEVEL=2,LENGTH=2
FUNC=STR
FUNC=FLD,NAME=GRU23,TYPE=N,LEVEL=2,LENGTH=3
FUNC=STR
FUNC=FLD,NAME=$$$$
FUNC=REP,DBD=EDO2DBD,SEGM=COURSE
FUNC=FLD,NAME=DUM41,TYPE=B,LEVEL=1,LENGTH=9
FUNC=STR,BEGIN=DESCRIPN
FUNC=FLD,NAME=DUN2,LEVEL=1,MAXOCC=2
FUNC=STR,BEGIN=TITLE
FUNC=FLD,NAME=GRU21,TYPE=N,LEVEL=2,LENGTH=1
FUNC=STR
FUNC=FLD,NAME=GRU22,TYPE=A,LEVEL=2,LENGTH=2
FUNC=STR
FUNC=FLD,NAME=GRU23,TYPE=N,LEVEL=2,LENGTH=3
FUNC=STR
FUNC=FLD,NAME=$$$$
FUNC=END
```

Forms Mode (IM=F) Example:

```
ADDDBD1    SEGM1
FLD                1FIELD-1                    000A0012N000
STR
FLD                1FIELD-ANY                  000A    N000
STRFIELD-1
FLD                2FIELD-ANY2                 000A0024N000
STR
FLD                 $$$$
STR
REPDBD2    SEGM2
FLD                1NEW-FIELD-NAME             000A0012N000
STR
FLD                 $$$$
END
```

Sample JCL:

```
//NATUDF   JOB  ......
//NATUDF   EXEC PGM=NATBATCH,PARM='...'
//STEPLIB  DD  DSN=...
//         DD  DSN=...
//SYSUDUMP DD  DUMMY
//CMPRINT  DD  SYSOUT=Y
//DDCARD   DD  DSN=NAT23n.SRCE(ADAPARM),DISP=SHR
//CMSYNIN  DD *
LOGON SYSDDM
NDPBCUDF
FUNC=REP,DBD=ED02DBD,SEGM=COURSE
FUNC=FLD,NAME=DUM1,TYPE=A,LEVEL=1,LENGTH=6
FUNC=STR,BEGIN=TITLE
FUNC=FLD,NAME=DUM2,TYPE=A,LEVEL=1,LENGTH=6
FUNC=STR,BEGIN=DESCRIPN
FUNC=FLD,NAME=$$$$
FUNC=END
FIN
```

Generation of DDMs from DL/I Segment Types

DDMs that represent DL/I segment types are generated from information contained in the NDB and UDF control blocks. These DDMs contain all fields that have been defined for the segment, both in the NDB and in the UDF.

In addition, the DDMs contain the fields from the ancestor segments that have been defined in the DBDGEN for these segments. Ancestor segments are defined as segments that form the hierarchical path from the root segment down to the current segment. Ancestor segment fields that

might have been defined in the DBDGEN for a segment include sequence fields, secondary index fields and search fields.

The DDM for a DL/I segment contains all fields that could be specified in the segment search argument (SSA), all fields that are available as part of the key feedback area and any segment I/O fields as well. Each DDM, therefore, contains all the fields that Natural requires to automatically build the concatenated key for the segment.

Once all fields have been defined for a specific segment DDM, the corresponding Natural DDM can be generated and cataloged (stored) on the Natural `FDIC` system file. This is done either with Predict or with the Natural *SYSDDM Utility*.

If you do not have Predict installed, use the `SYSDDM` function **DL/I Services** to generate Natural DDMs from DL/I segment types. This function is invoked from the main menu of `SYSDDM`.

57 System File Structure

As described in section *Accessing DL/I Data*, certain information must be stored and maintained on the Natural FDIC system file in order to access DL/I data. This information describes the database structure, the segment data and the processing intent of an application. Four elements on the Natural FDIC system file contain this information. One of these elements, the Natural DDM, is common to all DBMS environments. The remaining three elements, however, are used only by Natural for DL/I; they are NDB control blocks, NSB control blocks and UDF control blocks. Therefore, the Natural FDIC system file used by Natural for DL/I contains three subfiles.

This section covers the following topics:

The NDB Subfile

The NDB subfile contains the NDBs. The NDB, or Natural DBD, control blocks contain most of the information present in the DL/I DBD, combined with additional data used by Natural, such as the file number (FNR) and database identification (DBID) of the segment, and short names for fields defined in the DBD. The NDB control blocks are created and stored on the Natural FDIC system file by the NATDBD procedure.

An NDB consists of the following fields:

Field	Description
ND	DBD name (8 characters) combined with sequence number (1 byte, “binary”).
NC	The first two bytes contain the number of NZ fields in the record times 20. The second two bytes contain the total number of NZ fields in the NDB multiplied by 20.
NZ	NDB data.

The NSB Subfile

The NSB subfile contains the NSBs. The NSB, or Natural PSB, control blocks contain most of the information present in the DL/I PSB. These control blocks are created and stored on the Natural FDIC system file by the NATPSB procedure.

An NSB consists of the following fields:

Field	Description
NP	PSB name (8 characters) combined with sequence number (1 byte, “binary”).
NC	The first two bytes contain the number of NZ fields in the record times 20. The second two bytes contain the total number of NZ fields in the NSB multiplied by 20.
NZ	NSB data.

The UDF Subfile

The UDF subfile contains the UDFs. The UDF, or User-Defined Field, control blocks contain information on segment fields which have been specified by the user, either through the online **DL/I Services** function of the *SYSDDM Utility*, the NATUDF procedure, or by using Predict.

The fields are as follows:

Field	Description
NS	Database identification (1 byte, “binary”), file number (1 byte, “binary”) and sequence number (1 byte, “binary”). The DBID and FNR are those of the segment being described by this record.
NC	The first two bytes contain the number of NZ fields in the record times 20. The second two bytes contain the total number of NZ fields in the UDF multiplied by 20.
NZ	Field description as specified by the user using Predict, the EDIT segment layout facility of the *SYSDDM Utility* or the procedure NATUDF.
NW	The long field name.

Natural for DL/I Objects

Natural for DL/I objects are created during execution of the NATPSB procedure (NSB), during execution of the NATDBD procedure (NDB)), or when **assigning DBID/FNR** to a segment type (UDF). Consequently, at least one UDF block for each segment type with an assigned DBID/FNR is always present on FDIC - whether user-defined fields (UDF fields) have been defined by the user or not.

When displaying type definitions in the *SYSDDM Utility*, the NDB and its related UDF are combined automatically. The only way to display an UDF separately (for debugging purposes) is by using NDLBLOCK.

Displaying Keys of UDF Blocks

The utility program NDLULIST, cataloged in the library SYSDDM, is provided for listing the keys of all UDF blocks and for checking for duplicates.

For each duplicate found the following warning is issued:

```
More than one record with same DBID/FNR
```

Displaying the Size of Natural for DL/I Objects

The following utility programs, cataloged in library SYSDDM, are provided for displaying the sizes of the various Natural for DL/I objects:

- NDLSIZED displays the sizes of all NDBs stored on FDIC.
- NDLSIZEP displays the sizes of all NSBs stored on FDIC.
- NDLSIZEU displays the sizes of all UDFs stored on FDIC.

Displaying Natural for DL/I Objects

The utility program NDLBLOCK, cataloged in library SYSDDM, is provided for displaying the NDBs, NSBs and UDFs stored on FDIC. The utility displays the objects in hexadecimal format.

Control Blocks in Separate Buffer Pool

The Natural for DL/I control blocks NDB, NSB and UDF are read from FDIC and loaded into a buffer pool - resident or not, depending on the NDLPARM parameters RESINDB, RESINSB, and RESIUDF. This allows a given object to be shared by several users.

By means of the NTBPI macro (as described in the Natural *Parameter Reference* documentation) it is possible to have a buffer pool for NDB, NSB and UDF control blocks which is different from the buffer pool for Natural programs, thus allowing for better isolation between the different Natural objects.

If a separate buffer pool is allocated, Natural for DL/I locates its control blocks in this buffer pool. Otherwise, they are located in the Natural buffer pool.

The **Individual Object Statistics** function of the `SYSBPM` utility displays the NDB, NSB and UDF control blocks kept in the buffer pool as follows:

	Library	DBID	FNR
NDB	`SYSDLIND`	255	253
NSB	`SYSDLINS`	255	253
UDF	`U` *mmmnnn*	255	253

Notes:

1. The library names of NDB and NSB are fixed internal names and are not related to any Natural library.
2. The DBID/FNR values are fixed internal values and are not related to any Natural system file.
3. *mmm* is the DBID of the corresponding segment, *nnn* is the FNR of the corresponding segment.

The **Display Object Hexadecimally** function of the `SYSBPM` utility also allows you to display Natural for DL/I objects. This function might be useful when in doubt if the expected object has been read from `FDIC`, or if the object has been read from the expected `FDIC` (test/production).

Control Blocks in Buffer Pool Blacklist

The Natural for DL/I control blocks NDB, NSB and UDF can be added to the buffer pool blacklist.

This is done by the **Blacklist Maintenance** function of the `SYSBPM` utility.

As “Library” you enter `SYSDLIND` for NDBs, `SYSDLINP` for NSBs, and `SYSDLINS` for UDFs.

As **Object** you enter the NDB name for NDBs, the NSB name for NSBs, and `U`*mmmnnn* for UDFs where *mmm*/*nnn* are the DBID/FNR of the corresponding segment.

This feature allows you to modify NDBs, NSBs or UDFs without causing unpredictable results for active users.

If an attempt is made to load a locked object into the buffer pool, Natural for DL/I will issue error message NAT3935.

Natural for DL/I Objects and Natural DDMs

When referencing a DDM in a Natural program, Natural translates the DDM name into the corresponding DBID/FNR pair. If this DBID identifies the DDM as a DL/I DDM (by means of the `NTDB` macro), the Adabas control block is passed to Natural for DL/I for further processing.

Natural for DL/I takes DBID from the control block and tries to locate an UDF with this DBID/FNR in the buffer pool. If it is not found there, it is read from `FDIC` and loaded into the buffer pool.

The UDF contains the name of the related NDB in its header. Using this name, Natural for DL/I tries to locate the NDB in the buffer pool. If it is not found there, it is read from `FDIC` and loaded into the buffer pool.

The segment description including all DL/I fields is part of the NDB.

From this it is clear that:

- the NDB/UDF is required during runtime,
- the relation between the Natural program and the related NDB is established by means of DBID/FNR only.

This implies that the DBA has to ensure that DDMs and NDBs are always kept in synchronization. For example, it is not sufficient to transfer only the Natural programs from test to production.

58 Natural Batch Utilities

This section covers the following topics:

Transfer of NDBs/NSBs/UDFs from one System File to Another

The transfer of NDBs, NSBs and UDFs from one FDIC system file to another is performed either online using the utility SYSMAIN (as described in the Natural *Utilities* documentation) or in two batch steps, using two Natural batch utilities provided for this purpose:

- With the ULDDLI unload utility, the NDBs, NSBs and UDFs are transferred from one FDIC system file to a sequential work file.
- With the INPLDLI load utility, the NDBs, NSBs and UDFs are transferred from the sequential work file to another FDIC system file.

Both programs, ULDDLI and INPLDLI, are contained in the library SYSDDM.

Unloading the NDBs, NSBs and UDFs

The utility ULDDLI is used to unload NDBs, NSBs and UDFs from an FDIC system file to a sequential work file.

ULDDLI requires the following input:

- the specification of the FDIC system file to be unloaded (either in the NATPARM module or dynamically) and
- one or more parameter lines containing the following:
  - **Function code** (A1); the following function codes can be specified:

A	All NSBs, NDBs and UDFs are unloaded.
D	All NDBs with valid object names and their UDFs are unloaded. If no object names are specified, all NDBs and their UDFs are unloaded.
P	All NSBs with valid object names are unloaded. If no object names are specified, all NSBs are unloaded.
U	All UDFs with valid object names are unloaded. If no object names are specified, all UDFs are unloaded.
. (period)	Terminate ULDDLI; at least one parameter card with function code "." is required.

  - **Object name** (A8); 0 - 6 occurrences.

Note: With UDFs, the object name must be in the form *nnn**nnn*; that is, a 3-digit database ID, followed by 2 asterisks, followed by a 3-digit file number.

Work files: `CMWKF01` DD card must be provided with:

```
DCB=(RECFM=VB,LRECL=4624,BLKSIZE=4628)
```

When `ULDDLI` is executed, the specified NDBs, NSBs and UDFs are written from the `FDIC` system file to the `CMWKF01` dataset.

Note: DL/I fields of a segment are part of the NDB block and not of the UDF block, which means that you must still transfer the entire NDB block if you have modified a DL/I field in a segment.

Example 1 - Unload the NDBs TESTDB1 and TESTDB2:

```
LOGON SYSDDM
ULDDLI D TESTDB1 TESTDB2
  .
```

Example 2 - Unload all UDF Blocks:

```
LOGON SYSDDM
ULDDLI U
.
```

Example 3 - Unload UDF Blocks with DBID 10/FNR 150 and DBID 246/FNR 3:

```
LOGON SYSDDM
ULDDLI U 010**150 246**003
.
```

Loading NDBs, NSBs and UDFs

The utility `INPLDLI` is used to load NDBs, NSBs and UDFs - previously unloaded with `ULDDLI` - from the work file to an `FDIC` system file.

`INPLDLI` requires the following input:

- the specification of the `FDIC` system file into which the NDBs, NSBs and UDFs are to be loaded (either in the `NATPARM` module or dynamically);
- (optionally) the parameter `DEL=Y`:

  If you specify `DEL=Y`, all existing NDBs and UDFs found on the `FDIC` system file are first deleted. The ones contained on the input work file are added to the file. NSB definitions contained on the work file replace any identically named NSBs on the `FDIC` system file.

If you do not specify DEL=Y, existing identically named NDBs and NSBs are not replaced. Existing UDFs which have been allocated identical DBID/FNR combinations are not replaced either. Non-existent definitions are added. If you do not specify DEL=Y, it may occur that an NDB is loaded but all or some of its segments (UDFs) are not, or that segments (UDFs) are loaded without the corresponding NDB being loaded.

- (optionally) the parameter REP=Y: If you specify REP=Y, NDBs, NSBs and UDFs contained on the work file replace any identically named NDBs, NSBs and UDFs on the FDIC system file.

DEL=Y and REP=Y are mutually exclusive. If neither DEL=Y nor REP=Y is specified, existing NDBs, NSBs and UDFs are neither deleted nor replaced.

Work files: CMWKF01 DD card must be assigned to the work file which was created by the utility program ULDDLI.

When INPLDLI is executed, the NDBs, NSBs and UDFs are loaded from the work file into the specified FDIC system file, depending on whether they already exist and on whether DEL=Y was specified.

Example:

```
LOGON SYSDDM
INPLDLI REP=Y
```

Selecting NDBs, NSBs and UDFs from a Dataset

The utility SELDLI allows you to select Natural for DL/I objects (NDBs, NSBs, UDFs) from a dataset created by the ULDDLI utility. The output of SELDLI can be used as input for INPLDLI. Since INPLDLI does not allow to select objects from a dataset created by ULDDLI, you can use SELDLI to perform this function on desired objects prior to running INPLDLI.

SELDLI can, therefore, be used for backup/recovery or transfer of selected objects from test to production.

SELDLI also supports a SCAN (command SCN) feature that will list all of the objects on the input dataset without selecting any for output.

SELDLI can be used in batch mode only.

SELDLI requires the following input:

- the specification of the output dataset CMWKF01 from ULDDLI
- up to 30 parameter lines containing the following:
  - Object type (A3); the following types can be specified:
    - NSB - Select specified NSB
    - NDB - Select specified NDB

    - NDU - Select specified NDB and related UDF
    - UDF - Select specified UDF
    - SCN - List input dataset `CMWKF01`
  - terminate `SELDLI`
- Object name (A8); 1 occurrence

Notes:

1. With NDB/NSB, a wildcard (*) can be specified at the end of the name to select a range of names.
2. With UDFs, the object name must be in the form *nnn**nnn*; that is, a 3-digit database ID, followed by 2 asterisks, followed by a 3-digit file number.

`SELDLI` provides the following output:

- Dataset containing selected objects to be used as input to `INPLDLI`. It is specified with DDNAME `CMWKF02`.

When `SELDLI` is executed, the specified NDBs, NSBs and UDFs are copied from `CMWKF01` to `CMWKF02`.

Example 1 - Select all NDBs:

```
LOGON SYSDDM
SELDLI
NDB,*
.
FIN
```

Example 2 - Select NSB "ORDPSB" and UDF for DBID 151, FNR 3:

```
LOGON SYSDDM
SELDLI
NSB,ORDPSB
UDF,151**003
.
FIN
```

Example 3 - Select NDB "CUSTDBD" and its related UDFs:

```
LOGON SYSDDM
SELDLI
NSB,ORDPSB
NDU,CUSTDBD
.
FIN
```

Example 4 - List all objects on the input dataset:

```
LOGON SYSDDM
SELDLI
SCN
FIN
```

Utility NDUDFGEN for Natural Data Areas

The batch utility NDUDFGEN can be used to generate Natural data areas.

Input is provided by a UDF definition read from a work file.

Two kinds of data areas can be generated:

- a Natural view,
- a data structure (local data area).

A view in a local data area is generated from all fields contained in the input work file. The utility normalizes the data to the requirements of a view according to the Natural syntax. The field lengths are adapted to Natural field lengths, multiple-value fields and periodic groups are generated from record data structures. Arrays are generated by NDUDFGEN with the maximum length allowed by Natural. Field definitions are collected into a redefinition and the redefined field is generated according to the length of the individual fields collected. The generated field can then be used in the segment description as UDF; this means that not all UDFs need to be defined in the segment description, but only the generated fields.

A data structure as local data area is generated of all input fields. A level increment value can be specified for the fields. No other modifications to the input file data are permitted, so that the data are generated as specified in the input file.

Input for NDUDFGEN

The input layout is similar to the one for the NDPBCUDF utility.

The first card is the definition card; it contains the definition which is valid for all of the UDF definitions.

The FLD cards contain the actual field definitions and are separated from each other by STR cards.

The END card indicates the end of the field definitions. The input is required in forms mode (IM=F) as follows:

Definition Card

Definition	Explanation
Bytes 1 - 3	The first 3 bytes are not used.
Bytes 4 - 11	These 8 bytes contain the DBD name.
Bytes 12 - 19	These 8 bytes contain the segment name.
Bytes 20 - 27	These 8 bytes contain a prefix (generated for fields).
Bytes 28 - 30	These 3 bytes contain the maximum occurrence (default is 191).
Byte 31	This byte contains either `S` if a data structure is to be generated or `V` if a view is to be generated.
Byte 32	This byte contains the level increment.

Field Card

Definition	Explanation
Bytes 1 - 3	The first 3 bytes contain `FLD`.
Bytes 4 - 19	These 16 bytes are not used.
Byte 20	This byte contains the field level.
Bytes 21 - 39	These 19 bytes contain the name of the field being defined. This must be an alphanumeric value.
Bytes 40 - 42	These 3 bytes are not used.
Byte 43	This byte contains the format of the field.
Bytes 44 - 47	These 4 bytes contain the byte length of the field.
Byte 48	This byte is not used.
Byte 49 - 52	This byte contains the length as required by Natural (if this length is specified, the byte length is ignored).
Byte 53 - 57	These 4 bytes contain the maximum size of the 1st dimension of an array.
Byte 58 - 62	These 4 bytes contain the maximum size of the 2nd dimension of an array.
Byte 63 - 66	These 4 bytes contain the maximum size of the 3rd dimension of an array.

Example 1 - View Generation:

```
    DBDNAME SEGMENT PREFIX  191V
 FLD                1VAR1               000A0745
 STR
 FLD                1GROUP              000A0000N0000000200020000
 STR
 FLD                2VAR2               000A0006N00060005
 STR
 FLD                2VAR3               000A0030
 STR
 END
```

The above input generates the following view:

```
13:38:41                *****  E D I T  DATA  *****                    2006-05-25
Library: XYZ1      Name:          LOCAL                      DBID:  10 FNR:   5
Command:                                                                  > +
I T L Name                            F Leng  Index/Init/EM/Name/Comment
- - - -------------------------------- - ------------------------------------
    1 VAR1                            A  149 (5)
    1 GROUP                                  (4)
    2 VAR2                            A    6 (5)
    2 VAR3                            A   30
```

Example 2 - Structure Generation:

```
   DBDNAME SEGMENT PREFIX  191S
FLD                1VAR1               000A0745
STR
FLD                1GROUP              000A0000N0000000200020000
STR
FLD                2VAR2               000A0006N00060005
STR
FLD                2VAR3               000A0030
STR
END
```

The above input generates the following data structure:

```
13:41:20                *****  E D I T  DATA  *****                    2006-05-25
Library: XYZ1      Name:          LOCAL                      DBID:  10 FNR:   5
Command:                                                                  > +
I T L Name                            F Leng  Index/Init/EM/Name/Comment
- - - -------------------------------- - ------------------------------------
  V 1 DBDNAME-SEGMENT-VIEW                   DBDNAME-SEGMENT
  M 2 VAR1                            A  149 (5)
  P 2 GROUP                                  (4)
    3 PREFIX-1                        A   60 /*PREFIX-1
  R 3 PREFIX-1
    4 VAR2                            A    6 (5)
    4 VAR3                            A   30
```

59 Execution

This section covers the following topics:

PSB Scheduling

In all environments, Natural must know the name of the scheduled PSB, not only the address of the PCB list. In the online environments, the application developer must have the ability to change the scheduled PSB during a Natural session. This is accomplished by the Natural command `NATPSB` (in batch or CICS environments) or by calling `CMDEFSWX`/`CMDIRSWX` (in IMS TM environments).

The NATPSB Command

The `NATPSB` command handles PSB scheduling status and can be invoked with one of the following three options:

Option	Description
`INQ`	Performs an inquiry on PSB scheduling status.
`ON` *`psbname`*	Issues a PSB schedule of the PSB *`psbname`*.
`OFF`	Issues a `SYNCPOINT` to commit all updates and terminate the PSB.

Note: The `NATPSB INQ` command is valid in an IMS TM environment, too.

The following command, for example, issues a PSB schedule of `EDOOPSB`:

```
NATPSB ON EDOOPSB
```

A PSB scheduling operation is allowed only if there is no active PSB. If a PSB is active and another PSB is to be scheduled, the `ON` request for this new PSB must be preceded by an `OFF` request. Otherwise, the following message is issued:

```
NAT3900 PSB ... scheduled, but PSB ... already active
```

Since `NATPSB` is actually a Natural program, it can also be invoked with a `FETCH` or `FETCH RETURN` statement. The options described above should then be passed in the `FETCH` statement as two parameters. The first parameter would be an alphanumeric field of three bytes for `INQ`, `ON` or `OFF`. If the first parameter is `ON`, the second parameter must also be passed. It is an alphanumeric field of eight bytes and contains the name of the PSB to be scheduled.

Execution time errors of NATPSB can be intercepted by an ON ERROR statement. The error messages from NAT3900 to NAT3903 and from NAT3817 to NAT3820 are generated by NATPSB.

Example:

```
FETCH RETURN 'NATPSB' 'ON' 'PBNDL01'
ON ERROR
  IF *ERROR = 3900                          /* PSB already scheduled
    STACK TOP COMMAND 'NATPSB' 'ON' PBNDL01'
    STACK TOP COMMAND 'NATPSB' 'OFF'
    STOP
  END-IF
END-ERROR
END
```

PSB Scheduling in a Batch Environment

To execute a batch program that accesses a DL/I database, it is necessary to use the DL/I batch procedure which executes an application program under DL/I control. Therefore in the JCL/JCS used to execute Natural batch accessing DL/I databases, the first program in the step is a DL/I system program (DFSRRC00 for z/OS, DLZRRC00 for z/VSE).

PSB scheduling is performed by DL/I before control is passed to Natural. Since Natural requires the name of the scheduled PSB, it is necessary to invoke the Natural PSB scheduling program NATPSB before executing a Natural application program. This can be achieved by specifying the command NATPSB ON *psbname* as the first command in the batch input stream to Natural.

Batch Execution under z/OS

Under z/OS, the DL/I region controller program (DFSRRC00) invokes the NDLSINIB bootstrap module for Natural for DL/I by specifying MBR=NDLSINIB in the PARM field of the EXEC card. NDLSINIB reads two statements from the NDINPUT DD card:

- Statement 1 contains the name of the Natural module to be executed.
- Statement 2 contains the dynamic Natural parameters.

Before executing the user program, the command NATPSB ON *psbname* must be specified in the input stream to pass the name of the current PSB to Natural.

Example 1 - z/OS with Adabas System File:

```
//        EXEC DLIBATCH,PSB=psbname,MBR=NDLSINIB
//G.STEPLIB DD ...            Steplibs
//G.NDINPUT DD *              Input for NDLSINIB
natbatch                      Natural load module name
STACK=(LOGON user),DU=ON      Any Natural parameters
//DDCARD    DD *              Primary input file
ADARUN MODE=MULTI,PR=USER     ADARUN cards
//G.CMSYNIN DD *              Primary input file
NATPSB ON psbname             Mandatory Natural PSB scheduling
pgmname                       Natural user program name
/*                            End of Natural commands
```

Example 2 - z/OS with VSAM System File:

```
//        EXEC DLIBATCH,PSB=psbname,MBR=NDLSINIB
//G.STEPLIB DD ...            Steplibs
//G.NDINPUT DD *              Input for NDLSINIB
natbatch                      Natural load module name
STACK=(LOGON user),DU=ON      Any Natural parameters
//G.CMSYNIN DD *              Primary input file
NATPSB ON psbname             Mandatory Natural PSB scheduling
pgmname                       Natural user program name
/*                            End of Natural commands
```

In both examples, *natbatch* is assumed to be the load module produced by the respective link-edit procedure.

Batch Execution under z/VSE

Under z/VSE, the DL/I region controller program (DLZRRC00) invokes the NDLSINID bootstrap module for Natural for DL/I.

The SYSIPT cards are as follows:

- DL/I control statements:

  DLI,NDLSINID, *psbname*
  natbatch

  where:

  - DLI is a parameter for DLZRRC00,
  - NDLSINID is the name of the bootstrap module,
  - *psbname* is the name of the PSB,
  - *natbatch* is the name of the Batch Natural nucleus;
- dynamic parameters to be passed to Natural;

- ADARUN statements (only if Adabas system file is being used);
- Natural input cards.

A /* delimiter card is required before the ADARUN statements (if present) and before the Natural dynamic parameters and input cards.

Before executing the user program, the NATPSB ON *psbname* command must be specified in the input stream to pass the name of the current PSB to Natural.

Example 1 - z/VSE with Adabas System File:

```
 // EXEC DLZRRC00
DLI,NDLSINID,psbname                    DL/I control statements
natbatch                                Batch Natural nucleus name
/*
STACK=(LOGON user),DU=ON                Any Natural parameters
/*                                      End of Natural parameters
ADARUN MODE=MULTI,PR=USER               ADARUN cards
/*                                      End of ADARUN cards
NATPSB ON psbname                       Mandatory Natural PSB scheduling
pgmname                                 Natural user program name
/*                                      End of Natural commands
```

Example 2 - z/VSE with VSAM System File:

```
// EXEC DLZRRC00
DLI,NDLSINID,psbname                    DL/I control statements
natbatch                                Batch Natural nucleus name
/*
STACK=(LOGON user),DU=ON                Any Natural parameters
/*                                      End of Natural parameters
NATPSB ON psbname                       Mandatory Natural PSB scheduling
pgmname                                 Natural user program name
/*                                      End of Natural commands
```

In both examples, *natbatch* is assumed to be the load module produced by the respective link-edit procedure.

PSB Scheduling in a CICS Environment

Under CICS, the PSB must be scheduled using the NATPSB command, which actually invokes the appropriate scheduling or termination calls.

The active PSB can be changed dynamically during the Natural session using the NATPSB command. Therefore, more than one PSB can be used during a Natural session. Only one PSB, however, can be active for a CICS task at a time.

The NATPSB command can be entered in the Natural Command line or passed to Natural dynamically with the Natural STACK statement when starting a Natural session.

Examples:

```
MOVE 'STACK=(NATPSB ON ED00PSB)'
    TO DYNAMIC-PARM-KEYWORD-LIST.
EXEC CICS
    XCTL PROGRAM('NATvrs')
END-EXEC.
```

This example taken from a COBOL/CICS program assumes that NAT*vrs* is the value supplied for the PROGRAM keyword in the CICS PPT; where *vrs* is the current Natural version number.

Another possibility is to assign NATPSB commands to one or more PF keys when starting a Natural session as illustrated in the following example:

```
NATD STACK=(KEY PF1 = ED00PSB)
```

This example assumes that NATD is the value supplied for the TRANSID keyword in the CICS PCT. ED00PSB is the following Natural program (cataloged in the library SYSTEM):

```
STACK TOP COMMAND 'NATPSB ON ED00PSB'
STACK TOP COMMAND 'NATPSB OFF'
END
```

Whenever PF1 is pressed, the commands NATPSB OFF and NATPSB ON ED00PSB are executed.

PSB Scheduling in an IMS TM Environment

Under IMS TM, Natural for DL/I runs as a conversational transaction. It has the ability to perform direct or deferred message switching. This means that several different Natural transactions and PSBs can be invoked during a single Natural session. It is also possible to invoke multiple PSBs and provide the user with access to databases defined in different PSBs. This is accomplished by calling CMDEFSWX or CMDIRSWX.

Under IMS TM, PSB scheduling is performed by the IMS Control Region before control is passed to the Natural transaction running as an MPP (Message Processing Program) or BMP (Batch Message Processing). As in the batch environment, Natural needs to know the name of the scheduled PSB. This is accomplished internally at Natural session start by the driver which stores the pointer to the PCB address list and the name of the PSB into IOCB fields. The NATPSB INQ command can be issued in this environment but the NATPSB ON/NATPSB OFF commands cannot.

CALLNAT Interface

The Natural subprograms NDLPCBAD and NDLPSBSC are provided, which can be invoked with a CALLNAT statement from within a Natural program.

See the following sections:

- NDLPCBAD Subprogram
- NDLPSBSC Subprogram

NDLPCBAD Subprogram

The Natural subprogram NDLPCBAD provides the calling Natural program with the name of the currently scheduled PSB and the pointer to the PCB address list.

Example:

```
DEFINE DATA LOCAL
01 PSBNAME  (A8)
01 PCBADDR  (B4)
END-DEFINE
CALLNAT 'NDLPCBAD' PSBNAME PCBADDR
DISPLAY PSBNAME PCBADDR
END
```

This pointer can then be used by non-Natural programs to obtain the individual PCB addresses and to establish addressability to the PCBs. For example, move these addresses to the BLL cells (COBOL/VS) or use the SET ADDRESS instruction (COBOL II).

NDLPSBSC Subprogram

The Natural subprogram NDLPSBSC allows for scheduling a PSB in CICS or batch environments. It performs the same functions as the NATPSB command.

Using CALLNAT 'NDLPSBSC' (instead of FETCH RETURN 'NATPSB') avoids the NAT1108 error message, which is issued if a PSB is scheduled in an INPUT loop as follows:

```
INPUT ...
FETCH RETURN 'NATPSB' 'ON' 'psbname'
REINPUT ...                          /* returns NAT1108
```

Example:

```
DEFINE DATA LOCAL
01 COMMAND  (A3)
*  'ON'
*  'OFF'
*  'INQ'
01 PSBNAME  (A8)
01 RETCODE  (B1)
*  01: Command invalid
*  02: PSB name missing
*  03: PSB psbname active
*  04: PSB psbname not active
*  05: Not used
*  06: No PSB active
END-DEFINE
MOVE 'ON' TO COMMAND
MOVE 'psbname'TO PSBNAME
CALLNAT 'NDLPSBSC' COMMAND PSBNAME RETCODE
DISPLAY PSBNAME RETCODE
END
```

Under IMS TM, `NDLPSBSC` can only be used with parameter `'INQ'`, because PSB scheduling is performed by the IMS control region before control is passed to Natural.

Support of IMS-Specific Features

This section covers the following topics:

- Symbolic Checkpoint/Restart Functions - CHKP, XRST
- The INIT Call to Enable Data Availability Status Codes

Symbolic Checkpoint/Restart Functions - CHKP, XRST

A Natural program can make use of the IMS TM symbolic checkpoint and restart facilities by using the statements `GET TRANSACTION DATA` and `END TRANSACTION`.

The executing program can checkpoint user data on the IMS system log datasets by supplying an 8-byte checkpoint ID as the first operand in the `END TRANSACTION` statement and by specifying the areas to be checkpointed as additional operands.

To ensure that the checkpoints are written to the IMS log dataset, the Natural profile parameter `ETDB` (see the Natural *Parameter Reference* documentation) must be specified, and the database specified with the `ETDB` parameter must be a DL/I database.

If no operands are specified with the `END TRANSACTION` statement, Natural uses `NATDLICK` as the default checkpoint ID.

This checkpoint data are retrieved by executing the `GET TRANSACTION DATA` statement. The first operand of this statement must also be an 8-byte checkpoint ID. The remaining operands must be listed in the same sequence, length and format as in the corresponding `END TRANSACTION` statement.

Example:

```
RESET CKPID(A8) KEY(A10) AREA1(A20) AREA2(N6) AREA3(A120)
GET TRANSACTION DATA CKPID KEY AREA1 AREA2 AREA3
IF CKPID NE ' '                                          /* checkpoint restart
  MOVE KEY TO START-KEY(A10)
ELSE
  RESET START-KEY                                        /* normal restart
MOVE *PROGRAM-ID TO CKPID
  :
READ DLI-DB BY XKEY > START-KEY
  :
  UPDATE
  :
  END TRANSACTION CKPID XKEY AREA1 AREA2 AREA3
  :
END
```

Normal Restart:	Simply run the job. The checkpoint ID parameter in the program's `GET TRANSACTION DATA` statement is set to blanks by the DL/I call handler `NDLSIOBA`.
Checkpoint Restart:	To restart after an abnormal termination, specify one of the following checkpoint IDs in the `PARM` field of the `EXEC` statement in your program's JCL: `CKPTID=LAST` to restore data areas written to the log by the job at the last successful checkpoint; or `CKPTID=`*`cccccccc`* to restore data areas written with checkpoint ID *`cccccccc`*.

These are the usual IMS TM restart procedures. Each checkpoint ID used in an `END TRANSACTION` statement is displayed in the job output once the extended checkpoint has been successfully executed by IMS.

The checkpoint ID parameter of the program's `GET TRANSACTION DATA` statement is set to the actual checkpoint ID used by IMS.

The data areas are restored into the areas you specify in your `GET TRANSACTION DATA` statement.

Ensure that the `//IMSLOGR` DD statement specifies the correct IMS log dataset.

When Natural is started in a BMP region, the initialization routine issues an `XRST` call, to ensure that symbolic checkpointing is available. This is done whether the Natural user programs to be executed make use of IMS symbolic checkpoint logic or not. If the `XRST` was unsuccessful, Natural returns the following error message:

```
NAT3959 XRST call failed with DL/I status code xx
```

When a GET TRANSACTION DATA statement is directed to the Natural call handler and the initial XRST call has been flagged as successfully executed, the restart checkpoint ID and contents of this buffer are copied into the program's user fields.

When an END TRANSACTION statement is directed to the Natural call handler, the user fields to be checkpointed are copied into the buffer before a symbolic checkpoint call (CKPT) is issued.

If the database specified with the profile parameter ETDB (see the Natural *Parameter Reference* documentation) is not the same as the database affected by the transaction, the first operand of the END TRANSACTION statement will be used as checkpoint ID for the ETDB database, while NATDLICK will be used as checkpoint ID for the other database *not* specified with the ETDB parameter.

The total area to be checkpointed must not exceed 1992 bytes.

The INIT Call to Enable Data Availability Status Codes

If the INITCAL parameter of NDLPARM is set to YES, Natural issues an INIT call during session initialization and during each MPP transaction start. The character string in the I/O area is STATUS GROUPA. This informs IMS that Natural is prepared to accept status codes regarding data unavailability. IMS returns status codes BA or BB when the DL/I call requires access to unavailable data (for example, if the accessed database has been stopped).

The corresponding error messages of Natural for DL/I are:

```
NAT3897 DL/I status code 'BA'
NAT3898 DL/I status code 'BB'
```

For compatibility reasons, the default setting of INITCAL is NO.

The INIT call is issued only if Natural runs in a BMP or MPP region.

Fast Path Support

Natural supports Fast Path databases.

Fast Path database types include Main Storage Databases (MSDB) and Data Entry Databases (DEDB).

- MSDB:

  MSDBs have root only segments that are fixed-length. There are two types of MSDBs: terminal-related and non-terminal-related.

To read segments in an MSDB, GU and GN are used.

To update segments in an MSDB, REPL, DLET, ISRT, and FLD are used.

- DEDB:

  DEDBs use the design concept that database content can be physically partitioned by ranges of root keys or by groupings produced by a randomizing algorithm.

As a basic requirement, the non-conversational NATIMS driver must be used. This is because Fast Path programs cannot be conversational programs, that is, they cannot use an SPA.

For DEDB databases, no special processing is required by Natural for DL/I.

For MSDB databases, the (one and only) SSA is built without command codes because DL/I does not allow for it (not even the null command code must be used in case of MSDB databases).

When updating segments in an MSDB database, Natural for DL/I uses the REPL call (rather than the FLD call) because the UPDATE statement of the Natural language does not provide a search condition that indicates which segments must be updated (searched update).

Support of GSAM

Natural for DL/I supports the Generalized Sequential Access Method (GSAM), with which a sequential dataset can be handled as a sequential non-hierarchic database by IMS.

Although GSAM databases have no segments, keys or parentage, they are handled internally by Natural as root-only databases with fixed or variable-length segment types. Thus, it is possible to use DDMs instead of work files for GSAM record types.

For variable-length GSAM records, Natural maintains the record length; you need not reserve a field for the record length in the DDM.

A FIND or READ statement generates a GN (get next) call sequence for GSAM. Due to GSAM restrictions, UPDATE and DELETE statements are not allowed. Due to GSAM restrictions, a STORE statement must insert records at the *end* of the database.

IMS repositions GSAM databases for sequential processing, which means that the position need not be re-established by the application program after checkpoint calls. Therefore, Natural performs no repositioning after checkpoint calls in the case of PCBs for GSAM.

In order to use the extended restart feature of IMS, the Natural job has to terminate abnormally. This can be accomplished by calling the Natural IMS TM service module CMSVC13D. If the job terminates either normally or with a condition code, IMS does a clean-up and no restart is possible.

Every GSAM database structure which is to be used by Natural must be processed by the NATDBD procedure. The assembly step of this procedure extracts the relevant information from the DBD source and simulates an appropriate SEGM statement as shown in the following examples.

Example 1 - Segment Description of Fixed-Length GSAM Records:

```
DBD    NAME=TESTDB,ACCESS=(GSAM,BSAM)
DATASET DD1=INPUT,DD2=OUTPUT,RECFM=F,RECORD=80
DBDGEN
END
```

From the above source statements, NATDBD would simulate a segment with the name of the DBD and the length as specified with the RECORD keyword:

```
SEGM NAME=TESTDB,BYTES=80
```

Example 2 - Segment Description of Variable-Length GSAM Records:

```
DBD    NAME=TESTDB,ACCESS=(GSAM,BSAM)
DATASET DD1=INPUT,DD2=OUTPUT,RECFM=VB
DBDGEN
END
```

From the above source statements, NATDBD would simulate a segment with the name of the DBD, a maximum length of 32760 and a minimum length of 8:

```
SEGM NAME=TESTDB,BYTES=(32760,8)
```

In both examples, the NDB name and the segment name are TESTDB, and the generated DDM name would be TESTDB-TESTDB.

The Natural program to read this GSAM database would be as simple as:

```
READ TESTDB-TESTDB
  DISPLAY FIELDS-OF-TESTDB
LOOP
END
```

Processing in CICS Pseudo-Conversational Mode or under IMS TM

When Natural is running under CICS in pseudo-conversational mode (that is, with NATPARM parameter PSEUDO=ON) or under IMS TM, the Natural task/transaction is terminated following each write to a terminal, and a new task/transaction is started when new input is entered through the terminal. Because a Syncpoint is forced at the end of the task/transaction, all resources are released when the message is sent to the terminal. Therefore, the DL/I PSB is no longer active, nor are any DL/I GET HOLD calls in effect.

To avoid consistency problems on the DL/I databases, Natural performs additional processing when it is running in CICS pseudo-conversational mode or under IMS TM:

1. If a DL/I GET HOLD call is still active at the end of the task/transaction, the values of the fields read by the program that issued the corresponding READ or FIND (only the fields used, not the whole segment) are saved in an internal table of Natural for DL/I.
2. When a new task/transaction resumes the Natural session and the program issues an UPDATE or DELETE statement, Natural checks whether the field contents have been changed. If the check shows that the field contents have not been changed, the UPDATE/DELETE is executed. If they have been changed, an error message is returned by Natural notifying the user that the field values just read were changed by another user in the system and that, therefore, the UPDATE/DELETE operation is not carried out.

Natural also performs automatic PSB repositioning following resumption of the task/transaction. A Natural application is, therefore, not affected by pseudo-conversational mode, unless it uses conventional programming techniques, for example COBOL or PL/1.

If the task/transaction is terminated due to a screen I/O while a READ or FIND loop is being executed on a segment without a unique sequence field, Natural is not able to reposition the PSB in the database when the task/transaction is resumed. The same may occur when using secondary indices with non-unique key fields in pointer segments. Natural is not able to reposition the PSB in these instances because DL/I does not provide a method of re-establishing position in the middle of non-unique keys or non-keyed segments.

60 Programming Language Considerations

This section covers the following topics:

Natural versus Third Generation Languages

With a few exceptions Natural provides all of the functionality of third generation language programming in the DL/I environment.

However, accessing DL/I data using Natural is significantly different from programming techniques used in a third generation language. Natural application programmers do not have to code specific DL/I calls or build the segment search arguments (SSAs). They do not need to concern themselves with PCB mask information or keep track of PCB positioning between Syncpoints.

Natural for DL/I operates as a standard DL/I application and although most of the DL/I call processing is done internally, it is important to realize that all of the required DL/I processing is still performed:

PSBs are scheduled and terminated, PCBs are selected for use, database positioning is maintained, SSAs are created, the most efficient DL/I calls are issued, PCB mask information is evaluated, `GET HOLD` calls are issued before update or delete operations.

These tasks are all being performed for the application by Natural.

It is important to note that Natural is performing these tasks based on the information available in the application program. If, for example, a `READ` or `FIND` statement in a program is lacking essential segment search information, Natural selects a PCB, builds an SSA and issues a certain DL/I call based on this lacking information.

The Natural programmers use the same Natural statements to manipulate data in DL/I as they would for VSAM, Adabas or DB2.

Natural accesses DL/I segments based on the Natural DDM which is being referenced. Since the data access is always for one specific segment type (the one defined by the DDM), Natural does not issue path calls nor unqualified calls; that is, calls where the segment name is not specified.

Notes:

1. Due to the structure of the Natural programming language, application control over DL/I call command codes is not available.
2. The `LOG`, `STAT` and `GSCD` call functions are not supported for the IMS TM environment.

Natural Statements with DL/I

This section mainly consists of information also contained in the Natural Statements documentation, where each Natural statement is described in detail, including notes on DL/I usage where applicable. Summarized below are the particular points a programmer has to bear in mind when using Natural statements with DL/I.

Any Natural statement not mentioned in this section can be used without restrictions with DL/I.

BACKOUT TRANSACTION

The Natural statement `BACKOUT TRANSACTION` is used to back out all database updates performed during the current logical transaction.

How the statement is translated and which command is actually issued depends on the TP-monitor environment:

- Under CICS, the `BACKOUT TRANSACTION` statement is translated into an `EXEC CICS ROLLBACK` command. However, in pseudo-conversational mode (`PSEUDO=ON`), only changes made to the database since the last terminal I/O are undone. This is due to CICS-specific transaction processing.
- In batch mode and under IMS TM, Natural for DL/I issues `ROLB` calls without checking the `CMPAT` setting in the corresponding NSB. However, under IMS TM, only changes made to the database since the last terminal I/O are undone. This is due to IMS TM-specific transaction processing.

Because PSB scheduling is terminated by a Syncpoint/checkpoint request, Natural saves the PCB position before executing the `BACKOUT TRANSACTION` statement. Before the next command execution, Natural reschedules the PSB and tries to set the PCB position as it was before the backout.

Note: The PCB position might be shifted forward if any pointed segment had been deleted in the time period between the `BACKOUT TRANSACTION` and the following statement.

DELETE

The Natural statement DELETE is used to delete a segment from a DL/I database, which also deletes all descendants of the segment.

DISPLAY

The DL/I AIX fields can be displayed with the Natural statement DISPLAY only if a PCB is used with the AIX specified in the parameter PROCSEQ. If not, an error message is returned by Natural for DL/I at runtime.

END TRANSACTION

The Natural statement END TRANSACTION indicates the end of a logical transaction and releases all DL/I data locked during the transaction. All data modifications are committed and made permanent.

How the statement is translated and which command is actually issued depends on the TP-monitor environment:

- Under CICS, the END TRANSACTION statement is translated into an EXEC CICS SYNCPOINT command.
- In batch mode and non message-driven BMP environments, Natural for DL/I issues CHKP calls without checking the CMPAT setting in the corresponding NSB.
- In MPP and message-driven BMP environments, the END TRANSACTION statement is not translated into a CHKP call, but is ignored, because CHKP calls imply GU calls. As Natural is a conversational transaction, you must reply to the terminal before requesting the next message (that is, before issuing the next GU call). An implicit end-of-transaction is issued after each terminal I/O.

Because PSB scheduling is terminated by a SYNCPOINT/CHECKPOINT request, Natural saves the PCB position before executing the END TRANSACTION statement. Before the next command execution, Natural reschedules the PSB and tries to set the PCB position as it was before the END TRANSACTION statement.

Note: The PCB position might be shifted forward if any pointed segment had been deleted in the time period between the END TRANSACTION and the following command.

With batch-oriented BMP regions, user data can be checkpointed on the IMS system log data sets. This is done by supplying an 8-byte checkpoint ID as the first operand in the END TRANSACTION statement, and by specifying the areas to be checkpointed as additional operands.

If the database specified with the Natural profile parameter ETDB is not the same as the database affected by the transaction, the first operand of the END TRANSACTION statement will be used as checkpoint ID for the ETDB database, while NATDLICK will be used as checkpoint ID for the other database *not* specified with the ETDB parameter.

The total area to be checkpointed must not exceed 1992 bytes; see also ***Symbolic Checkpoint/Restart Functions***.

FIND

With DL/I, the Natural `FIND` statement is typically used when a specific search criterion is known and specific segments are to be retrieved. This issues a DL/I `GET UNIQUE` call. However, if the `FIND` statement specifies a lower level segment and is within an active `READ` or `FIND` loop for an ancestor segment, it generally results in a DL/I `GET NEXT WITHIN PARENT` call.

The `FIND` statement initiates loop processing, which is active until all segment occurrences which match the search criterion have been read.

When accessing a field starting after the last byte of the given segment occurrence, the storage copy of this field is filled according to its format (numeric, blank, etc.).

`FIND FIRST`, `FIND NUMBER` and `FIND UNIQUE` are not permitted. The `PASSWORD`, `CIPHER`, `COUPLED` and `RETAIN` clauses are not permitted either.

In the `WITH` clause, you can only use descriptors that are defined as key fields in DL/I and marked with "D" in the DDM.

When connecting search criteria, the following has to be observed:

```
[NOT] { basic-search-criterion } [ { OR } search-expression ] ...
      { (search-expression)    }   { NOT }
```

Connecting search criteria for segment type A results in multiple qualification statements within one DL/I segment search argument (SSA). Connecting search criteria for segment types A and B results in multiple SSAs. Therefore, the Boolean operator OR cannot be used to combine search criteria for different segment types.

GET TRANSACTION DATA

The Natural statement `GET TRANSACTION DATA` retrieves checkpoint data saved by an `END TRANSACTION` statement. The first parameter of this statement must be an 8-byte checkpoint ID. The remaining operands must be listed in the same sequence, length and format as in the corresponding `END TRANSACTION` statement; see also ***Symbolic Checkpoint/Restart Functions***.

READ

The Natural statement READ should be used to process a set of segment occurrences in sequential order and usually results in a DL/I GET NEXT call.

When the READ statement is used, segments are retrieved based on the sequence field of the root segment or based on a secondary index field. Since the READ statement initiates sequential access of the database, it is important to understand that the EQUAL TO clause means the same thing as the STARTING FROM clause; it initiates a sequential read loop beginning with the key value specified.

The READ statement initiates loop processing. A loop is active until all segment occurrences which match the search criterion have been read.

The PASSWORD and CIPHER clauses are not permitted.

IN PHYSICAL SEQUENCE is used to read records in the order in which they are physically stored in a database. The physical sequence is the default sequence.

Note: This is only valid when using Natural with HDAM databases.

BY ISN is not valid when using Natural with DL/I.

For Natural, the descriptor used must be either the sequence field of the root segment or a secondary index field. If a secondary index field is specified, it must also be specified in the PROCSEQ parameter of a PCB. Natural uses this PCB and the corresponding hierarchical structure to process the database.

RELEASE

The Natural statement RELEASE is not applicable for DL/I usage, since it releases sets of records retained by a FIND statement that contained a RETAIN clause, which is not valid when using Natural with DL/I.

STORE

The Natural statement STORE can be used to add a segment occurrence.

If the segment occurrence is defined with a primary key, a value for the primary key field must be provided.

In the case of a GSAM database, records must be added at the end of the database (due to GSAM restrictions).

The USING/GIVING NUMBER clause is not valid when using Natural with DL/I.

If the SET/WITH clause is used, the following applies with Natural for DL/I:

- Values must be provided for the segment sequence field and for all sequence fields of the ancestors.
- Only I/O (sensitive) fields can be provided.
- A segment of variable length is stored with the minimum length necessary to contain all fields as specified with the `STORE` statement. The segment length will never be less than the minimum size specified in the SEGM macro of the DBD.
- If a multiple-value field or a periodic group is defined as variable in length, at the end of the segment only the occurrences as specified in the `STORE` statement are written to the segment and define the segment length.

UPDATE

The Natural statement `UPDATE` can be used to update a segment in a DL/I database. The segment length is increased (if necessary) to accommodate all fields specified with the `UPDATE` statement. If a multiple-value field or a periodic group is defined as variable in length, only the occurrences as specified in the `UPDATE` statement are written to the segment.

The DL/I AIX field name cannot be used in an `UPDATE` statement. AIX fields, however, can be updated by referring to the source field which comprises the AIX field.

DL/I sequence fields cannot be updated because of DL/I restrictions.

If the `SET/WITH` clause is used, only I/O (sensitive) fields can be provided. A segment sequence field cannot be updated (`DELETE` and `STORE` must be used instead).

Due to GSAM restrictions, the `UPDATE` statement cannot be used for GSAM databases.

WRITE

With the Natural statement `WRITE`, the DL/I AIX fields can be displayed only if a PCB is used with the AIX specified in the parameter `PROCSEQ`. If not, an error message is returned by Natural for DL/I at runtime.

Statements not Available for DL/I

The following Natural statements are not available for DL/I users:

- `GET`
- `GET SAME`
- `HISTOGRAM`
- `PASSW`
- `RELEASE`

Natural System Variables with DL/I

With DL/I, the following restrictions apply to the following Natural system variables:

*ISN

As there is no DL/I equivalent to Adabas internal sequence numbers (ISNs), the system variable `*ISN` is not available with Natural for DL/I.

*NUMBER

With Natural for DL/I, the Natural system variable `*NUMBER` does not contain the number of segment occurrences found. It contains `0` if no segment occurrence satisfies the search criterion and a value of `8,388,607=X'7FFFFF'` if at least one segment occurrence satisfies the search criterion.

61 Problem Determination Guide

The items listed below are cross-referenced by Natural for DL/I error messages. They are supplied to advise Natural programmers, DL/I database administrators and system support personnel of actions required to correct a given problem.

Item Number	Corresponding Action
1	**Activate Natural Trace Facility for DL/I** **Note:** The Natural trace facility for DL/I is available in all Natural for DL/I environments. To activate the Natural trace facility for DL/I (Dynamic Trace Activation) ■ Execute the command `NDLTRACE` in library `SYSDDM` as follows: `NDLTRACE ON parm1 parm2 parm3` Permitted values for trace parameters are either `CMD`, `SER`, `ROU` (according to the specifications in the given error message) or `ALL` to trace all events of Natural for DL/I. To activate the Natural trace facility for DL/I (Initial Trace Activation) 1. Code the `TRACE` parameter in the `NDLPARM` module according to the specifications in the given error message. Or: Specify `TRACE=ALL` to trace all events of Natural for DL/I. 2. Assemble the `NDLPARM` module. 3. Link-edit the load module that contains Natural for DL/I. To create and display the Natural trace for DL/I 1. Start the Natural session with `DSIZE=64` (or smaller).

Item Number	Corresponding Action
	This is required because the trace data is written into the `DSIZE` buffer. 2. Activate the trace facility (see above) and specify the following commands: `TEST DBLOG D` Start `DBLOG` for DL/I. ... Reproduce your problem here. `TEST DBLOG D` Display the data logged.
2	**Obtain the Program Listing**
3	**Obtain the View Listing**
4	**Obtain the DBD Macros**
5	**Obtain the PSB Macros**
6	**Obtain the NDB Description Printout** To obtain the printout, execute the Natural module `NDLBLOCK` in the library `SYSDDM` with the following parameters: ■ block type (3 bytes alphanumeric) = `NDB` ■ block name (8 bytes alphanumeric) = *`dbd-name`*
7	**Obtain the NSB Description Printout** To obtain the printout, execute the Natural module `NDLBLOCK` in the library `SYSDDM` with the following parameters: ■ block type (3 bytes alphanumeric) = NSB ■ block name (8 bytes alphanumeric) = *`psb-name`*
8	**Obtain the UDF Description Printout** To obtain the printout, execute the Natural module `NDLBLOCK` in the library `SYSDDM` with the following parameters: ■ block type (3 bytes alphanumeric) = `UDF` ■ block name (8 bytes alphanumeric) = *`db-id**file-number`* (that is, 3 digits for the database ID, a literal separator "**" and 3 digits for the *`file-number`*)
9	**Obtain a DUMP**
10	**Obtain the NDLPARM Listing**
11	**Obtain the NATDBD Procedure Output**
12	**Obtain the NATPSB Procedure Output**

62 Performance Considerations

This section lists some special considerations which may help you increase the performance of your Natural for DL/I environment.

Parameters

Set the `DLISIZE` parameter to `0` if no DL/I database is to be accessed.

Do not modify `NDLPARM` parameters, unless requested by a corresponding Natural for DL/I error message. Unused buffers are compressed by the Natural compression algorithm.

DBID

Use the same DBID for all segment types (DDMs) of a given NDB, because an `OPEN` command is generated for each DBID.

Global and Local Data Areas

Keep global and local data areas as small as possible, because the format buffer contains *all* fields of the global and local data areas, not only those which are referenced by a Natural I/O statement.

FIND Statements

If the sequence field is unique, use a `FIND (1)` statement instead of a `FIND` statement to prevent an unnecessary second DL/I call.

Direct Access to Lower Levels

Access segments on lower levels directly (by using the field sequence of the parent); that is, access ancestor segments only if their contents are required by the application program.

In such cases, UDFs of ancestor segments as well as DL/I fields of ancestor segments which are not sequence fields are not available to the application program.

DBLOG Utility

Use the Natural utility `DBLOG` (`TEST DBLOG D`) to tune your application; see *Logging Database Calls (DBLOG)* in the Natural *Utilities* documentation.

63 DL/I Services

When you invoke "DL/I Services" from the `SYSDDM` main menu, the **DL/I Services Main Menu** is displayed which offers you the following functions:

- **NDB Maintenance**
  An NDB is a DL/I DBD (database description) which is defined to Natural.
- **NSB Maintenance**
  An NSB is a DL/I PSB (program specification block) which is defined to Natural.

NDB Maintenance

This section covers the following topics:

- Menu and Functions
- Select an NDB from a List
- Select an NDB Segment from a List
- Edit an NDB Segment Description
- Generate DDM from Segment Description

Menu and Functions

When you select **NDB Maintenance** on the **DL/I Services Main Menu**, the **NDB Maintenance** menu is displayed:

```
14:37:12                    **** DL/I Services ****                    2006-05-25
                              - NDB Maintenance -

                   Code Functions
                   ---- -------------------------------------
                     S  Select an NDB from a List
                     P  Purge an NDB
                     L  Select an NDB Segment from a List
                     E  Edit an NDB Segment Description
                     G  Generate DDM from Segment Description
                     ?  Help
                     .  Back
                     M  End
                   ---- -------------------------------------
         Enter Code: ?
           NDB Name:
      Segment Name:

ENTER  PF1  PF2  PF3  PF4  PF5  PF6  PF7  PF8  PF9  PF10  PF11  PF12
       Help      Back                                          End
```

The individual NDB maintenance functions are listed below:

Function	Explanation
Select an NDB from a List	List the NDBs which are defined on the Natural system file. You can then select NDBs from this list by entering the following function codes: `P` to purge an NDB, `L` to list the segments of an NDB. For details, see *Select an NDB from a List*.
Purge an NDB	Purge an NDB and its related segment descriptions from the Natural system file. The name of the NDB to be purged must be specified. Before this function is executed you are prompted to confirm the purge request. For details, see *Select an NDB from a List*.
Select an NDB Segment from a List	List the segments of the specified NDB. You can then select segments from this list for further processing. For details, see *Select an NDB from a List*.
Edit an NDB Segment Description	Edit a segment description. The segment name and its corresponding NDB name are required when invoking this function. A database ID (DBID) and file number (FNR) must have been assigned to the segment description (function code `A` on the **Segment List** display) before it can be edited. For details, see *Edit an NDB Segment Description*.
Generate DDM from Segment Description	Generate a DDM from a segment description. The DDM definition is a Natural DDM of the segment. Prior to execution of this function, a DBID and FNR must have been assigned to the segment (function code `A` on the **Segment List** display). For details, see *Generate DDM from Segment Description*.

Select an NDB from a List

When you select an NDB from a list, a list containing all NDBs defined on the Natural system file is displayed. In addition to the NDB name the following is displayed:

L/P	Indicates if `ACCESS=LOGICAL` or not.
length	Length of the NDB.
NoSGMS	Number of the segment types in the NDB.
ACCESS	The access specification taken from the DBD.

From the list, you can select NDBs for further processing by entering the following function codes in the **Func** column next to the NDB names:

Code	Function
P	**Purge NDB** This function is identical to the **Purge NDB** function available on the **NDB Maintenance** menu. It deletes an NDB and its related segment descriptions from the Natural system file. Before the function is executed you are prompted to confirm the purge request.
L	**List NDB Segments** This function is identical to the "Select NDB Segment from a List" function available on the **NDB Maintenance** menu. It lists the segments of the selected NDB. For details, see ***Select an NDB Segment from a List***.

Select an NDB Segment from a List

When you select an NDB segment from a list, a list containing all segments of the specified NDB is displayed. If you do not know the NDB name, use the **Select an NDB from a List** function.

```
10:50:48                    **** DL/I SERVICES ****                    2006-05-25
                                - Segment  List -
 DBD Name = EDOODBD
   Func   Level  Segment     DBID   FNR    Seg-Lgh       UDF-Lgh   Response
   --------------------------- Top of Data ---------------------------------
     _       1   COURSE      246    _10    75-80           100
     _       2   PREREQ      246    _11    36-36            40
     _       2   OFFERING    246    _12    41-41            40
     _       3   TEACHER     246    _13    24-24            60
     _       3   STUDENT     246    _14    40-40            40
     _                       ___    ___
     _                       ___    ___
     _                       ___    ___
     _                       ___    ___
     _                       ___    ___
   ----------------------------- Bottom ------------------------------------
     Code .. _ ( ? Help   . Back   M End )
 Func = E  Edit Segment Description    A  Assign DBID and FNR
        F  Free DBID and FNR          ' ' Change DBID and FNR
        G  Generate DDM                N  Take New Copy of UDF

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
Exec  Help        Exit                                                  Canc
```

Next to each segment you can enter one of the function codes listed below. You can mark several segments at the same time with a function code. If you do not enter any code, the list is scrolled forward until the bottom of the list is reached.

You can enter one of the following codes next to a segment on the segment list to perform one of the following functions:

Code	Function
A	**Assign DBID/FNR** Assign a DBID and a FNR to the selected segment. The DBID is a number in the range from 1 to 254. It must be contained in the database ID list (NTDB macro) of the Natural parameter module NATPARM. All Natural DDMs which refer to a DL/I segment must have a DBID belonging to this range. If a DBID has not been entered, a default value is assigned, which is the entry with the lowest value in the DBID list specified in the Natural parameter module. For a given NDB, all segments should be assigned the same DBID. Otherwise, Natural assumes different databases and generates an OPEN command (which, however, is ignored by the DL/I call handler). The FNR is a number in the range from 1 to 254. The FNR must be specified; no default value is assumed by Natural. The segments of a logical NDB must have file numbers different from those assigned to the segments of the physical NDB. The DBID/FNR combination must be unique on the Natural system file. It is used by Natural to uniquely determine the NDB and the segment within the NDB.
E	**Edit Segment Description** Edit the description of a segment within a given NDB. The function is the same as the **Edit an NDB Segment Description** function which you can invoke from the **NDB Maintenance** menu. Before you can edit a segment description, a DBID and FNR must have been assigned to the segment (see above). For details, see ***Edit an NDB Segment Description***.
F	**Free DBID/FNR** Release the DBID and FNR which have previously been assigned to the segment. Once a DBID and FNR have been released, they are available for assignment to another segment.
G	**Generate DDM** Generate a DDM definition from a segment description. The function is the same as the **Generate DDM from Segment Description** function which you can invoke from the **NDB Maintenance** menu. Before you can generate a DDM from a segment description, a DBID and FNR must have been assigned to the segment (see above). The generated DDM is a Natural view of the segment. Once it has been generated, the DDM can be modified and cataloged.

Code	Function
	For details, see *Generate DDM from Segment Description*.
N	**Take New Copy of UDF** Refresh the user-defined fields (UDFs) of a segment when the UDFs of the source segment have been changed. This applies to UDFs of segments belonging to a logical NDB and to UDFs of logical virtual children. Before you can execute this function, a DBID and FNR must have been assigned to the segment **(see above)**.
blank	**Change DBID/FNR** Change a previously assigned DBID and/or FNR. For changing a DBID or FNR, the same rules concerning DBID and FNR specification apply as for assigning a DBID/FNR **(see above)**.

Edit an NDB Segment Description

Additional segment fields, so-called user-defined fields (UDFs), can be defined.

This function is invoked either by entering function code E, an NDB name and a segment name on the **NDB Maintenance** menu, or by selecting the segment from the **Segment List** (by marking it with function code E). A DBID and a FNR must have been assigned to a segment description (function code A on the **Segment List** display) before it can be edited.

```
EDIT command:      DBD  ED00DBD  SEGMENT STUDENT  SEGLGH 40-40
 ALL  LEV  SN      FIELD NAME      START  DLI MAXOCC FOR LGH  V
      -------------------------------------------------------
       1   PM  EMPNO               00001  SQU         A    6
       1   PN  NAME                00007  SRC         A   33
       1   PO  GRADE               00040  SRC         A    1
       1   AA  BIRTHDATE           00025              A
       2   AB  DATE-DD                                N    2
       2   AC  DATE-MM                                N    2
       2   AD  DATE-YY                                N    2
       1   AE  BIRTHPLACE                             A   10
       1   AF  STUDENT-NAME        PN                 A   18
```

The following information is displayed on the status line at the top of the screen:

DBD	Name of the DBD which contains the edited segment.
SEGMENT	Name of the edited segment.
SEGLGH	Minimum and maximum length of the edited segment, separated by a hyphen.

DL/I fields and user-defined fields are displayed as shown above. You can add, delete or modify UDFs. DL/I fields, however, can neither be added nor deleted. If the specification TYPE=P is included in the FIELD statement of the DL/I DBD, the format of the field can be changed from P (decimal packed unsigned) to S (decimal packed signed) on the edit segment description screen. FOR (format) is the only attribute of a DL/I field you can modify. In particular, it is not possible to change the name of a DL/I field, because it is used by Natural to build the segment search arguments (SSA). If the name of a DL/I field is to be changed, the field can be redefined as an UDF.

Edit commands are available to copy or delete single lines or to insert a group of empty lines. In addition, commands for scrolling forward or backward are provided. For details you can enter a question mark in the "command" field to display the corresponding help information.

After modification of segment field attributes you can save the description by entering SAVE in the command field.

The following field definition attributes are displayed and can be modified for user-defined fields:

Attribute	Description
LEV	Level number used to define a group of fields.
SN	Short name of the field as used internally by Natural.
FIELD NAME	Name of the field as used in the application programs.
START	Start position of the field in the segment.
DLI	Type of the DL/I field, as follows: SIX secondary index field SQU sequence field (unique) SQM sequence field (multiple) SRC search field
MAXOCC	Maximum number of occurrences of a multiple field or periodic group.
FOR	Format of the field.
LGH	Length of the field.
V	Variable field length indicator.

Each user-defined field can be defined as follows:

Field Type	Description
Elementary Field	A field that contains only one value in a single segment. Example: Personnel number
Multiple Field	A field that can contain more than one value in a single segment. Reference to a particular value of a multiple field can be made by appending a one to three-digit subscript (value `1` - `191`) to the field name. Example: Languages - English, German, Italian
Group	A series of one or more adjacent fields that can be referenced with a single name (the group name). You can also refer to a single field of a group by specifying its name. Example: `01` Address Group field `02` City Elem. field `02` Street " " `02` Number " "
Periodic Group	A group which is repeated in multiple adjacent occurrences in a single segment. For a periodic group it is possible to refer to a range of occurrences (or a field within a periodic group) by specifying the first and the last occurrence number to be referenced (connected by a hyphen (-)) after the name and in ascending order. Multiple-value fields or periodic groups are not allowed within a periodic group. Example: Several addresses

Since DL/I fields cannot be modified as described above (with the exception of `FORMAT`), they cannot be directly defined as a group. To define a DL/I field as a group, it is necessary to redefine it as a user-defined field which then can be redefined as a group. In a DDM, these user-defined fields must not be specified as descriptor fields. When a DDM is generated, the UDFs are marked as non-descriptor fields.

Example - Redefinition of a DL/I Sequence Field as a Group:

The description of the segment `STUDENT` within the DBD named `ED00DBD` is used as shown in the **Segment List** screen above:

```
LEV  SN    FIELD NAME        START  DLI   NOCC  FOR LGH  V
-----------------------------------------------------------
  1  PM  EMPNO               00001  SQU          A    6
  .
  .
  .
```

If the DL/I sequence field PM is to be "structured", it must be redefined as a user-defined field (AAAAA in the figure below). This UDF can then be structured as required.

```
LEV  SN    FIELD NAME        START  DLI   NOCC  FOR LGH  V
-----------------------------------------------------------
  1  PM  EMPNO               00001  SQU          A    6
  .
  .
  .
  1  AA  AAAAA               PM
  2  AB  BBBBB                                    A    3
  2  AC  CCCCC                                    A    3
  .
  .
  .
```

The group field AAAAA has no format/lenght (FOR/LGH) specified. The length of a group is set equal to the sum of all fields belonging to the group.

UDF Parameters

For each user-defined field on the above screen, parameters can be specified as listed and described in the following table. The total length of all DL/I fields and user-defined fields must not exceed the segment length.

When attributes of a UDF are modified and an old copy of this UDF is contained in the shared UDF buffer pool, the old copy is marked "invalid". If the UDF is referred to again by a Natural program, the modified UDF is read from the Natural system file. Therefore, it is not necessary to restart the Natural session if a UDF has been modified. However, this applies only to physical UDFs; that is, to UDFs of a physical NDB. If a physical UDF is modified and a logical NDB refers to the appropriate segment type, the logical UDF is not marked "invalid" in the buffer pool. To invalidate a logical UDF it is necessary to restart the TP monitor or to execute function N (**Take New Copy of UDF**) of the **Segment List** screen on the appropriate segments in the logical NDB.

Field	Description
LEV (level number)	A one-byte value used to define a group. A field is a group only if the subsequent field has a higher level number. The field immediately after the last group element must have a lower level number. A group can be defined within another group. The level number of the first user-defined field must be 1.
SN (short name)	The name used internally by Natural to identify the field. It must be two bytes in length, the first character must be alphabetic in the range from A to G (E is not permitted). The second character can be alphanumeric (that is, up to 216 UDF fields can be defined). If the segment is a logical child, the first character must be alphabetic in the range from H to M. Short names must be unique among a segment type.
FIELD NAME	External field name, up to 19 bytes long.

Field	Description
START	The start position of the field in the segment. The position can be specified as absolute by giving a three-digit number or it can be specified as relative, by giving the short name of a previously defined field which is being redefined. It is important to specify the start position for the first user-defined field; otherwise, a default of 1 is used, which may cause overlapping with previous DL/I fields. The default for all other user-defined fields is the position immediately after the previous field. The redefinition of fields is possible only for fields which have the same level number. When the level is higher than 1 (that is, for a field inside a group), only the last field can be redefined with the same level number. An absolute position must not be specified for a field within a group.
MAXOCC	The maximum number of occurrences of a multiple -value field or periodic group in a segment.
FOR (format)	Standard field formats are: A Alphanumeric B Binary F Fixed Point P Packed decimal unsigned; that is, the zone halfbyte of the last byte is X'F'. S Packed decimal signed; that is, the zone halfbyte of the last byte is X'C' (positive) or X'B' (negative). N Unpacked
LGH (length)	Field length is a three-digit number; it must not exceed the maximum length permitted. These are as follows: 253 bytes for alphanumeric fields (A), 126 bytes for binary fields (B), 4 bytes for fixed point (F), 14 bytes for packed decimal unsigned (P), 14 bytes for packed decimal signed (S), 27 bytes for unpacked decimal (N) In addition, the length specified must not exceed the segment length. Length must not be specified for a group. The length of packed fields is the field length in bytes.
V (variable)	Depending on its value, V or blank, this parameter indicates whether a field has a variable length. Fields can be specified as variable only if the segment is a segment of variable length. Only one field can be defined as variable within a given segment description. An elementary field can be specified as variable in length only if it is the last field in the segment. A multiple field or a periodic group can be specified as variable in length regardless of its position in the segment.

Field	Description
	When applied to a multiple field or a periodic group, a setting of VARIABLE means that the number of occurrences is not known at definition time; therefore, MAXOCC should be specified using the maximum expected value.

Generate DDM from Segment Description

This function is invoked either by using the G function code of the **NDB Maintenance** menu - then an NDB name and a segment name must be specified -, or by selecting the segment from the **Segment List**, by marking it with function code G.

A DBID and a FNR must have been assigned to a segment description (function code A on the **Segment List** display) before a DDM can be generated.

The DDM is generated from a segment description and represents a Natural view of the segment. It must be generated and cataloged before the corresponding segment can be referenced by a Natural program. After generation, default options for field headers or edit masks (decimal positions) can be modified in the DDM. See *Catalog DDM* and *Edit DDM* in the Natural *Utilities* documentation for corresponding information.

It should be noted, however, that default options for field headers or edit masks (decimal positions) are stored with the DDM and not with the NDB or UDF. The data in the NDB or UDF reflects what is allowed by the DL/I FIELD macro in which the length can be specified only in bytes (decimals are not allowed). Consequently, when regenerating the DDM, prior modifications in the DDM must be applied again by the user.

In DL/I a program must be able to reference search fields, sequence fields and secondary index fields of ancestor segments in order to build a certain search criterion; therefore, DDMs for DL/I segments can also include fields which are not part of the actual physical segment.

To satisfy the requirements for DL/I processing, a DDM must contain all the fields which can be referenced. Therefore, the generated DDM can contain the following fields:

- DL/I sequence fields, search fields and secondary index fields of the current (physical) segment. These fields have been defined in the DBDGEN source for this segment. When the DDM is generated, information on these fields is obtained from the NDB control block for this segment. DL/I sequence fields and secondary index fields are marked as descriptor (D), search fields are marked as non-descriptor (N). All of these fields can be used to qualify search requests.
- DL/I sequence fields and secondary index fields of all the ancestor segments. These fields have been defined in the DBDGEN source for the ancestor segments. When the DDM is generated, information on these fields is obtained from the NDB control blocks for the ancestor segments. These fields are marked as descriptor (D). They can be used to qualify search requests.
- DL/I search fields of all the ancestor segments. These fields have also been defined in the DBDGEN source for the ancestor segments. When the DDM is generated, information on these fields is

also obtained from the NDB control blocks for the ancestor segments. However, these fields are marked as superdescriptor (S). They can be used to qualify search requests.

- Fields of the current segment defined by the user (UDFs). When the DDM is generated, information on these fields is obtained from the UDF control blocks. These fields cannot be used to qualify search requests.

Fields of format S in the segment description (see ***UDF Parameters***) generate format P in the DDM.

The following tables summarize how the various types of fields can be processed using Natural I/O statements. They illustrate which fields can be used to qualify search requests, and which fields can be used with the Natural statements DISPLAY, UPDATE or STORE. In addition, the tables indicate whether the field in the generated DDM is marked as descriptor, superdescriptor or non-descriptor.

Current Segment

Type of field	FIND/READ	DISPLAY	UPDATE	STORE	Marked
DL/I sequence	yes	yes	no	yes	D
DL/I search	yes	yes	yes	yes	D
DL/I SIX	yes	yes	no	no	D
UDF	no	yes	yes	yes	blank

Ancestor Segment

Type of field	FIND/READ	DISPLAY	UPDATE	STORE	Marked
DL/I sequence	yes	yes	no	yes	D
DL/I search	yes	no	no	no	S
DL/I SIX	yes	yes	no	no	D
UDF	no	no	no	no	blank

Notes:

1. Using the Natural staement DISPLAY, the DL/I SIX fields can be displayed only if a PCB is used with this SIX specified in the PROCSEQ parameter. If not, an error message is returned by Natural at runtime.
2. The DL/I SIX field name cannot be used in an UPDATE or STORE statement. SIX fields, however, can be updated/stored by referring to the source fields which comprise the SIX.
3. The READ statement returns records in ascending sequence. The possible sequences for DL/I segments are root sequence or the sequence of any secondary index.

As mentioned above, the generated DDM contains all fields of the current segment and all DL/I fields of the ancestor segment(s), marked either as `D` or `S`. The UDFs of the ancestor segments are not included in the generated DDM because a DDM refers only to one segment.

The generated external name of the DDM is equal to the segment name prefixed by the DBD name.

Example:

Name of DBD:	`EDOODBD`
Name of segment:	`STUDENT`
Name of generated DDM:	`EDOODBD-STUDENT`

The generated external name of DL/I fields is equal to the name specified in the DL/I FIELD macro during the DL/I DBDGEN procedure.

The generated external name of DL/I fields of ancestor segments is equal to the field name suffixed by the segment name.

Example:

Name of DL/I field:	`LOCATION`
Name of ancestor segment:	`OFFERING`
Name of generated field:	`LOCATION-OFFERING`

The generated external name of the UDFs is equal to the name specified by the user at definition time.

NSB Maintenance

When you select **NSB Maintenance** on the **DL/I Services Main Menu**, the **NSB Maintenance** menu is displayed.

From this menu, you can select the following NSB maintenance functions:

Function	Explanation
Select an NSB from a List	List the DL/I PSBs defined on the Natural system file. You can select NSBs from this list by entering the function code `P` to purge an NSB, or `L` to list all PCBs and SENSEGs of an NSB.

Function	Explanation
Purge an NSB	Delete an NSB and its related PCB descriptions from the Natural system file. The name of the NSB to be deleted must be specified. Before this function is executed, you are prompted to confirm the deletion.
`List PCBs and SENSEGs of an NSB`	For any NSB specified, this function lists the PCBs and their sensitive segments. If an indexed database exists, its name is displayed under the header “PROCSEQ”.

Select an NSB from a List

```
10:44:50                  **** DL/I SERVICES ****                    2006-05-25
                                - NSB List -

               Func     NSB Name  CMPAT  Length  NoPCBs   Response
               ----------------- Top of Data  -------------------
                 _      DFSIVP6    YES     140       3
                 _      PBNDL01    NO      160       3
                 _      PBNDL02    YES     160       1
                 _      PBNDL03    YES     160       3
                 _      PBNDL04    YES     160       1
                 _      PBNDL05    NO       80       1
                 _      PBNDL97    YES     160       3
                 _      PBNDL98    YES     200       5
                 _      PBNDL99    NO      200       5
                 _      PBPQA01    YES      60       5
                 _      PBSUP06    NO      440       5
               -------------------- - More - ---------------------
         Code .. _ ( ? Help, . Back, M End )


         Func .. P (Purge NSB) L (List PCBs and SENSEGs)

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
Exec  Help        Exit                                                   Canc
```

List PCBs and SENSECs of an NSB

```
10:46:57                  **** DL/I SERVICES ****                    2006-05-25
                                - PCB List -
  NSB Name: PBNDL01  (CMPAT=NO ,Length=00160)

      Number of PCB's  NDB Name     Level    SENSEG         PROCSEQ
      -------------------------- Top of Data --------------------------
              3        ED00DBD
                                       1     COURSE
                                       2     PREREQ
                                       2     OFFERING
```

```
                                        3     TEACHER
                                        3     STUDENT





         -------------------------- Bottom -----------------------------

      Code .. _ ( ? Help   . Back   M End )

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
Exec  Help        Exit                                                   Canc
```

```
10:49:10                   **** DL/I SERVICES ****                    2006-05-25
                                 - NDB List -

          Func     NDB Name  L/P  Length  NoSGMs  Access   Response
          ---------------------- Top of Data  ---------------------
            _      CCCBTD00   P     460       6
            _      DNDL01     P     540       5
            _      DNDL02     P     620      10
            _      DNDL03     L     820      10
            _      DNDL04     P      60       1   GSAM
            _      DPQA04     P     480       5
            _      DSUP02     L    1720      15
            _      DSUP05     P     380       5
            _      DSUP09     P     340       2
            _      DSUP10     L     880      10
            _      DUSA01     P     320       5   HDAM
          ------------------------ - More - -----------------------
    Code .. _ ( ? Help,  . Back,  M End )


      Func: P (Purge NDB) L (List NDB Segments)

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--PF12---
Exec  Help        Exit                                                   Canc
```

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