Natural

Database Management System Interfaces

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ADABAS & NATURAL

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Table of Contents

Database Management System Interfaces ix
1 About this Documentation 1
Document Conventions 2
Online Information and Support 2
Data Protection 3
I Natural for Db2 5
2 About Natural for Db2 7
What is Natural for Db2 8
Environment-Specific Considerations 8
Integration with Predict 11
Integration with Natural Security 11
Incompatibilities and Constraints 12
Messages Related to Db2 12
Terms Used in this Documentation 13
3 Accessing a Db2 Table 15
4 Using Natural Tools for Db2 17
Invoking Natural Tools for Db2 18
Editing within the Natural Tools for Db2 19
Global PF-Key Settings 21
Global Maintenance Commands 21
5 Application Plan Maintenance 23
About Application Plan Maintenance 24
Invoking the Application Plan Maintenance Function 24
Commands and PF-Key Settings 26
Prepare Job Profile 27
Create DBRMs 35
Bind Plan 37
Rebind Plan 41
Free Plan 43
Bind Package 44
Rebind Package 47
Free Package 50
List JCL Function 51
Display Job Output 52
6 Catalog Maintenance 55
Switching Between Fixed Mode and Free Mode 56
Invoking the Catalog Maintenance Function 58
Create Table Function 59
Create Tablespace Function 70
Alter Table Function 72
Alter Tablespace Function 79
SQL Skeleton Members 82
7 Interactive SQL 85

Invoking the Interactive SQL Function ... 86
SQL Input Members ... 87
Data Output Members ... 96
Processing SQL Statements ... 100
PF-Key Settings ... 104
Unloading Interactive SQL Results ... 105
8 Retrieval of System Tables ... 107
Invoking the Retrieval of System Tables Function ... 108
List Databases ... 111
List Tablespaces ... 113
List Plans ... 115
Commands Allowed on Plans ... 116
List Packages ... 122
List Tables ... 124
User Authorizations ... 126
List Statistic Tables ... 128
9 Environment Setting ... 131
Invoking the Environment Setting Facility ... 132
Connect ... 133
Release ... 134
Set Connection ... 135
Set Current SQLID ... 136
Set Current Packageset ... 137
Set Current Degree ... 138
Set Current Rules ... 139
Set Current Optimization Hint ... 140
Set Current Locale LC_CType ... 141
Set Current Path ... 142
Set Current Precision ... 144
Set Current Maintained Types for Optimization ... 144
Set Current Package Path ... 145
Set Current Refresh Age ... 146
Set Current Schema ... 147
Set Current Application Encoding Scheme ... 149
Set Encryption Password ... 150
Display Special Registers ... 152
10 Explain PLAN_TABLE ... 155
EXPLAIN Modes ... 156
Invoking the EXPLAIN_TABLE Function ... 158
List PLAN_TABLE - Latest Explanations ... 161
List PLAN_TABLE - All Explanations ... 161
Delete from PLAN_TABLE ... 164
Explain PLAN_TABLE Facility for Mass and Batch Processing ... 165
11 File Server Statistics ... 169
12 Issuing Db2 Commands from Natural ... 175

Invoking the Db2 Command Part ... 176
Displaying the Command File ... 177
Displaying the Output Report ... 179
13 Using Natural System Commands for Db2 ... 181
14 Generating Natural Data Definition Modules (DDMs) ... 183
SQL Services (NDB) ... 184
15 Dynamic and Static SQL Support ... 193
About SQL Support in Natural ... 194
Internal Handling of Dynamic Statements ... 195
Preparing Programs for Static Execution ... 198
Execution of Natural in Static Mode ... 206
Mixed Dynamic/Static Mode ... 207
Messages and Codes ... 207
Application Plan Switching ... 207
16 Using Natural Statements and System Variables ... 213
Db2 Special Register Consideration ... 214
Using Natural Native DML Statements ... 214
Using Natural SQL Statements ... 226
Using Natural System Variables ... 242
Multiple Row Processing ... 242
Error Handling ... 251
17 Processing Natural Stored Procedures and UDFs ... 253
Types of Natural UDF ... 254
PARAMETER STYLE ... 254
Writing a Natural Stored Procedure ... 263
Writing a Natural UDF ... 265
Example Stored Procedure ... 266
Example Natural User Defined Function ... 269
18 Interface Subprograms ... 271
Natural Subprograms ... 272
NDBCONV Subprogram ... 273
NDBDBRM Subprogram ... 274
NDBDBR2 Subprogram ... 275
NDBDBR3 Subprogram ... 276
NDBDBRZ Subprogram ... 278
NDBERR Subprogram ... 279
NDBISQL Subprogram ... 280
NDBISQLD Subprogram ... 282
NDBNOERR Subprogram ... 284
NDBNROW Subprogram ... 285
NDBSTMP Subprogram ... 285
DB2SERV Interface ... 286
19 Natural File Server for Db2 ... 293
About the File Server for Db2 ... 294
Preparations for Using the File Server ... 294

Logical Structure of the File Server ... 299
20 Tracing Dynamic SQL Statements ... 303
Enabling Tracing for Dynamic SQL Statements ... 304
Tracing Dynamic SQL Statements ... 305
II Natural for Db2 for zIIP ... 311
21 About Natural for Db2 for zIIP ... 313
Architecture overview ... 315
Installation structure ... 316
Natural Batch Considerations ... 317
Performance Considerations ... 318
Db2 Considerations ... 319
22 Restrictions ... 323
Restrictions Related to Db2 Datatypes ... 324
Restrictions Related to Db2 Statements ... 325
Restrictions Related to Static Preparation ... 326
Restrictions Related to Dynamic Execution ... 326
23 Operation ... 329
NDZ Server Commands ... 330
24 Configuration and Parameters ... 335
Configuration ... 336
Parameters ... 338
25 Error codes ... 343
26 Preparing Programs for Static Execution ... 347
About Preparation for Static Execution with NDZ ... 348
Static Preparation Steps ... 349
Unix Shell Scripts for Static Preparation ... 357
Comparison Between NDZ and NDB Static Preparation ... 358
27 Static Program Execution ... 361
III Natural for VSAM ... 363
28 About Natural for VSAM ... 365
What is Natural for VSAM ... 366
Environment-Specific Considerations ... 366
Natural for VSAM with Natural Security ... 367
Integration with Predict ... 367
Terms Used in this Documentation ... 368
Messages Related to VSAM ... 368
29 Natural for VSAM Structure ... 369
Components of Natural for VSAM ... 370
Structure of the Natural Interface to VSAM ... 371
30 Customizing Natural for VSAM ... 373
Customizing the Natural Parameter Module ... 374
Assembling the VSAM-specific Natural Parameter Module ... 376
Natural I/O Modules for VSAM ... 376
31 Operation ... 381
Invoking Natural for VSAM ... 382

OPEN/CLOSE Processing 382
Natural File Access 384
Buffers for Memory Management 395
Application Programming Interfaces 400
32 Natural Statements and Transaction Logic with VSAM 403
Natural Statements with VSAM 404
Natural Transaction Logic with VSAM 409
IV Natural Messaging 413
33 About Natural Messaging 415
What is Natural Messaging? 416
Components of Natural Messaging 416
Environment-Specific Considerations 417
Terms Used in this Documentation 420
34 Customizing Natural Messaging 421
Customizing the Natural Parameter Module 422
Changing the DBID of the DDM Used for Natural Messaging 423
Changing the Length of the MESSAGE Field in the MQ-QUEUE DDM 423
Increasing the Natural Thread Size for Large MQ Payloads 424
35 Working with the Natural Interface for Messaging 425
Invoking Natural Messaging 426
Communication between Natural and Messaging Systems 426
Buffers for Memory Management 426
36 Natural Statements and View Description with Natural Messaging 427
Introduction 428
Accessing Natural Messaging in Natural Programs 428
View Description 435
Index 441

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 Db2 for zIIP	The Natural for Db2 for zIIP interface enables Natural users to run Db2 workloads on IBM System z Integrated Information Processors (zIIP).
Natural for VSAM	The Natural interface to VSAM enables Natural users to access data stored in VSAM files.
Natural Messaging	The Natural interface to IBM MQ enables Natural to get and put messages from and to MQ.

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

1 About this Documentation

- Document Conventions 2
- Online Information and Support 2
- Data Protection 3

Document Conventions

Convention	Description
Bold	Identifies elements on a screen.
`Monospace font`	Identifies service names and locations in the format *`folder.subfolder.service`*, APIs, Java classes, methods, properties.
`Italic`	Identifies: Variables for which you must supply values specific to your own situation or environment. New terms the first time they occur in the text. References to other documentation sources.
`Monospace font`	Identifies: Text you must type in. Messages displayed by the system. Program code.
{ }	Indicates a set of choices from which you must choose one. Type only the information inside the curly braces. Do not type the { } symbols.
|	Separates two mutually exclusive choices in a syntax line. Type one of these choices. Do not type the | symbol.
[ ]	Indicates one or more options. Type only the information inside the square brackets. Do not type the [ ] symbols.
...	Indicates that you can type multiple options of the same type. Type only the information. Do not type the ellipsis (...).

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I Natural for Db2

This documentation describes the functionality and the use of Natural for Db2, which is a Natural interface required to access data in a Db2 database.

About Natural for Db2	Information such as purpose, environment-specific considerations, integration with Predict, incompatibilities and constraints, error messages related to Db2, and terms used in this documentation.
Accessing a Db2 Table	Enable access to a Db2 table with a Natural program.
Using Natural Tools for Db2	Invoke Natural Tools for Db2 to maintain Db2-specific objects and SQL statements.
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.
Issuing Db2 Commands from Natural	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.
Tracing Dynamic SQL Statements	Dynamic SQL Trace into shared memory object above the bar.

Related Documentation

For installation instructions and a description of the Natural for Db2 parameter module, refer to *Installing Natural for Db2* in the *Installation for z/OS* documentation.

For the various aspects of accessing data in a database with Natural, see also *Database Access* 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.

2 About Natural for Db2

- What is Natural for Db2 8
- Environment-Specific Considerations 8
- Integration with Predict 11
- Integration with Natural Security 11
- Incompatibilities and Constraints 12
- Messages Related to Db2 12
- Terms Used in this Documentation 13

What is Natural for Db2

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 or VSAM. 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 and VSAM. Therefore, programs written for Db2 tables can also be used to access Adabas or VSAM 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 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-conversational mode, set the keyword subparameter FSERV of Natural profile parameter DB2 to 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 keyword subparameter CONVERS of Natural profile parameter DB2 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 setting the keyword subparameter CONVRS2 of Natural profile parameter DB2 to ON 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 NTDB2 macro.

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 `NTDB2` macro.

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 `NTDB2` macro.

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.

Integration with Predict

Predict, an 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 shows the known incompatibilities and constraints against Db2 when using Natural for Db2 to access data from Db2.

- Data Type DECIMAL or NUMERIC

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 precision and scale of up to 29 digits.

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* 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 data sets, modules, etc.

3 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***. In the *Statements* documentation, you can find notes on Natural usage with Db2 attached to the descriptions of the Natural DML statements concerned.

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 Natural SQL statements; see ***Using Natural SQL Statements***. They are listed and explained in the *Statements* documentation.

4 Using Natural Tools for Db2

- Invoking Natural Tools for Db2 18
- Editing within the Natural Tools for Db2 19
- Global PF-Key Settings 21
- Global Maintenance Commands 21

This section describes how to invoke Natural Tools for Db2 and maintain Db2-specific objects and SQL statements. In addition, this section provides information on global PF-key settings and global maintenance commands within Natural Tools for Db2.

Notes:

1. See also *Special Requirements for Natural Tools for Db2* in *Installing Natural for Db2 on z/OS*.
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.
PRINT		Prints the data displayed.

Command	PF Key	Description
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.

5 Application Plan Maintenance

- About Application Plan Maintenance 24
- Invoking the Application Plan Maintenance Function 24
- Commands and PF-Key Settings 26
- Prepare Job Profile 27
- Create DBRMs 35
- Bind Plan 37
- Rebind Plan 41
- Free Plan 43
- Bind Package 44
- Rebind Package 47
- Free Package 50
- List JCL Function 51
- Display Job Output 52

About Application Plan Maintenance

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 Profiles*.
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.
PF10	Either shows the previous screen (<) or displays a **Entire System Server 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 data set `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 data set 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 )

 >---------+------- +-------------------------------------------+ ---------->&lt;
           +---- S  ! NAT Library,NAT Member,excl.Member  1 / 2  !
                    !      Test____ , PROG1___ , ________        !
                    !      Test____ , P*______ , PROG1___        !
>>----------------- !      ________ , ________ , ________       ! ---------->&lt;
                    !      ________ , ________ , ________        !
                    !      ________ , ________ , ________        !
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 J0.

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 data sets, 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 data set 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 data set of the type specified in the Sysout type field.

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

6 Catalog Maintenance

- Switching Between Fixed Mode and Free Mode 56
- Invoking the Catalog Maintenance Function 58
- Create Table Function 59
- Create Tablespace Function 70
- Alter Table Function 72
- Alter Tablespace Function 79
- SQL Skeleton Members 82

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 SQLCODE required to maintain the desired Db2 object. You can display, modify, save, and retrieve the generated SQLCODE.

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

Switching Between 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 SQLCODE. 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 SQLCODE 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 SQLCODE 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 SQLCODE 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
```

  On the **Natural Tools for Db2 Main Menu**, enter function code `C`, and press ENTER.

  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 SQLCODE:

```
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 object that contains an SQL skeleton that complies with the Db2 SQL syntax rules as described in the relevant IBM literature. The replaceable 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 text objects are delivered in the Natural system library `SYSDB2`, along with example SQL text objects.

7 Interactive SQL

- Invoking the Interactive SQL Function 86
- SQL Input Members 87
- Data Output Members 96
- Processing SQL Statements 100
- PF-Key Settings 104
- Unloading Interactive SQL Results 105

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 (text objects) in the interactive SQL input screen.
O	Displays output members (text objects) 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 (text objects). 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 (text object) 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 (text object) 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, SQLCODE 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 SQLCODE and remain on the **Create Table** screen.

Using PF5 (IBack), you include the generated SQLCODE and return to the **ISQL - Input** screen.

Retrieve an SQL Member

If you specify a unique member (text object) 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 SQLCODE 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 (text objects) 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 (text object) 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 (text objects) 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 SQLCODEs          !
 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            :  _______  !
                                      !                                       !
                                      ! Database type(DB2,CNX)    : DB2       !
                                      ! 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 (text object) currently on 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 (text object) 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 data set 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 (text object) 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.

8 Retrieval of System Tables

- Invoking the Retrieval of System Tables Function 108
- List Databases 111
- List Tablespaces 113
- List Plans 115
- Commands Allowed on Plans 116
- List Packages 122
- List Tables 124
- User Authorizations 126
- List Statistic Tables 128

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* in *Installing Natural for Db2 on z/OS*.

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.

Parameter	Description
`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.

9 Environment Setting

- Invoking the Environment Setting Facility 132
- Connect 133
- Release 134
- Set Connection 135
- Set Current SQLID 136
- Set Current Packageset 137
- Set Current Degree 138
- Set Current Rules 139
- Set Current Optimization Hint 140
- Set Current Locale LC_CType 141
- Set Current Path 142
- Set Current Precision 144
- Set Current Maintained Types for Optimization 144
- Set Current Package Path 145
- Set Current Refresh Age 146
- Set Current Schema 147
- Set Current Application Encoding Scheme 149
- Set Encryption Password 150
- Display Special Registers 152

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 = ----- __________ -------------------><
                                 ( 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 -


>>--- SET 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 ----------------------------------------------------->


 >--+- ____________________________________________________________ -+--><

    !                          (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**.

10 Explain PLAN_TABLE

- EXPLAIN Modes 156
- Invoking the EXPLAIN_TABLE Function 158
- List PLAN_TABLE - Latest Explanations 161
- List PLAN_TABLE - All Explanations 161
- Delete from PLAN_TABLE 164
- Explain PLAN_TABLE Facility for Mass and Batch Processing 165

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* in *Installing Natural for Db2 on z/OS*.

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.

Parameter	Description
	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.
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/Package .. ________
                          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 `0` 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 data set referred to by DD name `CMPRT01` (logical printer 1).

11 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.

12 Issuing Db2 Commands from Natural

- Invoking the Db2 Command Part 176
- Displaying the Command File 177
- Displaying the Output Report 179

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).

13 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.
`LISTPROF`	Displays either a list of SQLJ profiles (created by NDZ static generation) for a particular Natural program or a list of Natural programs that reference a particular SQLJ profile.

For a description of these commands, follow the links leading to the Natural *System Commands* documentation.

14 Generating Natural Data Definition Modules (DDMs)

- SQL Services (NDB) 184

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)

The **SQL Services (NDB)** 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 z/OS or a Linux 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 z/OS Db2 or a Linux 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 `NTDB2` macro; otherwise you might get SQLCODE `-518`.

- Using SQL Services
- Select SQL Table from a List
- Generate DDM from an SQL Table
- List Columns of an SQL Table

- Making a User Exit Routine Available

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__________
      Remark ....... O (Overwrite/SQL/Comment)




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 value in the **Table Name** and/or **Creator** fields. You can use asterisk notation (*) or the greater-than character (>) for a 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
- Assigning Default Values - Generating DDMs in Batch
- 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**. The default setting is is `Y` (Yes).
  - 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.

    By default, **Replace** is set to `N` (No) to prevent an existing DDM from being replaced accidentally.
  - In the **Remark** field you can specify the contents of the DDM **Remark** column. Enter:

`O` (Overwrite)	for SQL column remarks if defined, overwritten by field information generated by Natural if available. This is the default setting;
`S` (SQL)	for SQL column remarks if defined and blank otherwise;
`C` (Comment)	for field information generated by Natural if available. SQL column remarks will be copied to a separate DDM comment line.

    By default, **Remark** is set to `O` (Overwrite).
  - To define or alter a default value for the fields **Code**, **Table Name**, **Creator**, **Replace**, **DDM Name with Creator** or **Remark** use user exit `NDBDDM-2` and its data area `NDBDDM-L` provided in library `SYSDB2`. See *Making a User Exit Routine Available*. For detailed information on how to handle `NDBDDM-2`, refer to the remarks in its source.

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.

Assigning Default Values - Generating DDMs in Batch

To avoid user interaction popup windows during DDM field generation, the user exit `NDBDDM-1` and its data area `NDBDDM-L` provided in library `SYSDB2` can be used. For detailed information on how to handle `NDBDDM-1`, refer to the remarks in its source. See also ***Making a User Exit Routine Available***.

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) for the database type Db2. Any DBID not within this range is not accepted. The FNR can be any valid file number within the database (between 1 and 65535).

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 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 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.

Variable	Content
Not	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.II.SS.MMMMMM*. Alternatively, you can generate the Natural TIME field (data format T) as Db2 TIMESTAMP data type if the DBTSTI option of the COMPOPT system command is set to ON (see the *System Commands* documentation).

You can use the Natural subprogram NDBSTMP to compute TIMESTAMP (A26) fields.

Making a User Exit Routine Available

You can customize the **Generating Natural Data Definition Modules (DDMs)** map with user exit routine NDBDDM-1 or NDBDDM-2.

To make user exit routine NDBDDM-1 or NDBDDM-1 available

1 Catalog the NDBDDM-*num* source object under the name NDBDDMU*num* in library SYSDB2.

Note: The names of the source object and the cataloged object of the user exit routine must be different to ensure that the overwriting of the source object during an update installation does not affect the cataloged object.

2 Copy NDBDDMU*num* to steplib SYSLIBS.

A subprogram used by SYSDDM searches for NDBDDMU*num* in steplib SYSLIBS.

15 Dynamic and Static SQL Support

- About SQL Support in Natural 194
- Internal Handling of Dynamic Statements 195
- Preparing Programs for Static Execution 198
- Execution of Natural in Static Mode 206
- Mixed Dynamic/Static Mode 207
- Messages and Codes 207
- Application Plan Switching 207

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* in the Natural *Messages and Codes* documentation.
- For information on Static SQL with Natural Security, see ***Integration with Natural Security***.

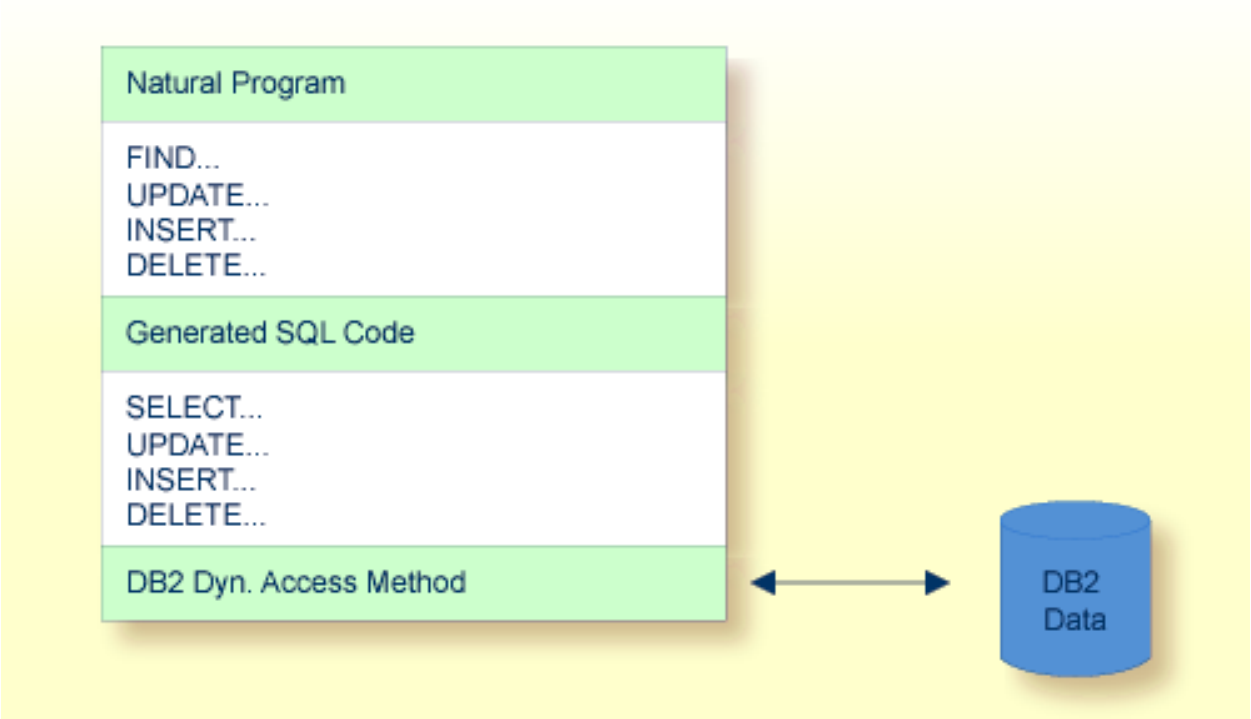
About SQL Support in Natural

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 SQLCODE, 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 Modifications for Natural for Db2* in *Installing Natural for Db2 on z/OS* in the *Installation* documentation) 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:

- About Static Execution in Natural
- Generation Procedure - CMD CREATE Command
- Precompilation of the Generated Assembler Program
- Modification Procedure - CMD MODIFY Command
- Modification Procedure - CMD MODIFYZ Command
- BIND of the Precompiled DBRM
- Impact of the DB2 MF parameter

For an explanation of the symbols used in this section to describe the syntax of Natural statements, see *Syntax Symbols* in the *Statements* documentation.

About Static Execution in Natural

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 medium 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

`Static-name` either specifies the name of the DBRM to be created by the static generation for NDB or the name of the SQLJ profile to be created by the static generation of NDZ.

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 { YES   } ] [ FS { OFF } ] [LIB                 [ DCTODP { OFF } ]
{ PREDICT        } [ XREF { NO    } ] [ FS { ON  } ] lib-name [ DCTODP { ON  } ]
{ DOCUMENTATION  } [ WITH { FORCE } ] [ FS { ON  } ] ]
```

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.

DCTODP Option

The DCTODP option is only relevant if you are doing a static generation for programs which have been catalogued with Natural parameter DC=',’.

By the DCTODP parameter it can be determined whether the static generation will change decimal literals in SQL statements by replacing the decimal character comma ‘,’ by the decimal character period ‘.’ in the generated static SQL assembler program. This will be necessary since the Db2 precompiler does not support decimal point comma in decimal literals.

When DCTODP OFF is specified no conversion of decimal point comma to decimal point period will take place. DCTODP OFF is the default value.

When DCTODP ON is specified static generation will convert decimal point comma to decimal point period.

If DCTODP ON is used, you should be sure your programs are coded unambiguously when using the comma as separator in function calls and various SQL clauses like IN or ORDER BY so that the comma as separator in element lists can’t be misinterpreted as decimal point of a decimal literal

For instance, if you code a SQL IN clause while using DC=',’ like

Column-name IN (10,20,30,40).

Static generation with DCTODP ON change the IN clause to

Column-name IN (10,20 , 30,40).

IN list contains two values 10.20 and 30.40.

The same IN clause in static generation with DCTODP OFF (default value) will be changed to

Column-name IN (10,20 , 30,40).

IN list contains four values 10 , 20 , 30 and 40.

If you had coded

Column-name IN (10 , 20 , 30 , 40).

Static generation will always generate the IN clause with DCTODP either ON or OFF to

Column-name IN (10 , 20 , 30 , 40).

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 data set 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 `CMD 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*.

Modification Procedure - CMD MODIFYZ Command

The modification procedure modifies the Natural objects involved by writing the SQLJ profile sequence number into the object and by marking the object header with the *static-name of the SQLJ profile* 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 is 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 MODIFYZ command which has the following syntax:

```
CMD MODIFYZ [XREF]
```

The input for the modifyz step is the generated SQL Assembler program by `CMD CREATE DBRM` command output which resides on a data set defined as the Natural work file `CMWKF01`.

The output consists of SQLJ 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 (remodified).

Assembler/Natural Cross-References

If you specify the `XREF` option of the `CMD MODIFYZ` 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.

```
-------------------------------------------------------------------------....
  SQLJPROF SQLJNO          LINE NATPROG  NATLIB   DB  FNR COMMENT           ....
-------------------------------------------------------------------------....
  TESTDBRM 000000      0390 TESTPROG SAG      010 042 INSERT             ....
           000001      0430                           INSERT             ....
           000002      0510                           SELECT             ....
           000003      0570                           SELECT             ....
           000004      0570                           SELECT      2ND    ....
           000005      0650                           UPD/DEL            ....
           000006      0650                           UPD/DEL     2ND    ....
           000007      0700                           SELECT             ....
           000008      0700                           SELECT      2ND    ....
```

Column	Explanation
`SQLJPROF`	Name of the SQLJ profile which contains the static SQL statement.
`SQLJNO`	SQLJ 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

We recommend that you execute the Db2 BIND command *after* the CMD MODIFY command.

The Db2 BIND command binds the DBRM into a Db2 package. You can bind one or more Db2 packages into a Db2 application plan. In addition to the packages of static DBRMs created with the CMD CREATE command, this application plan can also contain the package of the DBRM of the NDBIOMO module Natural provides for dynamic SQL execution.

A DBRM can be bound into any number of packages and the packages can be bound into any number of application plans where required. A plan is physically independent of the environment where the program is to be run. However, you can group your packages logically into plans which are to be used for either batch or online processing, where the same package 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.

Impact of the DB2 MF parameter

The DB2 MF parameter setting of the Natural session that performs the static generation, determines whether the DECLARE CURSOR statements of the generated static program contain the WITH ROWSET POSITIONING clause.

The WITH ROWSET POSITIONING clause enables the static program to use multi-fetching.

Code	Explanation
MF>0	WITH ROWSET POSITIONING clause is added to the DECLARE CURSOR statements. Multi-fetching will be used with the value of the MF parameter at execution time.
MF=0	No WITH ROWSET POSITIONING clause is added to the DECLARE CURSOR statements. Multi-fetching is not possible, regardless how the MF parameter is set at execution time. The generated static program can only operate with single-fetching.

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* in the Natural *Messages and Codes* documentation.

Application Plan Switching

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:

- About Plan Switching
- Plan Switching under CICS
- Plan Switching under Com-plete
- Plan Switching under IMS TM

- Plan Switching under TSO and in Batch Mode

About 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 the *Installing Natural for Db2 on z/OS* documentation.

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*ssssttt*t, where *ssss* is the remote or local CICS system identifier and *tttt* the CICS terminal identifier.

When running in a CICSplex environment, the CICS temporary storage queue PLAN*ssssttt*t 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

Initial connection and plan setting can be done using the subparameters DB2PLAN and DB2SSID of the NTDB2 macro or of the DB2 profile parameter without using the NATPLAN program. However, the initial settings could be overwritten by using the NATPLAN program.

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 issues the SQL call, a plan name must exist with the same name as the one of the static DBRM.

If dynamic SQL is used, a Db2 plan must exist which contains a package with the DBRM of the NDBIOMO module. If the name of the Db2 plan has neither been defined in the NATPLAN program nor with the DB2PLAN keyword subparameter, the Db2 Call Attachment Facility (CAF) uses the name of the NDBIOMO DBRM as 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

Initial connection and plan setting can be done using the keyword subparameters DB2COLL, DB2GROV, DB2PLAN, DB2SSID and DB2XID of the NTDB2 macro or of the DB2 profile parameter without using the NATPLAN program. However, the initial settings can be overwritten by using the NATPLAN program.

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
```

16 Using Natural Statements and System Variables

- Db2 Special Register Consideration 214
- Using Natural Native DML Statements 214
- Using Natural SQL Statements 226
- Using Natural System Variables 242
- Multiple Row Processing 242
- Error Handling 251

This section contains special considerations when using Natural native DML statements and Natural system variables with Natural SQL statements and 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 *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
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 except when the compiler option `DB2PKYU` is set to `ON`. If `DB2PKYU` is set to `OFF`, which is its default value, you can only update

a primary key field by using a non-cursor UPDATE operation. For more information, 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 *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 *Using Natural SQL Statements* in the *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 Conditions* in the *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_DAYS	INSTR	SIN
ADD_MONTHS	INTEGER	SINH
AI_ANALOGY	INTERPRET	SMALLINT
AI_COMMONALITY	JULIAN_DAY	SOAPHTTPC
AI_SEMANTIC_CLUSTER	LAST_DAY	SOAPHTTPV
AI_SIMILARITY	LCASE	SOAPHTTPNC
ASIN	LEAST	SOAPHTTPNV
ASCII	LEFT	SOUNDEX
ASCII_CHR	LENGTH	SPACE
ASCII_STR	LN	SQRT
ATAN	LOCATE	STRIP
ATAN2	LOCATE_IN_STRING	STRLEFT
ATANH	LOG	STPOS
BIGINT	LOG10	STRIGHT
BINARY	LOWER	SUBSTR
BLOB	LPAD	SUBSTRING
CCSID_ENCODING	LTRIM	TAN
CEIL	MAX	TANH
CEILING	MICROSECOND	TIME
CHAR	MIDNIGHT_SECONDS	TIMESTAMP
CHARACTER_LENGTH	MIN	TIMESTAMPADD
CHAR_LENGTH	MINUTE	TIMESTAMP_FORMAT
CLOB	MOD	TIMESTAMP_ISO
COALESCE	MONTH	TIMESTAMP_TZ
COLLATION_KEY	MONTHS_BETWEEN	TO_CHAR
COMPARE_DECFLOAT	MQPUBLISH	TO_CLOB
CONCAT	MQPUBLISHXML	TO_DATE
CONTAINS	MQREAD	TO_NUMBER
COS	MQREADCLOB	TO_TIMESTAMP
COSH	MQREADXML	TOTALORDER
DATE	MQRECEIVE	TRANSLATE
DAY	MQRECEIVECLOB	TRUNC
DAYOFMONTH	MQRECEIVEXML	TRUNC_TIMESTAMP
DAYOFWEEK	MQSEND	TRUNCATE
DAYOFWEEK_ISO	MQSENDXML	UCASE
DAYOFYEAR	MQSENDXMLFILE	UNICODE
DAYS	MQSENDXMLFILECLOB	UNICODE_STR

A - H	I - R	S - Z
DBCLOB	MQSUBSCRIBE	UNISTR
DEC	MQUNSUBSCRIBE	UPPER
DECFLOAT	MULTIPLY_ALT	VALUE
DECFLOAT_SORTKEY	NEXT_DAY	VARBINARY
DECIMAL	NORMALIZE_DECFLOAT	VARCHAR
DECRYPT_BIT	NORMALIZE_STRING	VARCHAR_FORMAT
DECRYPT_CHAR	NULLIF	VARGRAPHIC
DECRYPT_DB	OVERLAY	WEEK
DECRYPT_DATAKEY_BIT	POSSTR	WEEK_ISO
DECRYPT_DATAKEY_BIGINT	POW	XMLATTRIBUTES
DECRYPT_DATAKEY_CLOB	POWER	XMLCONCAT
DECRYPT_DATAKEY_DBCLOB	QUANTIZE	XMLCOMMENT
DECRYPT_DATAKEY_DECIMAL	QUARTER	XMLDOCUMENT
DECRYPT_DATAKEY_INTEGER	RADIANS	XMLELEMENT
DECRYPT_DATAKEY_VARCHAR	RAISE_ERROR	XMLFOREST
DECRYPT_DATAKEY_VARGRAPHIC	RAND	XMLMODIFY
DEGREES	RANDOM	XMLNAMESPACES
DIFFERENCE	REAL	XMLPARSE
DIGITS	REGEXP_COUNT	XMLPI
DOUBLE	REGEXG_INSTR	XMLQUERY
DOUBLE_PRECISION	REGEXP_LIKE	XMLSERIALIZE
DSN_XMLVALIDATE	REGEXP_REPLACE	XMLTEXT
EBCDIC_CHR	REGEXP_SUBSTR	XMLXSROBJECTID
EBCDIC_STR	REPEAT	YEAR
ENCRYPT_DATAKEY	REPLACE	
ENCRYPT_TDES	RID	
ENCRYPT	RIGHT	
EXP	ROUND	
EXTRACT	ROUND_TIMESTAMP	
FLOAT	ROWID	
FLOOR	RPAD	
GRAPHIC	RTRIM	
GENERATE_UNIQUE		
GETHINT		
GETVARIABLE		
GREATEST		
HASH		
HASH_CRC32		
HASH_MD5		
HASH_SHA1		
HASH_SHA256		
HEX		
HOUR		

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
COVAR_POP
COVARIANCE_SAMP
LISTAGG
MEDIAN
PERCENTILE_CONT
PERCENTILE_DISC
REGR_AVGX
REGR_AVGY
REGR_COUNT
REGR_ICPT
REGR_IMTERCEPT
REGR_R2
REGR_SLOPE
REGR_SXX
REGR_SXY
REGR_SYY
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

With the exception of `USER`, 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 COMPATIBILITY
CURRENT APPLICATION ENCODING SCHEME
CURRENT CLIENT_ACCNTG
CLIENT ACCNTG
CURRENT CLIENT_APPLNAME
CLIENT APPLNAME
CURRENT CLIENT_USERID
CLIENT USERID
CURRENT CLIENT_WRKSTNNAME
CLIENT WRKSTNNAME
CURRENT DATE
CURRENT_DATE
CURRENT DEBUG MODE
CURRENT DECFLOAT ROUNDING MODE
CURRENT DEGREE
CURRENT FUNCTION PATH
CURRENT GET_ACCEL_ARCHIVE
CURRENT_LC_CTYPE
CURRENT LC_CTYPE
CURRENT LOCALE LC_CTYPE
CURRENT LOCK TIMEOUT
CURRENT MAINTAINED TABLE TYPES FOR OPTIMIZATION
CURRENT_MEMBER
CURRENT OPTIMIZATION HINT
CURRENT PACKAGE PATH
CURRENT PACKAGESET
CURRENT_PATH
```

```
CURRENT PRECISION
CURRENT QUERY ACCELERATION
CURRENT QUERY ACCELERATION WAITFORDATA
CURRENT REFRESH AGE
CURRENT ROUTINE VERSION
CURRENT RULES
CURRENT SCHEMA
CURRENT SERVER
CURRENT_SERVER
CURRENT SQLID
CURRENT TEMPORAL BUSINESS_TIME
CURRENT TEMPORAL_SYSTEM_TIME
CURRENT TIME
CURRENT_TIME
CURRENT TIMESTAMP
CURRENT TIMEZONE
CURRENT_TIMEZONE
CURRENT_TIMEZONE USER
SESSION TIME ZONE
SESSION_USER
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 (SQL)* in the *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 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 50T 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. For further details and statement syntax, see *COMMIT (SQL)* in the *Statements* documentation.

`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 *Syntax 1 - Cursor-Oriented Selection* in *SELECT (SQL)* in the *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.

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 (SQL)* in the *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.

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 *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 *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 *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 (SQL)* in the *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 *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 *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 *Syntax 1 - Cursor-Oriented Selection* in *SELECT (SQL)* in the *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 *Syntax 2 - Non-Cursor Selection* in *SELECT (SQL)* in the *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 *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)
- Considerations for Multi-Fetch Usage (Standard)
- Size of the Multi-Fetch Buffer (Standard)
- Support of TEST DBLOG Q (Standard)
- Multiple Rows to Program (Advanced)

- Multiple Rows from Program (Advanced)

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
- DB2ARRY=ON
- INTO Clause
- WITH ROWSET POSITIONING Clause
- ROWS_RETURNED Clause
- Restrictions and Constraints
- File Server Usage and Positioned UPDATE and DELETE

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 (see *`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 (see *`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 (see *`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 Clause* 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 (see *`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 an *LINDICATOR Clause* or *INDICATOR Clause* is 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. The Natural for Db2 static generation creates an assembler language SQL program, which is precompiled by the Db2 precompiler, which in turn creates a DBRM necessary for static execution. However, the Db2 assembler precompiler has no support for host variable arrays. They can only be used when specified in a SQLDA structure, which has to be build at execution time. But a static `INSERT` with a multiple-row-insert `VALUES` clause does not allow the specification of an SQLDA, but only host-variable arrays, which are not supported by the Db2 assembler precompiler.

  It is not possible to use Natural arrays of views in the `INTO` clause (see *`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 SQLCODE. 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
```

17 Processing Natural Stored Procedures and UDFs

- Types of Natural UDF 254
- PARAMETER STYLE 254
- Writing a Natural Stored Procedure 263
- Writing a Natural UDF 265
- Example Stored Procedure 266
- Example Natural User Defined Function 269

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 *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
- Parameter DBINFO
- Determining Library, Subprogram and Parameter Formats
- Invoking a Natural Stored Procedure
- Error Handling
- Lifetime of Natural Session
- Example of DB2SQL - Natural Stored Procedure
- Example of DB2SQL - Natural UDF

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:

- Objects of NDBPURGN

- Defining the Stored Procedure NDBPURGN

Objects of NDBPURGN

The example stored procedure NDBPURGN comprises the following text objects (members) which are stored in the Natural system library SYSDB2:

Object	Explanation
CR6PURGN	Input member (text object) 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. Ensure that the Db2 special register PATH contains the schema name of the stored procedure NDBPURGN created by CR6PURGN. This can be achieved with the SQL statement SET PATH *schema-name*. If the schema name is missing, SQLCODE-440 can be returned.
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 objects 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 objects that are supplied in the Natural system library `SYSDB2`:

Object	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.
`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.

18 Interface Subprograms

- Natural Subprograms 272
- NDBCONV Subprogram 273
- NDBDBRM Subprogram 274
- NDBDBR2 Subprogram 275
- NDBDBR3 Subprogram 276
- NDBDBRZ Subprogram 278
- NDBERR Subprogram 279
- NDBISQL Subprogram 280
- NDBISQLD Subprogram 282
- NDBNOERR Subprogram 284
- NDBNROW Subprogram 285
- NDBSTMP Subprogram 285
- DB2SERV Interface 286

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.

This section covers the following topics:

- *Natural Subprograms*
- *DB2SERV Interface*

Natural Subprograms

The following Natural subprograms are provided:

Subprogram	Function
NDBCONV	Sets or resets conversational mode 2.
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.
NDBDBRZ	Checks whether a Natural program contains SQL access, whether it has been modified for NDZ 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.
NDBISQLD	Executes SQL statements in dynamic mode, using dynamic variables.
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.

In addition, the Natural library SYSTEM in the FNAT system file contains the subprogram DBTLIB2N and the subroutine DBDL219S. They are used by NDBDBRM and NDBDBR2. The corresponding parameters must be defined in a DEFINE DATA statement.

The Natural subprograms NDBDBRM, NDBDBR2 and 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 actual FNAT file or the FUSER file is used to locate the program to be examined depending on whether the library name begins with "SYS" or not.

Programs invoking NDBDBRM, NDBDBR2 or NDBDBR3 without these parameters will also work like before this change as the added parameters are declared as optional.

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 object provided with the subprogram (*subprogram-name*T).

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.

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 object 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.

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 DBRM (database request module) name from the header of a Natural program generated as static (see also **Preparing Programs for Static Execution**).

A sample program called CALLDBRM is provided on the installation medium; it demonstrates how to invoke NDBDBRM. A description of the call format and of the parameters is provided in the text object 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 values:

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 (database request module) 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 CALLDBR2 is provided on the installation medium; it demonstrates how to invoke NDBDBR2. A description of the call format and of the parameters is provided in the text object 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	A8	Unsupported parameter; retained for compatibility reasons. only.
#PCRELLEV	A1	Unsupported parameter; retained for compatibility reasons only.
#ISOLLEVL	A1	Unsupported parameter; retained for compatibility reasons only.
#DATEFORM	A1	Unsupported parameter; retained for compatibility reasons only.
#TIMEFORM	A1	Unsupported parameter; retained for compatibility reasons only.

Parameter	Format/Length	Explanation
#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 values:

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.

NDBDBR3 Subprogram

The Natural subprogram NDBDBR3is 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 (database request module) 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 medium; it demonstrates how to invoke NDBDBR3. A description of the call format and of the parameters is provided in the text object 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, ■ DBRM name, if program has been generated static.
#TIMESTAMP	B8	Consistency token generated by precompiler.
#PCUSER	A8	Unsupported parameter; retained for compatibility reasons only.
#PCRELLEV	A1	Unsupported parameter; retained for compatibility reasons only.
#ISOLLEVL	A1	Unsupported parameter; retained for compatibility reasons only.
#DATEFORM	A1	Unsupported parameter; retained for compatibility reasons only.
#TIMEFORM	A1	Unsupported parameter; retained for compatibility reasons only.
#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 values:

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.

NDBDBRZ Subprogram

The Natural subprogram NDBDBRZ 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, #SQLJPROF '*DYNAMIC') and whether it has been modified for NDZ static execution (#RESP 0, #SQLJPROF *SQLJ profile name*). It is also used to obtain the corresponding SQLJ profile name from the header of a Natural program generated as static (see also **Preparing Programs for Static Execution**).

A sample program called CALLDBRZ is provided on the installation medium and it demonstrates how to invoke NDBDBRZ. A description of the call format and of the parameters is provided in the text object NDBDBRZT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBDBRZ' #LIB #MEM #SQLJPROF #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.
#SQLJPROF	A8	Returns the SQLJ profile name. ■ Space, if program has SQL access, ■ *DYNAMIC, if program contains only dynamically executable SQL, ■ SQLJ profile name, if program has been generated static.
#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 values:

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 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 SQLCODE (which means a NAT3700 error).

A sample program called CALLERR is provided on the installation medium; it demonstrates how to invoke NDBERR. A description of the call format and of the parameters is provided in the text object 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 medium; it demonstrates how to invoke NDBISQL. A description of the call format and of the parameters is provided in the text object 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 (EXECUTE) or receives a data row (FETCH).	
#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
		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.

Function	Parameter	Explanation
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		SQLCODE 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.

NDBISQLD Subprogram

The Natural subprogram NDBISQLD 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 NDBISQLD.

A sample program called CALISQLD is provided on the installation medium. It demonstrates how to invoke NDBISQLD. A description of the call format and of the parameters is provided in the text object ISQLDT.

The calling Natural program must use the following syntax:

```
CALLNAT 'NDBISQLD'#FUNCTION #TEXT #SQLCA #RESPONSE #WORK #DBTYPE
```

The various parameters are described in the following table:

Parameter	Format/Length	Explanation	
#FUNCTION	A8	For valid functions, see below.	
#TEXT	A DYNAMIC	Contains the SQL statement (EXECUTE) or receives the data row (FETCH).	
#SQLCA	A136	Contains the SQLCA.	
#RESPONSE	I4	Returns a response code.	
#WORK	A DYNAMIC	Workarea used to hold SQLDA/SQLVAR and auxiliary fields across calls (optional). If specified, #WORK has to be sized large enough to hold all auxiliary fields (SQLDA) for the SQL request.	
#DBTYPE	I2	Database type (optional).	
		0	Default
		2	DB2
		4	CNX

Valid functions for the #FUNCTION parameter are:

Function	Parameter	Explanation
CLOSE	-	Closes the cursor for the SELECT statement.
EXECUTE	#TEXT	Executes the SQL statement. Contains the SQL statement. The first four characters must be blank.
FETCH	#TEXT	Returns a row from the SELECT statement. #TEXT has to be sized large enough to hold the row of the result set created by the SELECT statement. After FETCH, the *LENGTH(#TEXT) is reduced to the exact size of the row.
TITLE	#TEXT	Returns the header literals for the SELECT statement. #TEXT has to be sized large enough to hold the row of the result set created by the SELECT statement.

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	-	SQLCODE 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. NDBISQLD 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 NDBISQLD by #WORK(A)DYNAMIC.

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(A)DYNAMIC during NDBISQLD 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 SQLCODE. After the SQL call has been performed, NDBERR is used to investigate the SQLCODE.

A sample program called CALLNOER is provided on the installation medium; it demonstrates how to invoke NDBNOERR. A description of the call format and of the parameters is provided in the text object 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 medium; it demonstrates how to invoke NDBNROW. A description of the call format and of the parameters is provided in the text object 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 medium; it demonstrates how to invoke NDBSTMP. A description of the call format and of the parameters is provided in the text object 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.

Code	Explanation
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.

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 P**, invokes an Assembler module named NDBPLAN.

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 literature. Examples can be found below and in the demonstration programs DEM2* in the Natural system library SYSDB2.

Note: The conditions that apply to issuing the Natural END TRANSACTION or BACKOUT TRANSACTION statements also apply when issuing the 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 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 SQLERR.

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 Db2 to provide an application program with information on the execution of its SQL statements.

The following two examples show 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.

Example of Function D - DEM2SET:

```
************************************************************************
*  DEM2SET - Set Current SQLID                                         *
************************************************************************
*
DEFINE DATA
LOCAL USING DEMSQLCA
LOCAL
*                                   Parameter for DB2SERV
1 STMT         (A250)
1 STMTL        (I2)     CONST <250>
1 RETCODE      (I2)
1 OLDSQLID     (A8)
1 NEWSQLID     (A8)
*
END-DEFINE
*
SELECT DISTINCT CURRENT SQLID
  INTO OLDSQLID
  FROM SYSIBM.SYSTABLES
ESCAPE BOTTOM
END-SELECT
*
MOVE  'SET CURRENT SQLID="PROD"';
  TO   STMT
CALL 'DB2SERV' 'D' STMT STMTL SQLCA RETCODE
*
IF RETCODE > 0
  FETCH 'SQLERR'
ELSE
  SELECT DISTINCT CURRENT SQLID
    INTO NEWSQLID
```

```
    FROM SYSIBM.SYSTABLES
  ESCAPE BOTTOM
  END-SELECT
*
  WRITE ' Old SQLID was :' OLDSQLID
  WRITE ' New SQLID is  :' NEWSQLID
END-IF
*
END
************************************************************************
```

When using 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. Thus, table names must not be qualified by a creator name if this is to be substituted by the SQLID.

In all supported TP-monitor environments, the SQLID can then be kept across terminal I/Os until either the end of the session or its resetting via DB2SERV.

Function P

Function P invokes an Assembler module named NDBPLAN, which is used to establish and/or terminate the Db2 connection under TSO and in batch mode. This allows a Natural application to perform **plan switching under TSO and in batch mode**.

The program DEM2PLAN is an example of the use of DB2SERV with Function P.

The name of the current Db2 subsystem (#SSM) and the name of the new application plan (#PLAN) must be specified. In addition, an interface return code (#RETCODE) and the Db2 reason code (#REASON) are returned.

Command Syntax

```
CALL 'DB2SERV' 'P' #SSM #PLAN #RETCODE #REASON
```

Variable	Format/Length	Explanation
#SSM	A4	Contains the name of the current Db2 subsystem.
#PLAN	A8	Contains the new plan name.
#RETCODE		Returns an interface return code. The following codes are possible: 0 No warning or error occurred. 12 The specified new application plan is not scheduled. 99 The current environment is not a Call Attachment Facility (CAF) environment.

Variable	Format/Length	Explanation
		nnn Return code from the CAF interface (see also the relevant Db2 literature by IBM).
#REASON	I4	Returns the reason code of the CAF interface (see also the relevant Db2 literature by IBM).

Example of Function P - DEM2PLAN:

```
************************************************************************
*  DEM2PLAN - Switch application plan under TSO/Batch with CAF interface *
************************************************************************
*
DEFINE DATA
LOCAL
*                                   Parameter for DB2SERV
01 #SSM         (A4))    CONST <'DB2'>
01 #PLAN        (A8
01 #RETCODE     (I2)
01 #REASON      (I4)
*
END-DEFINE
*
INPUT 'PLEASE ENTER NEW PLAN NAME' #PLAN (AD='_'I)
*
END TRANSACTION
*
CALL 'DB2SERV' 'P' #SSM #PLAN #RETCODE #REASON
*
DECIDE FOR FIRST VALUE OF #RETCODE
*
  VALUE  0
    IGNORE
  VALUE  99
    INPUT 12/23 'This is not a CAF environment !!'
  VALUE  8,12
    INPUT 12/18 'New plan not scheduled, reason code'
                #REASON (AD=OI EM=H(4))
  NONE
    INPUT 12/15 'CAF interface error'
                #RETCODE (AD=OI EM=Z(3))
               'with reason code'
                #REASON (AD=OI EM=H(4))
*
END-DECIDE
*
END
************************************************************************
```

Important: Plan switching under TSO and in batch mode is possible with the CAF interface only; see also the section ***Plan Switching under TSO and in Batch Mode***.

19 Natural File Server for Db2

- About the File Server for Db2 294
- Preparations for Using the File Server 294
- Logical Structure of the File Server 299

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.

About the File Server for Db2

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 – Shared Memory Object

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 medium 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 `NTDB2` macro. In this case, the primary, secondary and maximum allocation amounts for the file server are specified by `EBPPRAL`, `EBPSEC`, `EBPMAX` parameters of the `NTDB2` 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; see *Editor Buffer Pool* 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.

File Server – Shared Memory Object

A z/OS shared memory object above the bar is used as the storage medium for the file server. In this case, the shared memory object has the same structure as the VSAM RRDS file mentioned in the previous section, but all data is maintained in virtual storage above the bar. A file server that uses a shared memory object is referred to as a Shared Memory Objects File Server (FSSM).

To use a Shared Memory Objects File Server

1. Define the shared memory object in the `ASMPARM` parameter file (see the *Operations* documentation) of a Natural Authorized Services Manager that contains the `NATFSSM` module.

   For the messages that can be returned by the Authorized Services Manager, see *Messages from the Shared Memory Objects File Server under NDB* in the *Messages and Codes* documentation.
2. Set the `SMFSRV=ON` as the keyword subparameter of the `DB2` profile parameter or `NTDB2` macro.
3. Specify the name of the shared memory object to be used with the `DDFSERV` keyword subparameter of `DB2` (`NTDB2`).
4. Start the Authorized Services Manager configured in Step 1.

When Natural for zIIP is enabled in your Natural environment, switching between SRB and TCB modes for accessing the file server is not required since no disk I/O has to be performed.

Defining Size and Format of an FSSM

The size and format of the FSSM is defined in the `ASMPARM` data set of the Authorized Services Manager, similar to the way the VSAM file server is defined. Each definition has the following format:

```
FSSMxxxx=(name,number-of-blocks,number-of-users,primary-blocks,secondary-blocks,maximum-blocks,block-size)
```

Explanations:

`FSSMxxxx`	The initialization keyword required to define a file server. `FSSM` is a mandatory prefix that can be followed by 1 to 4 characters *xxxx*.
name	The logical name for the file server. The name can contain up to 8 characters and must match the name specified with the `DDFSERV` keyword subparameter of `DB2` (`NTDB2`) used in the Natural session.
number-of-blocks	The number of blocks used by the file server. Valid range: 3 - 2147483647. The number has to be a multiple of 8.
number-of-users	The number of users that can use the file server concurrently. Valid range: 1 - 32767

primary-blocks	The primary block allocation for each user. Valid range: 1 - 32767
secondary-blocks	The secondary block allocation for each user. Valid range: 1 - 32767
maximum-blocks	The maximum block allocation for each user. Valid range: 1 - 32767
block-size	The size of each block in the file server. Valid range: 1 - 32767

Examples:

```
FSSMPRM1=(CMFSERV,1000,500,50,10,100,31744)
```

```
FSSMPRM2=(CMFSERV2,1000,203,50,10,200,4080)
```

Formatting of an FSSM

The FSSM is formatted implicitly when the first user starts a Natural session with `SMFSRV=ON` with the name of the shared memory object specified in `DDFSERV`.

If another user from another address space also uses the same shared memory object, Natural for Db2 implicitly establishes access to the shared memory object for this address space. Access to the shared memory object for an address space only fails when the address space terminates.

Immediately before the first access to the file server, a file server directory entry is allocated to the Natural session and the number of blocks specified as primary allocation is allocated to the Natural session.

The primary allocation is used as the intermediate storage for the result of a database selection and should be large enough to contain all rows of an ordinary database selection. Should the file server require more space, the file server modules perform a secondary allocation using the number of blocks specified for the 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 blocks allowed for the secondary allocations depends on the maximum number of blocks you are allowed to allocate.

The number of blocks defined for the secondary allocation is allocated repeatedly, until either all selected data has been written to the file, or until 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 secondary allocation are no longer needed (that is, once the Natural loop associated with this allocation ends), they are returned to the free blocks pool of the file

server. However, your primary allocation of blocks is always allocated to you until the end of your Natural session.

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.

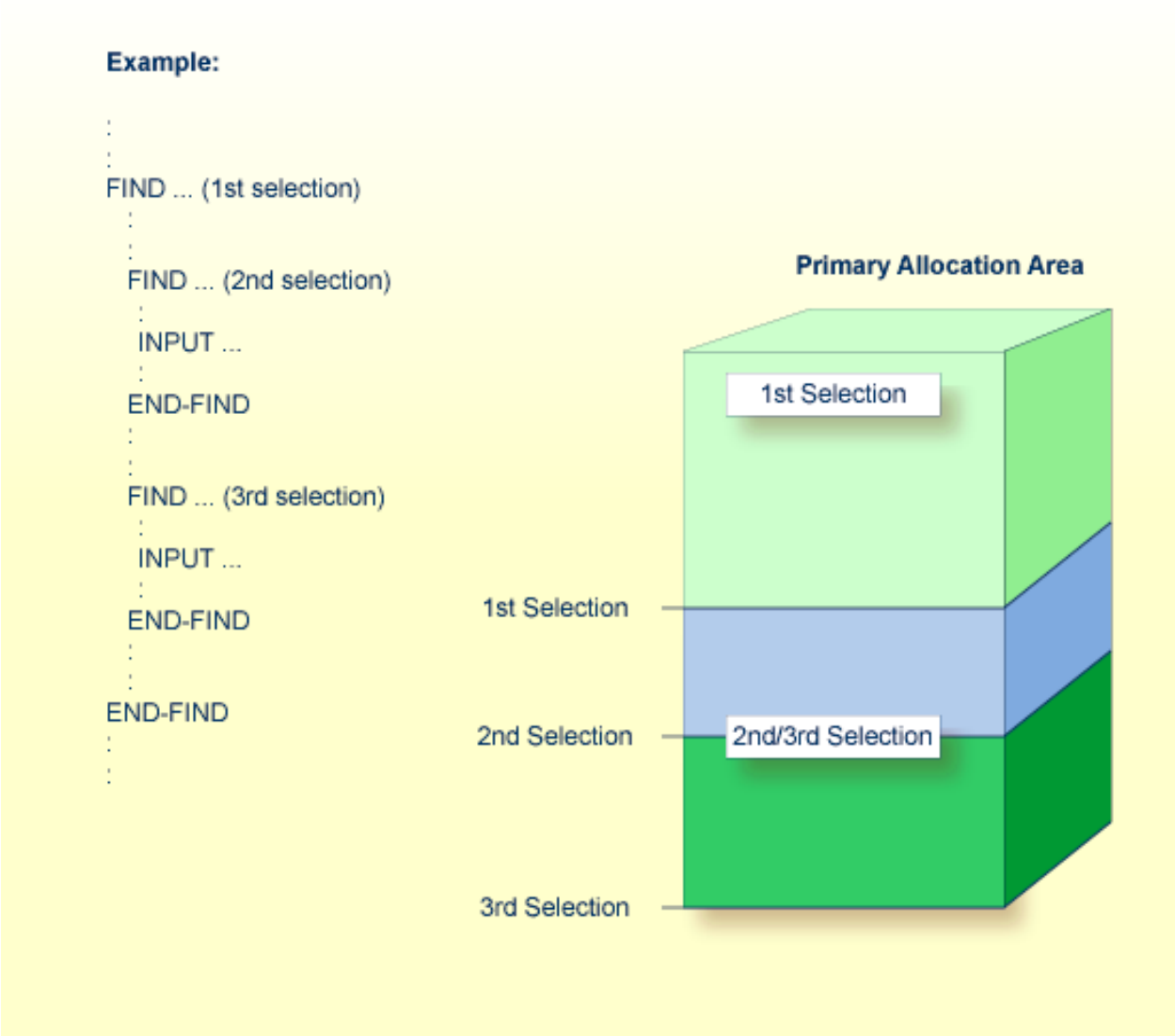
Positioned `UPDATE` and/or Positioned `DELETE` statements against rolled-out scrollable cursors are performed against the Db2 base table and against the logical file on the file server.

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.

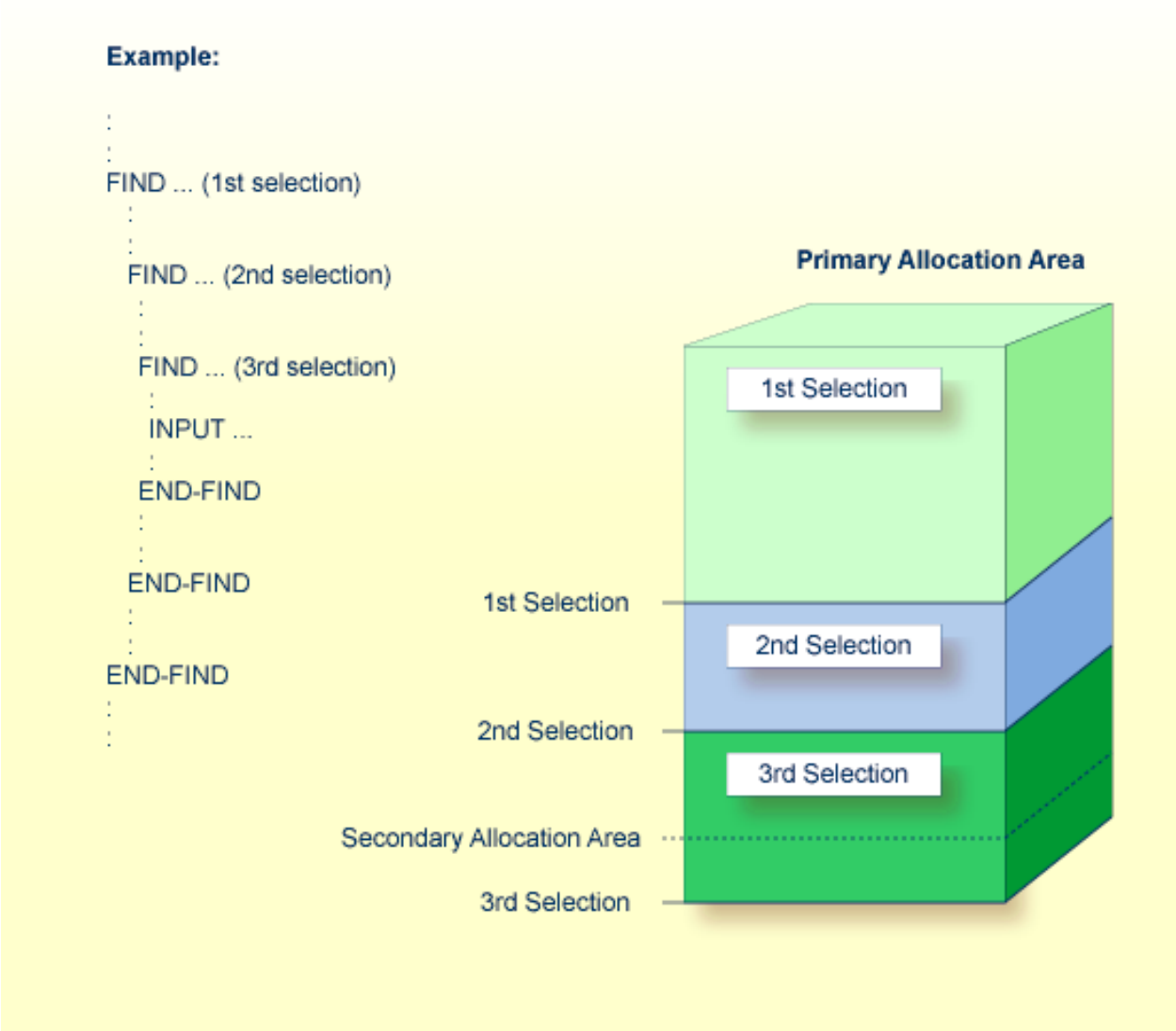
In the following example, the space allocated to the first selection is not released until all rows selected during the third selection have been retrieved. The same applies to the space allocated to the third selection.

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.

20 Tracing Dynamic SQL Statements

- Enabling Tracing for Dynamic SQL Statements 304
- Tracing Dynamic SQL Statements 305

Natural for Db2 provides a facility to trace all dynamically executed SQL statements within one machine (LPAR). This trace facility allows you to determine the Natural program from which the dynamic SQL request originates.

When tracing is enabled with the `DYSQLTR` parameter, all dynamically executed SQL statements are traced into a shared memory object above the bar. The name of that shared memory object is specified with the `DSTNAME` parameter. The first Natural for Db2 session in an LPAR creates the shared memory object and attaches its address space or region to the shared memory object. The subsequent Natural for Db2 sessions with the same `DSTNAME` and `DYSQLTR` parameter settings in an LPAR will also attach to the shared memory object if the address space is not already attached to the shared memory object.

For every dynamically executed SQL statement, the Natural for Db2 session writes a trace entry into the buffer before it calls Db2 and a trace entry after the return from Db2.

Each trace entry contains the following data:

Date and time
Natural library, program name, and line number
Username, terminal name, job name, and job number
The Db2 DBRM name (NDBIO*xxx*), the Db2 section number, statement number, and the statement type (OPEN, FETCH, CLOSE, etc)
The Db2 SQLCODE return information

You can start and terminate dynamic SQL tracing and retrieve the trace data in the shared memory object with the NDBDST00 Natural subprogram. If the trace buffer gets filled to the upper end, tracing continues by overwriting the content at the lower end of the buffer.

Enabling Tracing for Dynamic SQL Statements

By default, the Natural for Db2 session does not particiapte in dynamic SQL tracing. To enable dynamic SQL tracing for a Natural for Db2 session, you must set `DYSQLTR=ON` within the `NTDB2` macro in the Natural parameter module. You must also specify a name for the shared memory object where all dynamically executed SQL statements will be traced. The default name is `NDBRDC01`. For details about the `NTDB2` macro syntax, see *DB2 - Parameters for SQL Database Management Interfaces*.

After tracing is enabled, the Natural for Db2 session attaches to the shared memory object. If that shared memory object does not yet exist, the Natural for Db2 session creates the shared memory object specified in `DSTNAME` and attaches the Natural session to it. For this purpose, the session calls the Authorized Services Manager (ASM) that is associated with the `SUBSID` of the Natural subsystem. The session searches for the name and size of the shared memory object in the `FSSMDSTx` cards of the ASM. That is why you must **define the size of the shared memory object** and the

type of tracing in the ASMPARM parameter file. Within this parameter file, you set the FSSMDSTx parameter:

```
FSSMDSTx=(name,n,tracetype,[T])
```

- FSSMDSTx indicates this is a parameter card for the shared memory object trace buffer. x is arbitrary.
- name denotes the name of the shared memory object.
- n denotes the size of the shared memory object in units of megabytes.
- tracetype determines which trace records are written to the trace buffer. The possible values are:

  S - write trace records before and after a Db2 call

  B - write trace records before a Db2 call

  A - write trace records after a Db2 call

  T - don't write trace records
- T is an optional attribute that requests the create and attach requests to be logged to the job log.

The following example defines a shared memory object called NDBDST01 that is 10MB in size with tracing before and after a Db2 call:

```
SUBSID=NDB1
MSGCASE=M
FSSMDST1=(NDBDST01,10,S)
```

After you set up the tracing, you can use the available Natural objects to start tracing, retrieve tracing data, and terminate tracing.

Tracing Dynamic SQL Statements

Natural provides the following objects with which you can start tracing, retrieve tracing data, and terminate tracing:

- NDBDST00 - Start Tracing, Retrieve Records, Terminate Tracing
- NDBDST_L - Description of Retrieved Dynamic SQL Trace Data
- NDBDSTPA - Write Trace Records after a Db2 Call
- NDBDSTPB - Write Trace Records before a Db2 Call
- NDBDSTPF - Read Trace Entries from Oldest to Newest
- NDBDSTPL - Read Trace Entries from Newest to Oldest
- NDBDSTPR - Reset the Trace Buffer

- NDBDSTPS - Restart Tracing
- NDBDSTPT - Terminate Tracing

These programs operate on the shared memory buffer that is specified with the `DSTNAME` parameter in the NTDB2 macro in the NATPARM module or with the `DB2=(DSTANAM=)` subparameter. To use these programs, you must also set `DYSQLTR=ON`.

NDBDST00 - Start Tracing, Retrieve Records, Terminate Tracing

The NDBDST00 Natural subprogram starts dynamic SQL tracing, retrieves the dynamic SQL trace data, and terminates tracing. Use the following syntax in the calling Natural program:

```
CALLNAT 'NDBDST00' #FUNCTION #RETCODE #KTXT #GDATA #LDATA #TRACESTATE
```

The syntax of this program contains the following parameters:

Parameter	Format/Length	Description
`#FUNCTION`	A1	Function code for input. Possible values: `A` - Start the trace after Db2 call trace entries are written `B` - Start the trace before Db2 call trace entries are written `F` - Retrieve the first/oldest trace entry `L` - Retrieve the latest/newest trace entry `N` - Retrieve the next/newer trace entry `P` - Retrieve the prior/older trace entry `R` - Reset the trace buffer. The dynamic SQL trace buffer is treated as it is initialized for the first time `S` - Start tracing `T` - Terminate tracing
`#RETCODE`	I4	Return code. Possible values: `0` - Okay `4` - End of data. No more trace entries are available `8` - Insufficient number of parameters `12` - Unknown function code `16` - Session not attached to shared memory object `20` - Session not attached to shared memory object
`#KTXT`	B48	Context used during calls. The caller must not modify this parameter.
`#GDATA`	A252	Contains dynamic SQL trace data related to Natural program that calls Db2. See ***NDBDST-L***.
`#LDATA`	A252	Contains dynamic SQL trace data about the access to Db2.

Parameter	Format/Length	Description
		See *NDBDST-L*.
#TRACESTATE	A1	The current state of the dynamic SQL trace. Possible values: A - Trace is active only after Db2 call entries are written. B - Trace is active only before Db2 call entries are written. S - Trace is active before and after Db2 call entries are written. Blank - Trace is inactive, no DB2 call entreis are written.

NDBDST_L - Description of Retrieved Dynamic SQL Trace Data

The local data area NDBDSTPF contains the description of retrieved dynamic SQL trace data. It is split in two groups GDATA and LDATA. GDATA comprises the data related to the Natural program calling Db2 and LDATA comprises the data related to the access to Db2.

Name	Format/Length	Description
GBASP	A8	Basic Product ID (NATURAL)
GVER	A4	Basic Product ID Version (9202)
GOPS	A8	Operating System Name (MVS/ESA)
GTPM	A8	TP-Monitor Name (CICS, IMS/DC)
GTERM	A8	TP-Terminal ID
GIUID	A8	Initial User ID
GCUID	A8	Current User ID
GCAPL	A8	Current LOGON library
GGRP	A8	Current LOGON Group ID
GPGM	A8	Current program
GLINE	N4	Current statement number
GLEV	I1	Current program level

GDATA

Name	Format/Length	Description
TDB2FUNC	A4	BDb2 before Db2, ADb2 after Db2 call
TDB2TIST	B8	Local Store Clock time
TDB2DBRM	A8	DBRM name (UTF-8)
TDB2CONT	B8	Db2 consistency token
TDB2SQLC	I4	SQLCODE
TDB2STYPE	I2	Db2 statement type
TDB2SECT	I2	Db2 section number

Name	Format/Length	Description
TDB2STNR	I4	Db2 statement number
TDB2JNAM	A8	Job name of requestor
TDB2JNO	A8	Job number of requestor
TDB2HOLD	A2	Cursor WITH HOLD (NO, HO)
TDB2SCRL	A2	SCROLL Type (NO, AS, IN, SD, SS)
TDB2RETU	A2	Cursor WITH RETURN (NO, RT)
TDB2ROWP	A2	Cursor WITH ROWSET processing (NO, RP)
TDB2FECO	A2	FETCH continue Type (NO, CC, CO)
TDB2MFC	I2	Multi Fetch Count
TDB2MODE	A1	Dynamic (D)

LDATA

NDBDSTPA - Write Trace Records after a Db2 Call

The NDBDSTPA Natural subprogram starts the writing of trace records for a Natural for Db2 session only after a Db2 call entry.

NDBDSTPB - Write Trace Records before a Db2 Call

The NDBDSTPB Natural subprogram starts the writing of trace records for a Natural for Db2 session only before a Db2 call entry.

NDBDSTPF - Read Trace Entries from Oldest to Newest

The NDBDSTPF sample program demonstrates the sequential retrieval of trace entries starting from the oldest trace entry and ending with the newest trace entry.

You can use this program as a template to create your own trace retrieval programs and suit the output to your needs.

NDBDSTPL - Read Trace Entries from Newest to Oldest

The NDBDSTPL sample program demonstrates the sequential retrieval of trace entries starting from the newest trace entry and ending with the oldest trace entry.

You can use this program as a template to create your own trace retrieval programs and suit the output to your needs.

NDBDSTPR - Reset the Trace Buffer

The NDBDSTPR Natural subprogram resets the dynamic SQL trace buffer to its initial state. All trace entries are lost.

NDBDSTPS - Restart Tracing

The NDBDSTPS Natural subprogram starts the writing of trace records for a Natural for Db2 session both before and after a Db2 call entry.

NDBDSTPT - Terminate Tracing

The NDBDSTPT Natural subprogram demonstrates the termination of the trace.

II Natural for Db2 for zIIP

This documentation describes the functionality and the use of Natural for Db2 for zIIP (product code: NDZ). The documentation is organized under the following headings:

About Natural for Db2 for zIIP	Information about the purpose, architecture and general concepts of NDZ.
Restrictions	Information about restrictions regarding Db2 data types, statements, static and dynamic execution.
Operation	Information about the NDZ operation and started task commands.
Configuration and Parameters	Information about the NDZ parameter options.
Error codes	Information about NDZ error codes.
Preparing Programs for Static Execution	Information about the necessary prerequisites to execute static programs with NDZ.
Static Program Execution	How the SQL of a Natural program is executed in an NDB and an NDZ environment, either dynamically or static.

Related documentation

For installation instructions, refer to *Installing Natural for Db2 for zIIP* in the *Installation for z/OS* documentation.

For information on accessing data in Db2 databases from Natural, refer to *Natural for Db2* documentation.

For the various aspects of accessing data in a database with Natural, see also *Database Access* 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.

21 About Natural for Db2 for zIIP

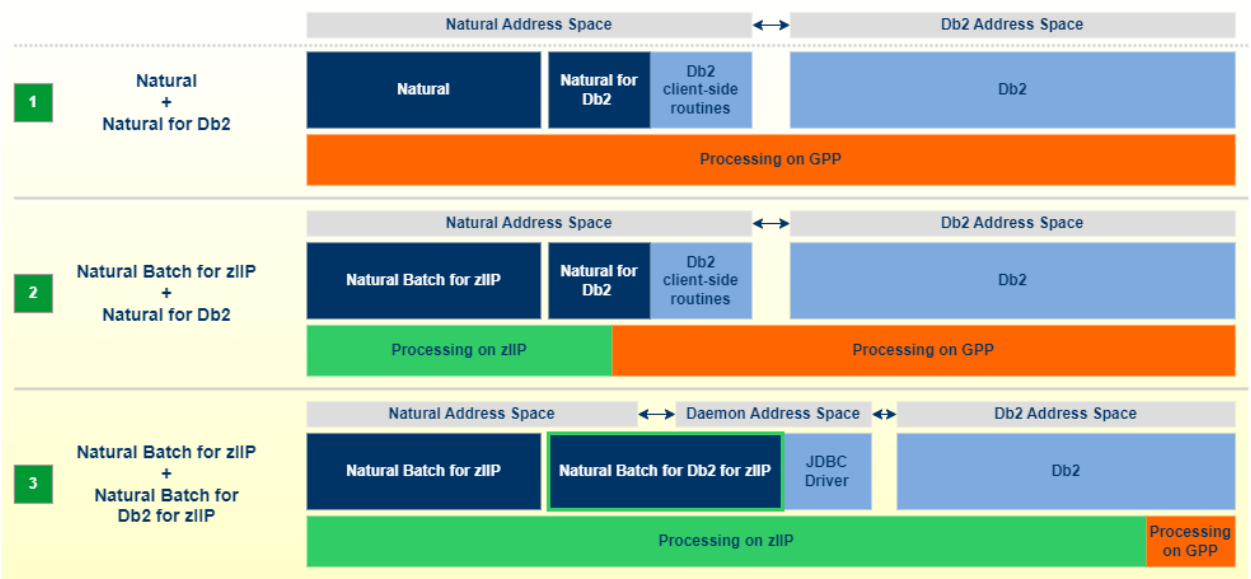
- Architecture overview 315
- Installation structure 316
- Natural Batch Considerations 317
- Performance Considerations 318
- Db2 Considerations 319

Natural for Db2 for zIIP (NDZ) complements Natural for Db2 (NDB) Database Management Interface by adding the ability to run Db2 workloads on IBM System z Integrated Information Processors (zIIP).

Natural for Db2 for zIIP (NDZ) makes use of the zIIP capabilities by accessing Db2 through a remote DRDA protocol, instead of using conventional Db2 local attachments. Local calls to Db2 are not zIIP eligible, therefore accessing Db2 using the DRDA protocol enables Natural programs to run continuously on zIIP processors.

Java workloads running on z/OS are zIIP eligible, therefore Natural for Db2 for zIIP (NDZ) uses Java and Java Database Connectivity (JDBC) to access Db2 using the DRDA protocol. The following diagrams show an approximate comparison of the workload distribution when accessing Db2 using only NDB and when using NDB and NDZ at the same time.

Some workloads, e.g. I/O calls are not zIIP eligible. zIIP ineligible workloads require the respective Natural programs to run temporarily on the general processors. The 'Processing on GP' in figure 3 in below diagram represents the workload executed on General processor. This workload includes 40 percent of zIIP ineligible Db2 workload, part of Natural workload and part of NDZ workload that is not zIIP eligible. For example, NDZ server executes in General Processor during start up, shut down and while executing the modify operator commands.

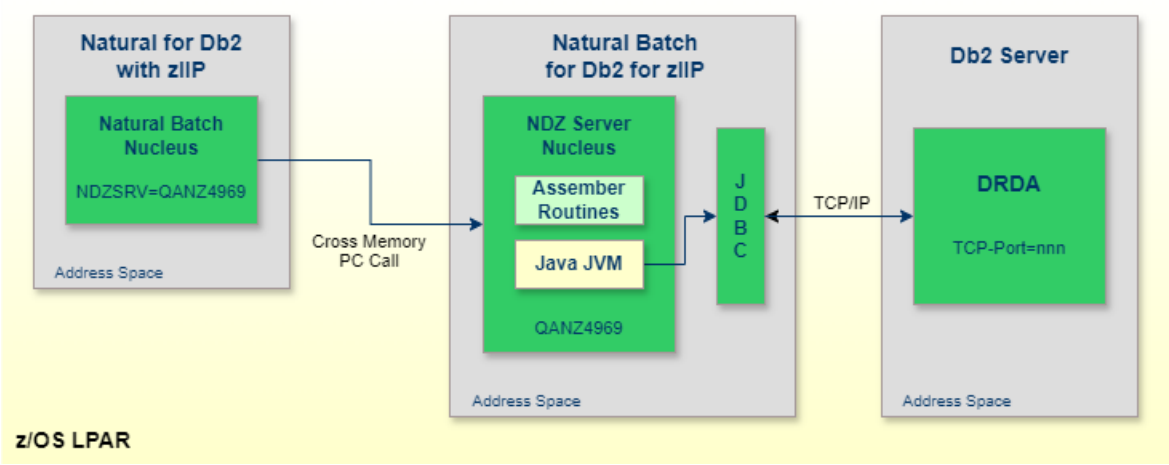


zIIP utilization comparison diagram

To benefit from Natural for Db2 for zIIP (NDZ) capabilities, you must ensure that enough System z Integrated Information Processors (zIIP) are available in the target environment. Running NDZ workloads without the required zIIP capacity can lead to increased general processor utilization, due to zIIP eligible workload running on general processors. Refer to the section ***Honor Priority*** in the manual *z/OS MVS Planning: Workload Management*.

Architecture overview

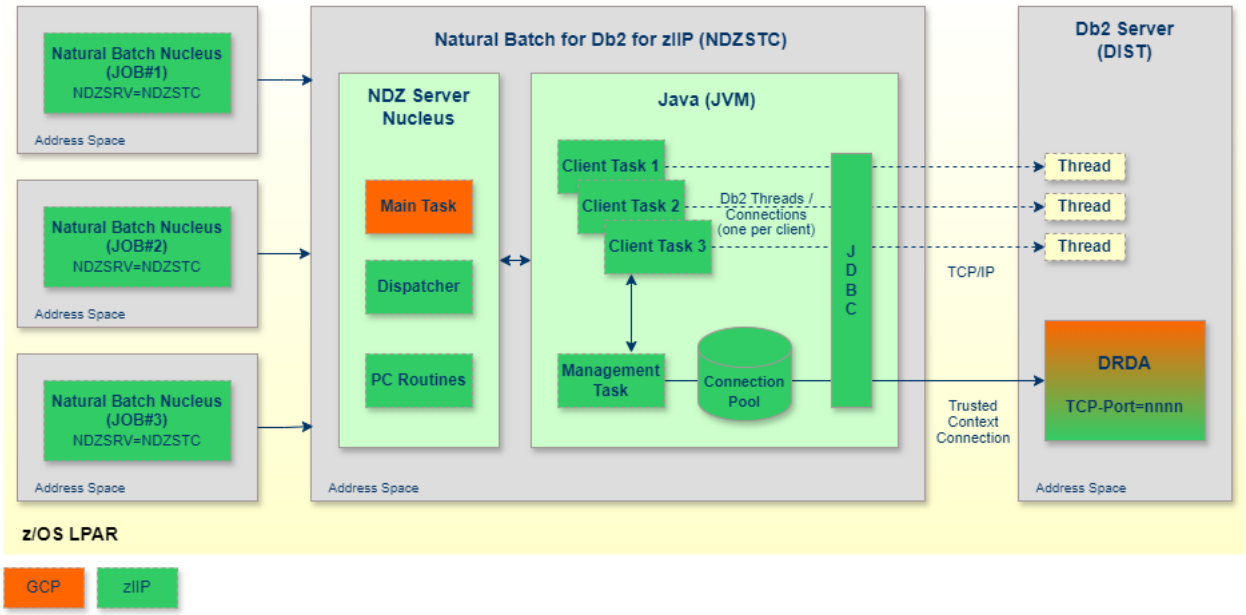
Natural for Db2 for zIIP (NDZ) runs on its own address space. An instance of the NDZ Server is capable of handling requests from multiple Natural batch jobs. The following diagram represents the overall Natural for Db2 for zIIP architecture.



The following diagram represents requests from different clients executing Db2 statements in a NDZ instance running in the started task `NDZSTC`.

Since NDZ uses multiple simultaneous client requests, it uses connection pool by the IBM Data Server Driver for JDBC and SQLJ to reduce the processing usage. It reuses the existing connections to minimize the impact of creating and closing the connection for each Db2 request.

The NDZ server comprises both a nucleus and a Java Virtual machine. During initialization, NDZ connects to Db2 through JDBC in a trusted context and creates both Java client tasks and a pool of Db2 connections that can be used later to process SQL requests on behalf of its clients. A Natural Batch client can select one NDZ server instance through the Db2 sub-parameter *NDZSRV*. When the client connects to the NDZ server instance, a new Db2 thread with the same user ID of the Natural Batch client job is created from one of the pooled connections.



Installation structure

Natural for Db2 for zIIP distribution consists of a native load library, TAR file and jobs to install and configure NDZ components. The native load library consists of the following load modules.

- NDZ nucleus load module
- NDZJVM load module

The NDZ installation directory extracted from distributed TAR file consists of following sub directories.

classes	Contains executable jar files for NDZ.
bin	Contains executable scripts for the configuration and execution of NDZ.
etc	Contains the *ndz.properties* and *db2.properties* files. These properties files allow you to specify the parameters for Db2 for z/OS and NDZ configurations.
lib	Contains shared libraries (*.so* files) for NDZ.
static	Directory to store the static serialized profile information.

For more detailed information on the NDZ installation jobs, refer to *Installing Natural for Db2 for zIIP* .

Natural Batch Considerations

- Build
- Execution
- Failover Mechanism

Build

The Natural Batch nucleus needs to be link edited to do the following actions

- Include NDBNDZ from Natural load library. This contains NDZ's own DSNHLI interface to be included in Natural Batch nucleus.
- Include Db2 interface module DSNALI or DSNELI based on the environment, renaming the entry point DSNHLI to DB2HLI.

For detailed information about the build step, refer to *Installing Natural for Db2 for zIIP* documentation.

Execution

TSO Db2 Interface (DSNELI) – Considerations

If NDB is using TSO Db2 interface *DSNELI* a connection to Db2 will be created using DSN statement. If NDZSRV is specified in the job, the NDZ server will use its own connections from the connection pool and TSO connection is unused. If executed without IKJEFT01 the TSO connection won't be created, but the failover mechanism won't work as there is no explicit connection issued. It is better to use CAF DSNALI to avoid any unused connections and to fail over to NDB in case NDZ server is not available.

DB2=(NDZSRV=) sub parameter

Specify NDZSRV parameter as part of DB2 parameters to utilize the NDZ server to execute the Db2 workloads on a zIIP processor. Make sure the NDZ server specified is up and running. For more details refer to *NDZSRV*.

Failover Mechanism

Failover to NDB when NDZSRV is unavailable

```
NAT7380: NDZ server ":1:" is not available.
NAT7382: Natural SQL interface active without Natural for Db2 for zIIP.
```

Natural for Db2 for zIIP complements the Natural for Db2 and executes the Db2 workloads executed on zIIP. If the NDZ server specified in NDZSRV parameter is not available, the following warning message is displayed and Db2 request will be handled through local connection and executed in a general processor.

This failsafe mechanism helps process a Db2 request even when NDZ server is unavailable.

Performance Considerations

- Client WLM enclaves under NDZ started task
- Db2 DIST enclaves
- Automatic profile reload

Client WLM enclaves under NDZ started task

A WLM enclave is created for each client connected with the specific qualifiers. Following are the NDZ set WLM qualifiers.

Qualifier	Value set by NDZ
Correlation	Client Job ID
User ID	Client Job User ID
Process name	Client Job name
Transaction / Job name	NDZ started task name
Subsystem type	STC
Subsystem name	NDZ started task name

You can create a WLM classification rule to place NDZ STC and/or enclaves into a different service/report class using these qualifiers. For more information, refer to the IBM documentation *z/OS MVS Planning: Workload Management*.

Db2 DIST enclaves

DDF workloads run on specific designated enclaves. These enclaves are controlled by the WLM service class definitions. NDZ creates one thread per client connected. During Db2 thread creation, it assigns the following thread/connection values.

Qualifier	Value set by NDZ
Client transaction or Application name (CTN)	Client Job name
Client user ID (CUI)	Client Job User ID
Client Accounting Information (CAI)	Client Job name
Correlation ID(CI)	Client Job name

You can create a WLM classification rule to place DDF enclaves into a different service/report class using these qualifiers. For more information, refer to the IBM documentation *z/OS MVS Planning: Workload Management*.

Automatic profile reload

Every time the static profiles are created/updated in the **NDZ static directory**, NDZ static profile cache need to be reloaded to pick updated profiles. NDZ provides an option to automatically pick these changes and reload the static profile cache. The parameter `ndz.automaticProfileReload`, determines whether to reload the static profiles cache whenever the changes occur in the directory specified.

Note: Setting Automatic profile reload means that a static directory is monitored for any changes and will consume lot of resources. This option can be set to false to avoid this resource usage. In that case, when a profile is changed, you need to manually reload the static profiles using the modify command R.

For detailed information about static preparation process, refer to ***Preparing Programs for Static Execution***.

Db2 Considerations

- Connection and trusted context
- Password encryption
- Db2 security considerations

- Static preparation and execution

Connection and trusted context

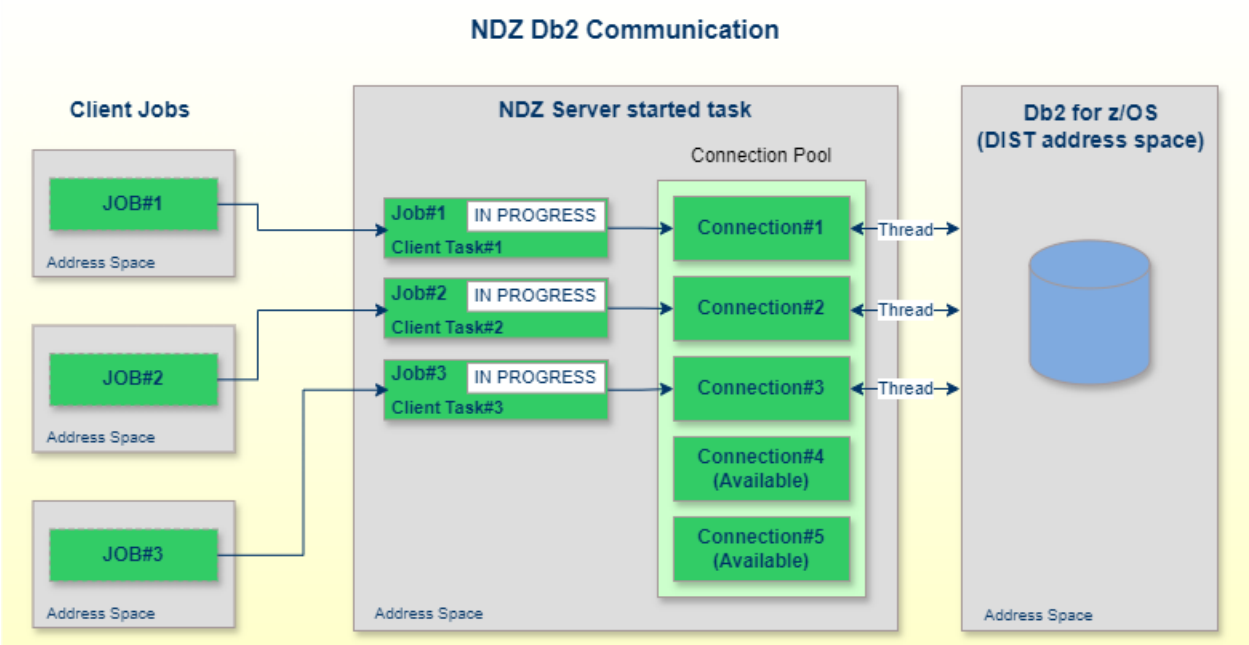
NDZ has a single connection to Db2 using a trusted context and creates connections on behalf of its clients. You need to create a trusted context based on a system authorization id (ndzDb2user) and connection attributes.

When executing Db2 requests, a connection is established on behalf of the user who submitted the request without the need to authenticate the user at the Db2 server.

Connection Pool

In the multi-threaded environment, opening and closing of each connection will be expensive and hence NDZ uses connection pool. The main advantage is that it promotes reusability and eliminates the need to open and close the connections.

NDZ creates one thread per client connected. For example, when there are four Natural batch jobs connected to NDZ there will be four simultaneous Db2 connections / threads. Once the client disconnects, when the Natural batch client job ends, the threads are terminated.



NDZ keeps pooled connections opened to be reused by clients. They will not appear in the `DIS THD(*) LOCATION(*) TYPE(ACTIVE) DETAIL` command output until assigned to a client. When a Natural Batch job client connects to NDZ, one of the connections is assigned to it and a Db2 thread is created.

The following diagram describes the `-DISPLAY THREAD` output where two clients are connected executing their Db2 workload via NDZ. They are connected to Db2 via trusted context created for ndzDb2user NATJAVA. Application name identifies the jobname and plan identified as `DISTSERV` and this is same for all jobs executed through NDZ as NDZ connects to Db2 remotely. `AUTHID` indicates the user submitted the job and the `SYSTEM AUTHID` refers to the ndzDb2user.

```
DSNV401I  = DISPLAY THREAD REPORT FOLLOWS -
DSNV402I  = ACTIVE THREADS -

NAME     ST A   REQ ID           AUTHID   PLAN     ASID TOKEN
SERVER   RA *  8024 db2jcc_appli JAYM     DISTSERV 00EF 13262
 V485-TRUSTED CONTEXT=CTXNDZ,
      SYSTEM AUTHID=NATJAVA,
      ROLE= *
 V437-WORKSTATION=DB2CALL
      USERID=JAYM
      APPLICATION NAME=NDZDS1K4
 V442-CRTKN=NDZDS1K4
 V445-GA144A3D.P510.DF9F35DB7498=13262 ACCESSING DATA FOR
  ::FFFF:10.20.74.61

SERVER   RA *  8026 db2jcc_appli JAYM     DISTSERV 00EF 13261
 V485-TRUSTED CONTEXT=CTXNDZ,
      SYSTEM AUTHID=NATJAVA,
      ROLE= *
 V437-WORKSTATION=DB2CALL
      USERID=JAYM
      APPLICATION NAME=NDZDS1K3
 V442-CRTKN=NDZDS1K3
 V445-GA144A3D.P50F.DF9F35DB7368=13261 ACCESSING DATA FOR
  ::FFFF:10.20.74.61
```

Password encryption

Natural for Db2 for zIIP (NDZ) provides a mechanism to safely store the password of ndzDb2 user.

The script *<NDZ home directory>/bin/ndz-db2-pass.sh* allows the user to encrypt the password. During the execution, NDZ decrypts the password based on the key file and uses it for Db2 connections. This is the recommended approach to store the password for the ndzDb2 user.

Make sure you have "Execute" access to the *ndz-db2-pass.sh* script and write access to the NDZ library as NDZ will create a *<NDZ home directory>/var* directory when you execute this script.

Find more details in ***Db2 Password Encryption***.

Db2 security considerations

Natural for Db2 for zIIP (NDZ) connect to Db2 remotely using a Db2 distributed data facility. Any remote client applications that access Db2 via the Db2 distributed data facility are associated, by default, with plan DISTSERV. Hence, adding security via plan authorizations is not possible.

You can manage authorizations using GRANT/REVOKE on packages and collections.

Accounting

Since NDZ connects to Db2 through DDF, the generation of accounting records is managed by the Db2 subsystem parameters `ACCUMACC` and `ACCUMUID`.

The `ACCUMUID` parameter specifies which qualifier of the thread should be considered to identify a unique client. Depending on its value, all the NDZ threads may be considered as the same client. In this case, a new accounting record will be generated after the number of transactions defined by the `ACUMMACC` parameter, when it is not set to NO.

Currently, NDZ sets the following Db2 thread/connection values:

Qualifier	Value
Application Name	Client Job name
User ID	Client Job User ID
Client Accounting Information	Client Job name
Correlation Token	Client Job name

The value of the parameter `ACCUMUID` should be set accordingly to consider the Application name, and optionally the user ID, to uniquely identify clients.

For example, 0 (User ID, application name and workstation name), 4 (User ID and application name), among others. For more details about the parameters `ACCUMUID` and `ACUMMACC`, refer to *Db2 Installation and Migration Guide*.

Static preparation and execution

Natural for Db2 for zIIP (NDZ) support static preparation and execution through SQLJ and it is independent from the static generation of NDB.

For detailed information about static preparation and Execution of Natural programs with NDZ, refer to ***About Preparation for Static Execution with NDZ***.

22 Restrictions

- Restrictions Related to Db2 Datatypes 324
- Restrictions Related to Db2 Statements 325
- Restrictions Related to Static Preparation 326
- Restrictions Related to Dynamic Execution 326

Restrictions Related to Db2 Datatypes

- Casting DATE and TIME datatypes to CHAR
- Retrieval of Timestamp data with a precision more than nine
- Retrieval of Timestamp data with time zone
- Difference in Round off mechanism for Floating Point datatype

Casting DATE and TIME datatypes to CHAR

When casting a DATE/TIME datatype column to `CHAR`, the DATE/TIME format resulting from the function will always have the ISO format. The format in the `db2.properties` is not honored. This is due to a Db2 JDBC driver limitation. For JCC packages, the pre-compiler DATE/TIME option is set to ISO. The `CHAR` function default behavior is influenced by the pre-compiler DATE/TIME option which has precedence over the DECP options. You can use the additional parameter in the `CHAR` function to change the DATE/TIME format.

```
CHAR(CURRENT DATE)
/* RESULT FORMAT EXAMPLE: 2023-05-01

CHAR(CURRENT TIME)
/* RESULT FORMAT EXAMPLE: 01.01.01
```

Retrieval of Timestamp data with a precision more than nine

When retrieving timestamp data, the data is retrieved in a standard JDBC format with a precision of up to nine. This is due to a Db2 JDBC driver limitation. Casting the result to `CHAR` solves the problem.

```
CURRENT TEMPORAL BUSINESS_TIME
/* RESULT EXAMPLE: 2011-02-28-01.01.01.123456789
CHAR(CURRENT TEMPORAL BUSINESS_TIME)
/* RESULT EXAMPLE: 2011-02-28-01.01.01.123456789012
CURRENT TIMESTAMP(12)
/* RESULT EXAMPLE: 2023-04-25-11.06.11.292553363
CHAR(CURRENT TIMESTAMP(12))
/* RESULT EXAMPLE: 2023-04-25-11.06.11.292553363769
```

Retrieval of Timestamp data with time zone

When retrieving data from a `TIMESTAMP WITH TIMEZONE` column, the data is retrieved in a standard JDBC format without a time zone. The returned value is adjusted for the difference between the time zone of the column value and the default time zone.

This is due to a Db2 JDBC driver limitation. Casting the result to `CHAR` solves the problem.

```
SELECT TIMESTAMP_W_TIMEZONE_COLUMN FROM ...
/* RESULT EXAMPLE: 2012-02-29-05.03.59.100000
SELECT CHAR(TIMESTAMP_W_TIMEZONE_COLUMN) FROM ...
/* RESULT EXAMPLE: 2012-02-29-07.03.59.100000+02:00
```

Difference in Round off mechanism for Floating Point datatype

When retrieving data from a `FLOATING POINT` column which has data more than 16 digits, the last digit value may be different from the Natural for Db2 (NDB) result. This is due to the JDBC driver round off mechanism is different than Db2 for z/OS round off mechanism for Floating point datatype.

```
/* Result with NDB
STDDEV SALARY = .9742432961021595E 04
/* Result with NDZ
STDDEV SALARY = .9742432961021594E 04
/* Result with NDB
STDDEV SALARY =  9742.432961021595
/* Result with NDZ
STDDEV SALARY =  9742.432961021594
```

Restrictions Related to Db2 Statements

The following Natural/Db2 SQL statements are currently not supported by Natural for Db2 for zIIP as JDBC drivers do not support them natively.

- `CONNECT TO`
- `GET DIAGNOSTICS`

Restrictions Related to Static Preparation

- SET CURRENT DECFLOAT MODE = :HV1 fails with SQL error -104
- SQL statement to set global variables fails during static preparation
- SENSITIVE DYNAMIC cursor changes to SENSITIVE STATIC during program static preparation
- FORWARD ONLY cursor changes to SENSITIVE STATIC during program static preparation

SET CURRENT DECFLOAT MODE = :HV1 fails with SQL error -104

SQL statement SET CURRENT DECFLOAT MODE = :HV1 fails with SQL error -104 during static preparation. This is due to a bug in IBM SQLJ customization and `BIND`. Alternately, the statement works fine when keyword or literal is specified instead of host variable.

SQL statement to set global variables fails during static preparation

The SQL statement to set the values for global variables fails during static preparation with the message 'Unsupported statement'. This is due to the SQLJ customization and `BIND` behavior.

SENSITIVE DYNAMIC cursor changes to SENSITIVE STATIC during program static preparation

During static preparation process, cursor type `SENSITIVE DYNAMIC` is changed to `SENSITIVE STATIC`. `SENSITIVE DYNAMIC` usage is currently not supported.

FORWARD ONLY cursor changes to SENSITIVE STATIC during program static preparation

During static preparation process, cursor type `FORWARD ONLY` is changed to `SENSITIVE STATIC` when we have positioning update on a Rowset. This is because JDBC does not support rowset natively.

Restrictions Related to Dynamic Execution

Cursor Sensitivity

Cursor types `SENSITIVE DYNAMIC`, `STATIC` and `ASENSITIVE` will be changed to the cursor type specified in the JDBC property `cursorSensitivity`. This JDBC property can be defined in the ***Db2.properties*** file.

The default value is `STATIC`. For more details on the `cursorSensitivity` property, refer to the **IBM documentation**.

MERGE Statement with FOR n ROWS Clause

To successfully execute `MERGE` statements including the `FOR n ROWS` clause, the Db2 JDBC property `statementConcentrator` should be set to "off" (1). This JDBC property can be defined in the ***Db2.properties*** file.

Statements with WHERE CURRENT OF Clause

To successfully execute statements containing the `WHERE CURRENT OF` clause, rowset support must be disabled. This can be achieved by setting one or both Db2 JDBC properties `useRowsetCursor` and `enableRowsetSupport`. These JDBC properties can be defined in the ***Db2.properties*** file.

23 Operation

- NDZ Server Commands 330

Starting Natural for Db2 for zIIP

Issue the following MVS console start command to start the NDZ Server:

```
START NDZ STARTED TASK NAME
```

Stopping Natural for Db2 for zIIP

Issue the following MVS console stop command to stop the NDZ Server:

```
STOP NDZ STARTED TASK NAME
```

NDZ will perform the shutdown process after the last client disconnects. The following message displays in the MVS console if there are clients connected to the NDZ Server when the `STOP` command is issued:

```
NDZMAIN Stop requested. Waiting for clients to finish
```

To force NDZ termination despite the connected clients, add the F option to the stop command. Example:

```
STOP NDZ STARTED TASK NAME F
```

NDZ displays the following message in the console and performs the shutdown process:

```
NDZMAIN Forced stop requested
```

NDZ Server Commands

- D CLI - Display clients
- D CPU - Display CPU utilization report
- R - Reload static profiles
- P CLI=CLIENT NUMBER – Stop client

Use the MVS console modify command to issue commands to the NDZ Server:

```
MODIFY NDZ STARTED TASK NAME,COMMAND PARAMETER1, PARAMETER2, ...
```

NDZ Servers accept the commands described below.

D CLI - Display clients

The D CLI modify command lists the clients that are currently connected to the NDZ Server. The output message has the following format:

```
---------------------------------------------
NDZ CLIENTS REPORT
 CURRENT DATE AND TIME                   18.06.2024  11:31:32.54
 MAXIMUM NUMBER OF CLIENTS ALLOWED                             4
 NUMBER OF CONNECTED CLIENTS                                   3
 CLIENT   JOB NAME   JOB ID     USER ID    PROGRAM    LIBRARY
      1   NDZDS1K1   J0208314   USER       NDZDS1K1   NDZ1
      2   NDZDS1K2   J0208315   USER       NDZDS1K2   NDZ2
      3   NDZDS1K3   J0208316   USER       NDZDS1K3   NDZ3
---------------------------------------------
```

Where:

Report Item	Explanation
CLIENT	The client slot which the current client occupies. Client numbers are in the interval between 1 and the value of ndz.maxClients parameter in the ndz.properties file.
JOBNAME	The name of the client's job.
JOBID	The ID of the client's job.
USERID	The User ID that is associated with the client job.
PROGRAM	The name of the Natural program that the client is executing at the moment.
LIBRARY	Natural Library where the program is present.

D CPU - Display CPU utilization report

The D CPU modify command displays CPU utilization report at the moment and the workload distribution.

```
---------------------------------------------
NDZ CPU UTILIZATION STATISTICS (SECONDS)
 CURRENT DATE AND TIME                   18.06.2024  11:25:17.20
 GENERAL PROCESSORS: 5     ZIIPS: 1     NORMALIZ. FACTOR:  13.51
 NUMBER OF EXCPS                                          1548481
 TOTAL TIME ON GP (EXCL. ZIIP ELIGIBLE)    0.48%        0.241684
  TCB TIME ON GP                           0.45%        0.227081
  SRB TIME ON GP                           0.03%        0.014456
  ENCLAVE SRB TIME ON GP                   0.00%        0.000147
 ZIIP ELIGIBLE TIME ON GP                  0.64%        0.318578
 TOTAL TIME ON ZIIP (NORMALIZED)          98.88%       49.360806
  TCB TIME ON ZIIP                        98.88%       49.360543
  ENCLAVE SRB TIME ON ZIIP                 0.00%        0.000263
 TOTAL CPU TIME                          100.00%       49.921068
---------------------------------------------
```

Report Item	Explanation
GENERAL PROCESSORS	The number of GPs running under your z/OS system.
ZIIPS	The zIIP normalization factor indicates the ratio of zIIP to GP speed.
NORMALIZ.FACTOR	This factor tells you how fast your zIIP runs compared to a throttled GP with reduced power. In the example above, the value of 13.51 means that one zIIP is about 13.5 times faster than one GP.
NUMBER OF EXCPS	This EXCP number refers to the number of I/O signals.
TOTAL TIME ON GP (EXCL. ZIIP ELIGIBLE)	The total GP time consumed within the NDZ WLM enclave.
TCB TIME ON GP	The GP time consumed within the TCB execution.
SRB TIME ON GP	The GP time consumed within the SRB execution.
ENCLAVE SRB TIME ON GP	The GP time consumed within the NDZ WLM enclave SRB.
ZIIP ELIGIBLE TIME ON GP	The CPU time within the NDZ WLM enclave on the GP qualified for zIIP but not used by it. A non-zero value means that zIIP-eligible workload could not be offloaded because no zIIP was available.
TOTAL TIME ON ZIIP (NORMALIZED)	The total zIIP time consumed within the NDZ WLM enclave.
TCB TIME ON ZIIP	The zIIP time consumed within the TCB execution.
ENCLAVE SRB TIME ON ZIIP	The zIIP time consumed within the NDZ WLM enclave SRB.
TOTAL CPU TIME	The total CPU time (GP plus zIIP) consumed.

R - Reload static profiles

The R modify command reloads the static profiles cache from directory specified in the `ndz.staticPath`. This command can be used to reload the static profile when the property `ndz.automaticProfileReload` is set to false. The command output is shown in STDOUT as below.

```
[2024-06-18 09:33:18 GMT] Static Profiles reloaded
```

P CLI=CLIENT NUMBER – Stop client

Release a client slot that is held by a non-executing client job.

Important: This command **SHOULD NOT** be used to cancel the execution of NDZ client jobs that are currently executing. Use the appropriate MVS or JES2 command instead if you need to cancel a job. Using this command on a job that is currently in execution can lead to unexpected results including, but not limited to, loss of uncommitted data.

If a NDZ client job abnormally terminates or is canceled, it usually disconnects from NDZ and releases the client slot it was occupying automatically. If the client job doesn't disconnect automatically, you can issue this command to release the client slot that is currently held by the job that is no longer running. To release a client slot:

1. Identify the Job ID of the client job.
2. Issue the `D CLI` modify command to list all clients that are connected to the NDZ Server.
3. Check the CLIENT# and JOBID columns to identify the client number of the job.
4. Issue the `P CLI=`*`client number`* modify command, where *`client number`* is the value from the CLIENT# column.

24 Configuration and Parameters

- Configuration 336
- Parameters 338

Configuration

- General Product Configuration
- Db2 Configuration
- Db2 Password Encryption

General Product Configuration

Below you will find the components with which you can configure the NDZ according to your specifications.

NDZ Started Task

NDZ server started task streamlines and executes the Db2 requests remotely using JDBC and SQLJ drivers. For more information about using sample jobs to create NDZ started task in the NDZ installation, see *Installing Natural for Db2 for zIIP* . For information about NDZ server started task parameters, see ***NDZ started task procedure***.

NDZ server supports Language Environment (LE). For details about the LE runtime options and recommended options for the NDZ server, see ***Language Environment Runtime Options for NDZ Server***.

NDZ Configuration

You specify Natural for Db2 for zIIP (NDZ) parameters in the *ndz.properties* present in the */etc* directory to configure NDZ. These parameters control the properties of NDZ started task and the client related configurations of NDZ. For detailed information about the NDZ parameters, refer to ***NDZ configuration file (ndz.properties)***.

Setting Environment Variables

The *<NDZ-directory>/bin/setenv.sh* script is used in the other scripts and batch jobs for static preparation to set the required environment variables. NDZ builds the environment variables like CLASS_PATH and LIB_PATH based on the parameters supplied by you. For detailed information about the parameters to specify in the setenv.sh script, refer to the section ***NDZ USS environment configuration file (setenv.sh)***.

Db2 Configuration

Natural for Db2 for zIIP (NDZ) requires Db2 related information to connect to Db2 and modify Db2, JDBC and SQLJ driver properties. You can add these parameters in db2.properties. To know more about parameters required for Db2 configuration, refer to ***Db2 configuration file (db2.properties)***. Other than the parameters mentioned in the section, you can also specify JDBC and SQLJ properties in the Db2 configuration file.

Db2 Password Encryption

Natural for Db2 for zIIP provides a password encryption mechanism to safely encrypt your password using encryption keys.

You need to generate an encryption key, and this key is used to encrypt the password. You can generate the key and encrypt the password using the script *<NDZ home directory>/bin/ndz-db2-pass.sh*.

Execute the following script and enter the Db2 connection password when prompted:

`<NDZ home directory>`*/bin/ndz-db2-pass.sh*

Options:

`-g` To generate the key file.

Use the option `-g` when you generate the key file or change the existing encryption key.

Example:

```
ndz-db2-pass.sh -g ↩
```

This option `-g` should be used when you execute the script for the first time to generate an encryption key file.

However, if you want to change the password without changing the key file, execute the script without option `-g`.

Example:

```
ndz-db2-pass.sh
```

Note:

If your Db2 connection password is encrypted, the password parameter in the *db2.properties* will be ignored.
If your Db2 connection password is not encrypted, you will receive a warning message when you start the NDZ server.

Message:

```
WARNING - Db2 encrypted password is not available at <NDZ home directory/var>. Using
password from db2.properties
```

Parameters

- NDZ Started Task Procedure
- Language Environment Runtime Options for NDZ Server
- Db2 Configuration File (db2.properties)
- NDZ Configuration File (ndz.properties)
- NDZ USS Environment Configuration File (setenv.sh)

NDZ Started Task Procedure

You specify the following parameter for the NDZ started task procedure.

Parameter name	Mandatory	Description
PATH	Y	The home directory where the NDZ files were installed in Unix System Services (USS).

Example:

```
//NDZ11 EXEC PGM=NDZNUC11,REGION=0M,
//PARM=('PATH=/u/nat/ndz/dev/ndz11') ↩
```

Language Environment Runtime Options for NDZ Server

This section describes the Language Environment (LE) runtime options and recommended options for the NDZ server.

The LE options you specify depend on the site specifications and the workload executed on the NDZ Server. You can determine the optimal values for your site from the reference values in the report on memory usage by the NDZ Server. To retrieve the report, set the options `RPTOPTS(ON)` and `RPTSTG(ON)`.

You only need to use `RPTOPTS` and `RPTSTG` to retrieve the report and set the LE options in NDZ Server.

After you set the LE runtime options, set `RPTOPTS(OFF)` and `RPTSTG(OFF)` as these options increase the time to complete the task.

Option	Description
HEAP64	Controls the allocation of the user heap.
HEAPPOOLS64	Specifies that the (Quick) heap storage manager can be used to manage user heap storage above the 2G bar.
IOHEAP64	Controls the allocation of the I/O heap storage.
LIBHEAP64	Controls the allocation of the library heap storage.
STACK64	Controls the allocation and management of the stack storage.
STORAGE	Controls the contents of storage that is allocated and freed.
THREADSTACK64	Controls the allocation of the thread-level stack storage for both the upward and downward growing stack.

LE Runtime Options for NDZ Server

You set the LE runtime options in NDZ server started task by specifying them under `DDNAME CEEOPTS`, for example:

```
//CEEOPTS  DD  *
ENVAR("LIBPATH=&LP1.&LP2.&LP3."),POSIX(ON),
HEAP64(100M,1M,KEEP,209785904,32768,KEEP,0,4096,FREE),
LIBHEAP64(1M,1M,FREE,8192,8192,FREE,0,4096,FREE),
IOHEAP64(1M,1M,FREE,40960,8192,FREE,4096,4096,FREE)
```

In addition to the specified runtime options, you can set all other options to site-specific values.

Db2 Configuration File (db2.properties)

You specify the following parameters for Natural for Db2 for zIIP (NDZ) to connect to Db2 and to perform SQL operations.

Parameter name	Mandatory	Description
user	Y	Userid to connect to Db2. Note that the user should have required access on Db2 to perform required SQL operations. This is a mandatory parameter.
password	Y	Password for the Db2 user mentioned above. Note that you can encrypt the password using NDZ *Db2 password encryption* capability, be aware that this is the recommended method to store your password. If you do not have an encrypted password, you can mention the password here. However, it is recommended to encrypt your password using NDZ *Db2 password encryption*.
databaseName	Y	Db2 database location name to connect to the specific Db2 system. Example – DAEFDB2D. This is a mandatory parameter.
serverName	Y	Fully qualified domain address of the z/OS system you need to connect. This is a mandatory parameter.

Parameter name	Mandatory	Description
portNumber	Y	TCP/IP port number that identifies the specific Db2 subsystem. This is a mandatory parameter.
statementConcentrator	N (recommended)	Suggested setting: `statementConcentrator=1`. When `statementConcentrator` is not set (`statementConcentrator=0`) or is enabled (`statementConcentrator=2`), a `MERGE` statement containing the `FOR n ROWS` clause will fail with the SQLCODE `-20186`. Therefore, it is strongly recommended to set this parameter to "off" (`statementConcentrator=1`). See also ***Restrictions Related to Dynamic Execution***. For more details, refer to the Db2 for z/OS *Application Programming Guide and Reference for Java* manual.
useRowsetCursor / enableRowsetSupport	N (recommended)	Suggested setting: `useRowsetCursor=false`. To execute statements with the `WHERE CURRENT OF` clause, rowset support must be disabled. This can be achieved by setting the properties `useRowSetCursor=false` and/or `enableRowsetSupport=1`. Any of them or both can be used. See also ***Restrictions Related to Dynamic Execution*** When rowset support is enabled and a statement containing the `WHERE CURRENT OF` clause is executed, NDZ will return the error `606`. See ***Error Codes*** for details.

You can also set the IBM JDBC and SQLJ properties by specifying the properties in db2.properties file. Refer to *Application Programming Guide and Reference for Java* related to different JDBC and SQLJ properties.

NDZ Configuration File (ndz.properties)

You specify the following parameters to configure the NDZ server instance.

Parameter name	Mandatory	Description
java.home	Y	The Java JDK installation directory.
db2.home	Y	The Db2 installation directory which contains licenses, JDBC and SQLJ drivers.
ndz.maxClients	Y	The maximum number of clients that can connect simultaneously to NDZ server to execute Db2 requests. Accepted values are 1-999.
ndz.initDb2Connection	Y	Number of initial connections to Db2.
ndz.bufferLentgh		Length of the client buffer in MB. Accepted values are 1-5000.
ndz.staticPath	Y	Path(s) for the static profiles. During the static preparation, serialized profiles are generated in the directory mentioned in this

Parameter name	Mandatory	Description
		parameter. The profiles in the static path are used during the runtime to execute the SQL statements statically.
ndz.automaticProfileReload	N	Specifies if static profiles cache will be reloaded when changes occur in the directory specified in the `ndz.staticPath`. Possible values are true/false. The default value is false. When it is set to true, there is an additional CPU consumption to monitor the directory for any changes and reload the static profiles. If the value is set to false, you can reload static profiles using modify command R.
ndz.retryCount	N	Specifies the number of attempts to check for new requests before NDZ client tasks switch to wait state. The performance of NDZ client applications can be improved when the task processing the requests run continuously, avoiding context switches. This behavior is in effect only when this property is set to a value different than zero. The default value is 0.
ndz.redispatchCount	N	Specifies after how many retry attempts (property `ndz.retryCount`) the NDZ client task will yield its use of the processor to other tasks. Setting this property can improve the performance of NDZ, avoiding over-utilization of the CPU. This behavior is in effect only when this property and `ndz.retryCount` are set to values different than zero. The default value is 0.

NDZ USS Environment Configuration File (setenv.sh)

The following are the parameters needed for the Natural for Db2 for zIIP (NDZ) to set the environment variables.

Parameter name	Mandatory	Description
`DB2_HOME`	Y	Update the Db2 installation directory which contains licenses, JDBC and SQLJ drivers. (Ex - /usr/lpp/db2vrs)
`JAVA_HOME`	Y	Update the Java JDK installation directory (Ex - /usr/lpp/java/Jvrs)
`NDZ_HOME`	Y	NDZ installation directory path where NDZ files are present.

25 Error codes

This section describes the error codes in Natural for Db2 for zIIP (NDZ).

Note that no `Action` is specified for an internal error in the following table. If it is an internal error or if the error is not resolved after the recommended action is performed, contact support mentioning the specific error code and associated message.

The following table explains the error codes with their description.

Error category	Return code	Message
Error during session initialization	101	Error occurred while obtaining a storage area
	102	NDZ Server is not available `Action:` Verify the value of the parameter NDZSRV and ensure the NDZ Server specified is up and running
	103	Number of connected clients reached the maximum clients limit(ndz.maxClients) specified in the ndz.properties file `Action:` Modify the ndz.maxClients parameter in ndz.properties file to run more jobs parallelly
	104	Error creating pause element
	105	Error releasing pause element
	106	Error pausing a client task
	107	Session initialization request for the client cannot be processed because the NDZ Server is already in terminating state `Action:`

Error category	Return code	Message
		If the NDZ server is terminating, restart the NDZ server again and execute the job
	108	Insufficient access for caller to access a protected storage
Error during processing request	201	NDZ Server is not available `Action:` Verify the value of the parameter NDZSRV and ensure the NDZ Server specified is up and running
	202	The client address is invalid
	203	Error releasing pause element
	204	Error pausing client task
	205	Request to stop the client is pending. The client is either in Invalid or in terminating state `Action:` If the NDZ server is terminating, restart the NDZ server again and execute the job
	206	Client JOBID does not match with the client NDZ server is processing.
	207	There is already a request pending for the client
	208	Insufficient access for caller to access a protected storage
Error during session termination	301	NDZ Server is not available `Action:` Verify the value of the parameter NDZSRV and ensure the NDZ Server specified is up and running
	302	The client address is invalid
	303	Error releasing pause element
	304	Error pausing client task
	305	Request to stop the client is pending. The client is either in Invalid or in terminating state `Action:` If the NDZ server is terminating, restart the NDZ server again and execute the job
	306	Client JOBID does not match with the client NDZ server is processing.
	307	There is already a request pending for the client
	308	Insufficient access for caller to access a protected storage
Error during connection to Db2	500	Error creating User Context. The associated exception text describes the possible cause for the error.

Error category	Return code	Message
	501	Error registering static statement during static execution. The associated exception text describes the possible cause for the error `Action:` Ensure the static preparation steps were successfully executed and the associated profile is available in the NDZ static directory(ndz.staticPath) specified in the ndz.properties file
	540	Error fetching CURRENT PATH special register value from Db2. The associated exception text describes the possible cause for the error.
	550	Error getting connection for Db2. The associated exception text describes the possible cause for the error.
	551	Error creating pooled connection for Db2. The associated exception text describes the possible cause for the error.
	552	Error creating pooled connections. Number of connections exceed maximum clients `Action:` Adjust the maximum clients parameter in ndz.properties file to run more jobs parallelly
Error during request execution through distributed connection	600	The statement type <statement type> is not supported by NDZ
	601	The type <data type> is not supported by NDZ
	602	The java.sql type <jdbcsqltype> is not supported by NDZ
	603	NDZ does not support the set var statement requested. (internal request number='')
	604	Error fetching parameter types for procedure <Procedure name>. Please verify if the procedure name is correct
	605	The cursor <Cursor name> is not available
	606	UPDATE and DELETE statements with the clause WHERE CURRENT OF are not supported by the IBM Db2 JDBC driver for scrollable cursors when useRowsetCursor is specified
	650	The encoding <Encoding type> is not supported
Error related to LOB columns	701	Error reading LOB file <File name> (SQL file option: <>, File mode: <>)
	702	Error writing LOB file <File name> (SQL file option: <>)
	703	Error fetching data from LOB column
Error related to SQL data unavailability	800	The input SQLDA is not present or does not contain any SQLVAR
	801	The output SQLDA is not present or does not contain any SQLVAR
	802	The first extended output SQLDA is not present
Error related to password encryption	901	The file 'db2.properties' was not found `Action:`

Error category	Return code	Message
		Please make sure the db2.properties file present in directory <NDZPATH>/etc/ and the user have the access to the file. The associated exception text describes the possible cause for the error
	910	Error creating directory for Db2 encrypted password (<Exception message>). The associated exception text describes the possible cause for the error
	911	Error reading Db2 password encryption key (<Exception message>). The associated exception text describes the possible cause for the error
	912	Error reading Db2 encrypted password file (<Exception message>). The associated exception text describes the possible cause for the error
	913	Error writing Db2 password encryption key (<Exception message>). The associated exception text describes the possible cause for the error
	914	Error writing Db2 encrypted password file (<Exception message>). The associated exception text describes the possible cause for the error
	915	Error while generating Db2 password encryption key. The associated exception text describes the possible cause for the error
	916	Error while decrypting Db2 password. The associated exception text describes the possible cause for the error
	917	The Db2 encrypted password file is not available at <file_path> and the property 'password' is not set in the file db2.properties `Action:` Execute the script <NDZ home directory>/bin/ndz-db2-pass.sh to encrypt the password to use or specify the password in db2.properties file
	918	The Db2 encryption key is not available at <file_path> `Action:` Verify if the key file is present in <NDZ home directory>/var and the user has the required access. If the file is not present, execute the script <NDZ home directory>/bin/ndz-db2-pass.sh with option -g to generate the key and encrypt the password to use
Unspecified errors	997	Error executing rollback due to an unhandled exception. The associated exception text describes the possible cause for the error
	998	Runtime exception caused by:<Error description>. The associated exception text describes the possible cause for the error
	999	Unhandled exception. The associated exception text describes the possible cause for the error

26 Preparing Programs for Static Execution

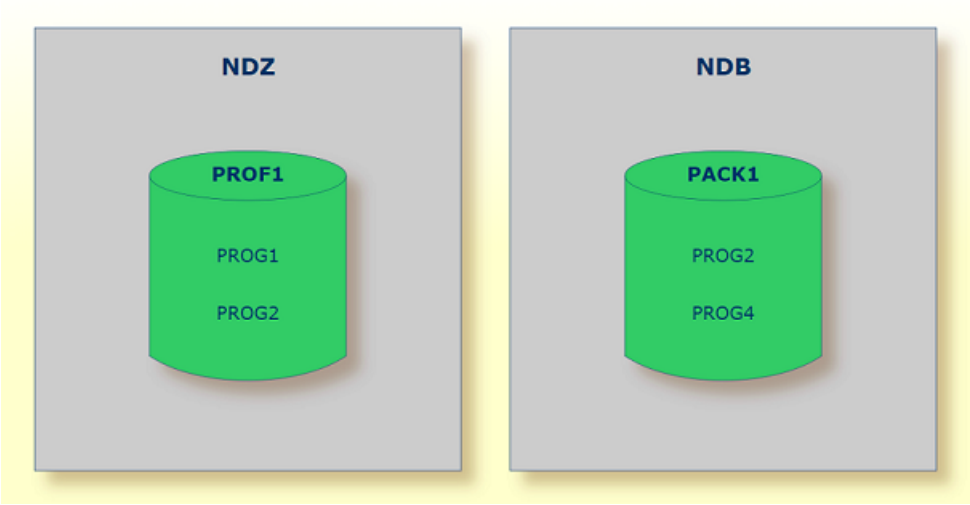
- About Preparation for Static Execution with NDZ 348
- Static Preparation Steps 349
- Unix Shell Scripts for Static Preparation 357
- Comparison Between NDZ and NDB Static Preparation 358

In order to execute Natural programs that contain Db2 statements statically with NDZ, you must perform the static generation steps for each program you want to execute. All necessary information about static program preparation and execution with NDZ is described in this section.

About Preparation for Static Execution with NDZ

Compatibility with Natural for Db2 (NDB)

The program static preparation for Natural for Db2 for zIIP (NDZ) is independent from the program static preparation for Natural for Db2 (NDB). Natural programs already prepared for static execution with NDB are not impacted in any way when NDZ is installed. Those programs will continue to execute statically with NDB. However, when a Natural session is successfully initialized with NDZ, they will be executed dynamically until they are also prepared for static execution with NDZ. The Natural programs subject to NDZ static generation and NDB static generation don't have to be identical. However, one Natural program can be in only one SQLJ profile and/or in one NDB DBRM/PACKAGE. The following graphic shows an NDZ static generation done for Natural programs PROG1 and PROG2 contained in the SQLJ profile and package PROF1 and an NDB static generation done for Natural programs PROG2 and PROG4 contained in package PACK1.



About NDZ and the SQLJ Standard

NDZ uses Java to connect to Db2 and execute SQL statements. The standard for embedding SQL statements in Java programs is called SQLJ and the Java programs containing embedded SQL are called SQLJ programs. NDZ provides a SQLJ Generator, which translates temporary assembler programs generated by the NDB command `CMD CREATE` into SQLJ. The NDZ SQLJ Generator is described in ***Step 2 - NDZ SLQJ Generator***.

About the SQLJ Translator and Serialized Profiles

NDZ requires SQLJ Serialized Profiles to execute Db2 SQL statements from Natural programs statically. SQLJ serialized profiles are files containing the description of the SQL statements and cursors from a particular program. NDZ uses SQLJ serialized profiles at runtime, therefore they are mandatory for Db2 static execution with Natural and NDZ. They are generated by the SQLJ translator. The SQLJ translator is provided by IBM.

The SQLJ translator receives an SQLJ program as input. The usage of the IBM SQLJ Translator in the context of NDZ is described in ***Step 3 - IBM SLQJ Translator***. For more information about the SQLJ translator, refer to the IBM Db2 Java documentation for SQLJ.

Serialized Profile Customization and Binding

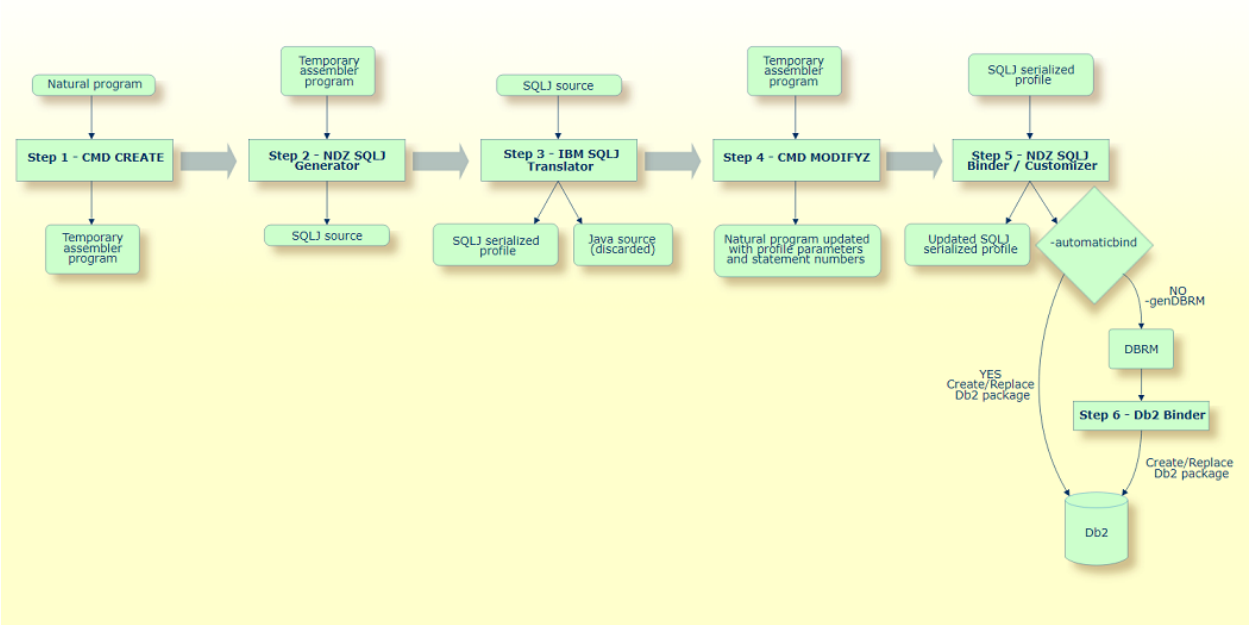
An SQLJ program can run statically only when it has SQLJ serialized profiles that are customized and bound to Db2. NDZ provides its own binder and customizer program which calls the IBM SQLJ customizer.

The NDZ binder uses the connection parameters specified in the NDZ configuration file db2.properties to execute the customization and optionally the bind process in Db2.

If you want, you can set the NDZ Binder and customizer to skip the bind process and instead generate a DBRM file to be bound to Db2 in subsequent step. The NDZ Binder and Customizer is described in ***Step 5 - NDZ SQLJ Binder / Customizer***.

Static Preparation Steps

To execute Natural programs containing Db2 statements statically with NDZ, you must always have a SQLJ serialized profile. The SQLJ profile is used at runtime and, optionally, in the bind process. If you want, you can generate a DBRM file from the SQLJ serialized profile and bind that file to Db2 using the Db2 BIND PACKAGE command. This is especially useful when the user specified in NDZ does not have the required permissions to execute the bind in Db2. In this case, the bind can be done with the permissions of the executor of the BIND PACKAGE command, for example, the user that submits the batch job containing the command. See **the JCL in step 6** for an example of that.



- Step 1 – CMD CREATE
- Step 2 – NDZ SQLJ Generator
- Step 3 – IBM SQLJ Translator
- Step 4 – CMD MODIFYZ
- Step 5 – NDZ SQLJ Binder / Customizer
- Step 6 – Db2 Binder (Optional)

Step 1 – CMD CREATE

Run the `CMD CREATE` command, selecting the Natural programs you want to prepare for static execution with NDZ.

The `CMD CREATE` statement generates a temporary assembler program with the SQL statements contained in the selected Natural programs. This step is identical for NDZ and NDB. For detailed information about the `CMD CREATE` command, refer to ***Natural for z/OS > Database Management System Interfaces > Natural for Db2 > Dynamic and Static SQL Support > Generation Procedure: CMD CREATE Command***.

JCL Example:

```
//GENERATE EXEC PGM=natural batch nucleus
//CMPRMIN  DD
    Natural parameters
//*
//STEPLIB  DD DSN=nucleus load library,DISP=SHR
//SYSUDUMP DD SYSOUT=X
//*********  OUTPUT DECKS
//CMWKF01  DD DSN=&&TMP1,UNIT=SYSDA,DCB=(DSORG=PS,RECFM=FB,LRECL=80,
//         BLKSIZE=3120),DISP=(,PASS),SPACE=(TRK,(5,5))
//CMWKF02  DD DSN=&&TMP2,UNIT=SYSDA,DCB=(DSORG=PS,RECFM=FB,LRECL=80,
//         BLKSIZE=3120),DISP=(,PASS),SPACE=(TRK,(5,5))
//CMWKF03  DD DSN=&&TMP3,UNIT=SYSDA,DCB=(DSORG=PS,RECFM=FB,LRECL=80,
//         BLKSIZE=3120),DISP=(,PASS),SPACE=(TRK,(5,5))
//CMWKF04  DD DSN=&&TMP4,UNIT=SYSDA,DCB=(DSORG=PS,RECFM=FB,LRECL=80,
//         BLKSIZE=3120),DISP=(,PASS),SPACE=(TRK,(5,5))
//CMWKF05  DD DSN=&&TMP5,UNIT=SYSDA,DCB=(DSORG=PS,RECFM=FB,LRECL=80,
//         BLKSIZE=3120),DISP=(,PASS),SPACE=(TRK,(5,5))
//CMWKF06  DD DSN=&&TMP6,UNIT=SYSDA,DCB=(DSORG=PS,RECFM=FB,LRECL=80,
//         BLKSIZE=3120),DISP=(,PASS),SPACE=(TRK,(5,5))
//CMPRINT  DD SYSOUT=X
//CMSYNIN  DD *,SYMBOLS=JCLONLY
LOGON SYSDB2
CMD CRE DBRM PROFILE NAME USING INPUT DATA WITH XREF YES|NO FS ON/OFF
LIBRARY,PROGRAM
LIBRARY,PROGRAM
.
FIN
```

Step 2 – NDZ SQLJ Generator

Execute the `com.softwareag.ndz.sqljgen.SQLJGenerator` Java class through the IBM JZOS Batch Launcher using the assembler program that you generated in step 1 as input.

NDZ provides the Java class `com.softwareag.ndz.sqljgen.SQLJGenerator` to translate temporary assembler programs generated in step 1 into SQLJ programs. The Java class must be executed through the IBM JZOS Batch Launcher. The IBM JZOS Batch Launcher is available with any Java version for z/OS supported by NDZ.

DD Name	Description
`INPUT`	Temporary assembler program generated in step 1.
`OUTPUT`	SQL program translated from the input.

DD Names

JCL Example:

```
//GENSQLJ  EXEC PROC=JVMPRC86|11|17|xx,REGSIZE=1024M,
//         JAVACLS='com.softwareag.ndz.sqljgen.SQLJGenerator'
//INPUT    DD DSN=&&TMP6,DISP=(OLD,PASS)
//OUTPUT   DD PATH='programs directory/program name.sqlj',
//         PATHDISP=(KEEP,DELETE),
//         PATHOPTS=(OCREAT,ORDWR),
//         PATHMODE=(SIRUSR,SIWUSR,
//             SIRGRP,SIWGRP,
//             SIROTH,SIWOTH),
//         FILEDATA=TEXT
//MAINARGS DD *,SYMBOLS=JCLONLY
&PROFILE
//STDENV   DD *,SYMBOLS=JCLONLY
. /etc/profile
. ndz installation path/bin/setenv.sh

/*
```

Step 3 – IBM SQLJ Translator

Execute the `sqlj.tools.Sqlj` Java class through the IBM JZOS Batch Launcher using the SQL program translated in step 2 as input.

The Java class `sqlj.tools.Sqlj` is provided with the IBM JDBC/SQLJ driver for Db2 for z/OS. The IBM SQLJ Translator has a similar function as a Db2 pre-compiler for Assembler or COBOL. The translator allows the embedded SQL statements in a program to be executed statically with Db2.

The main difference is that the SQLJ Translator generates both a serialized profile and a modified version of the input program as output. Another important difference is that the IBM SQLJ Translator does not generate a DBRM file. For details about the IBM SQLJ Translator, refer to the *IBM Db2 Application Programming and Reference for Java* documentation.

JCL Example:

```
//GENPROF  EXEC PROC=JVMPRC86|11|17|xx,REGSIZE=1024M,
//         JAVACLS='sqlj.tools.Sqlj'
//MAINARGS DD *,SYMBOLS=JCLONLY
-compile=true -d=profiles directory
programs directory/program name.sqlj
//STDENV   DD *,SYMBOLS=JCLONLY
. /etc/profile
. ndz installation path/bin/setenv.sh
/*
```

Step 4 – CMD MODIFYZ

Run the `CMD MODIFYZ` command to update the Natural objects from step 1 with the information generated in step 3.

The modification procedure writes the SQLJ serialized profile name and the sequence numbers of the SQL statements to the Natural objects. For more details about the CMD MODIFYZ command, refer to *Natural for z/OS > Database Management System Interfaces > Natural for Db2 > Dynamic and Static SQL Support > Modification Procedure: CMD MODIFYZ Command*.

JCL Example:

```
//MODIFYZ  EXEC PGM=natural batch nucleus,
//         REGION=3000K
//CMPRMIN  DD  *
    Natural parameters
/*
//*
//STEPLIB  DD DSN=nucleus load library,DISP=SHR
//*********  OUTPUT DECKS
//CMWKF01  DD  DSN=&&TMP6,DISP=(OLD,DELETE)
//CMWKF02  DD DSN=&&TMP22,UNIT=SYSDA,DCB=(DSORG=PS,RECFM=FB,LRECL=80,
//         BLKSIZE=3120),DISP=(,PASS),SPACE=(TRK,(5,5))
//CMPRINT  DD SYSOUT=X
//CMSYNIN  DD *,SYMBOLS=JCLONLY
LOGON SYSDB2
CMD MODIFYZ XREF YES|NO
FIN
```

Step 5 – NDZ SQLJ Binder / Customizer

Run the Java class `com.softwareag.ndz.sqljbinder.Main` through the IBM JZOS Batch Launcher to customize the serialized profile generated in step 3 and, optionally, execute the Db2 bind.

NDZ provides the Java class `com.softwareag.ndz.sqljbinder.Main` with the following options:

Option	Argument	Mandatory	Descripton
`-url`	Db2 connection URL in the format `jdbc:db2://server:port/database`	No	The URL connection to a Db2 server instance. If this option is not specified, the connection parameters available in the configuration file db2.properties are used instead. If this option is specified, the options `-user` and `-password` must also be specified.
`-user`	Db2 connection user ID	No	The connection user ID to authenticate to a Db2 server

Option	Argument	Mandatory	Descripton
			instance. If this option is not specified, the user specified in the configuration file db2.properties is used instead. If this option is specified, the options `-url` and `-password` must also be specified.
`-password`	Db2 connection password	No	The connection user password to authenticate to a Db2 server instance. If this option is not specified, the encrypted password or the password specified in the configuration file db2.properties is used instead. If this option is specified, the options `-url` and `-user` must also be specified.
`-automaticbind`	YES | NO	No	Specifies whether the bind will be executed after the customization or not. If it is set to NO, it is recommended to use the options `-genDBRM` and `-DBRMDir` to generate a DBRM file that you can use for Db2 binding. This option is treated as YES even if not specified.
`-genDBRM`	-	No	Specifies whether the class generates a DBRM file after execution. When this option is specified, the option `-DBRMDir` must also be specified.
`-DBRMDir`	DBRM files directory	No	Unix System Services directory where the DBRM file generated from the serialized profile is stored, when the option `-genDBRM` is specified. The generated DBRM file name is the value specified in the parameter `-profile`. This option must be specified when the option `-genDBRM` is specified.
`-bindoptions`	Db2 bind options	Yes	The bind options used to bind the serialized profile to Db2.

Option	Argument	Mandatory	Descripton
			The isolation level (ISOLATION CS | RS | RR | UR | NC) must always be specified. If the option `-automaticbind` is set to YES, you can also specify additional bind options.
`-profile`	Serialized profile name	Yes	Name of the profile generated in the directory specified in the property ndz.staticPath of the properties file ndz.properties. The generated profile file name has the format *`serialized profile name`*`_SJProfile0.ser`
`-collection`	Db2 collection name	No	The collection to which to add the packages generated in the bind process.
`-staticpositioned`	YES | NO	No	Specifies whether positioned update statements will execute statically or dynamically. It is recommended that you to set this option to YES.
`-onlinecheck`	YES | NO	No	Specifies whether online checking of data types will be performed against the Db2 instance specified in the file db2.properties or in the `-url` option. It is recommended that you to set this option to YES. When set to YES, the user must have authorization to execute the statements that are being customized. This option is treated as YES even if not specified.
`-pkgversion`	AUTO | version-id	No	Specifies which package version is used when packages are bound to the server for the serialized profile that is being customized. If this parameter is not specified, no version is used.
`-qualifier`	Qualifier name	No	Specifies the qualifier that is to be used for unqualified objects in the SQLJ program during

Option	Argument	Mandatory	Descripton
			online checking, when the option `-onlinecheck` is set to YES.

NDZ SQLJ BInder/ Customizer Options

If the option `-automaticbind` is set to YES, the class binds the serialized profile to Db2 using the connection parameters specified in the NDZ configuration file db2.properties, unless the properties `-url`, `-user` and `-password` are specified. In any case, the user must have the SYSADM or DBADM privileges. In addition, if the package doesn't exist, the user must have the BINDADD privilege as well as either CREATEIN or PACKADM authority on the collection, or all collections. If the package exists, the user must have the BIND privilege on the package.

If the option `-automaticbind` is set to NO and the options `-genDBRM` and `-DBRMDir` are specified, the class does not execute the bind of the serialized profile to Db2. Instead, the class generates a DBRM file in the directory specified in the option `-DBRMDir`. You can copy the DBRM file to a dataset and bind it to Db2 by executing the Db2 `BIND PACKAGE` command, the same way as NDB. For more information about the Db2 `BIND PACKAGE` command, refer to the *IBM Db2 for z/OS SQL Reference*.

When the option `-onlinecheck` is set to YES, the user specified in the properties file db2.properties, or the user specified in the parameter `-user`, must have access to execute the statements contained in the SQLJ program that is being customized.

JCL Example:

```
JCL Example
//CUSTOM   EXEC PROC= JVMPRC86|11|17|xx,REGSIZE=1024M,
//         JAVACLS='com.softwareag.ndz.sqljbinder.Main'
//MAINARGS DD *
-profile profile name
-onlinecheck YES|NO
-staticpositioned YES|NO
-collection collection
-bindoptions ISOLATION CS|RS|RR|UR|NC
-automaticbind YES|NO
-genDBRM -DBRMDir DBRM directory
//STDENV   DD *,SYMBOLS=JCLONLY
. /etc/profile
. ndz installation path/bin/setenv.sh
/*
```

Step 6 – Db2 Binder (Optional)

Bind the DBRM file generated in step 5 to Db2 by using the Db2 `BIND PACKAGE` command.

This step must only be completed when both `-automaticbind` is set to NO and `-genDBRM` is specified in step 5. For more information about the Db2 `BIND PACKAGE` command, refer to the IBM Db2 documentation.

JCL Example:

```
//BIND     EXEC PGM=IKJEFT01,DYNAMNBR=20,REGION=4096K
//STEPLIB  DD DSN=Db2 high level qualifier.SDSNLOAD,DISP=SHR
//DBRMLIB  DD DSN=DBRM Dataset,DISP=SHR
//SYSTSPRT DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//SYSTSIN  DD *,SYMBOLS=JCLONLY
  DSN SYSTEM(DB2 SSID)
  BIND PACKAGE(COLLECTION)  -
  MEM(DBRM NAME)            -
  Other bind options -
  END
/*
```

Unix Shell Scripts for Static Preparation

Some of the static preparation steps can be done using z/OS Unix System Services shell scripts. NDZ provides the following scripts in the *bin* subdirectory:

- ndz-generate-profile.sh – Execute Step 3 - IBM SQLJ Translator
- ndz-binder.sh – Execute Step 5 - NDZ Binder / Customizer
- ndz-print-profile.sh – SQLJ Profile Printer

ndz-generate-profile.sh – Execute Step 3 - IBM SQLJ Translator

Syntax:

```
ndz-generate-profile.sh  program name
```

Where *`program name`* is the SQLJ program name.

ndz-binder.sh – Execute Step 5 - NDZ Binder / Customizer

Syntax:

```
ndz-binder.sh  parameters
```

Where *parameters* are the NDZ Binder / Customizer **parameters**.

ndz-print-profile.sh – SQLJ Profile Printer

This script executes a IBM Db2 utility to print a SQLJ profile. For more details, refer to the IBM Db2 documentation for Java / SQLJ.

Syntax:

```
ndz-print-profile.sh  profile name
```

where *profile name* is an SQLJ profile previously created and stored in the NDZ static profiles directory defined in the configuration file *ndz.properties*.

Comparison Between NDZ and NDB Static Preparation

The following table compares the steps you must perform to prepare a program for static execution with NDZ and NDB.

Step #	NDZ	NDB
Step 1	`CMD CREATE` – generate temporary SQL assembler program using `CMD CREATE DBRM`.	`GENERATE/GENERATION` – generate temporary SQL assembler program using `CMD CREATE DBRM`.
Step 2	NDZ SQLJ Generator – generate temporary SQLJ program.	This step is omitted in NDB static preparation.
Step 3	IBM SQLJ Translator – generate the SQLJ profile.	PC – Db2 precompiles the SQL assembler program.
Step 4	CMD MODIFYZ – modify the Natural programs with SQLJ profile numbers and SQLJ sequence numbers using CMD MODIFYZ	MODIFY – modify Natural programs with DB2 DBRM name and section and statement numbers using CMD MODIFY
Step 5	NDZ SQLJ Binder / Customizer – place static SQL information into DB2 to BIND PACKAGE or, optionally, generates a DBRM file which can be used in the step 6.	BIND – place static SQL information into DB2 to BIND PACKAGE.

Step #	NDZ	NDB
Step 6 (optional)	Db2 BIND - place static SQL information into DB2 to BIND PACKAGE, when the bind process is not executed in the step 5.	

27 Static Program Execution

The following table shows how the SQL of a Natural program is executed in an NDB and an NDZ environment, either dynamically or static, depending on the static generation mode and the Natural execution mode.

Static generated NDB	Static generated NDZ		Executed with NDB	Executed with NDZ	Run with NDB	Run with NDZ
Yes	Yes		Static	Static	Dynamic	Dynamic
Yes	No		Static	Dynamic	Dynamic	Dynamic
No	Yes		Dynamic	Static	Dynamic	Dynamic
No	No		Dynamic	Dynamic	Dynamic	Dynamic

Note: If a program is recataloged, both NDB and NDZ static information is lost and the program is converted back in dynamic mode.

III Natural for VSAM

This documentation describes the various aspects of Natural when used in a VSAM environment.

About Natural for VSAM	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.
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.

Related Documentation

For installation instructions, see Installing Natural for VSAM in the *Installation for z/OS* documentation.

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

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).

28 About Natural for VSAM

- What is Natural for VSAM 366
- Environment-Specific Considerations 366
- Natural for VSAM with Natural Security 367
- Integration with Predict 367
- Terms Used in this Documentation 368
- Messages Related to VSAM 368

What is Natural for VSAM

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 z/OS 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 data set 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.

Natural for VSAM supports local shared resources (LSR) under TSO and in z/OS 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 data set name sharing (DSN) under TSO, and batch-mode processing in z/OS, in particular to access data sets using a defined path.

Natural for VSAM supports extended-format data sets for all types of VSAM data set organization. This means that for extended ESDS VSAM files the internal size of the `*ISN` can be up to P19. Its value can be up to 16 TB if you specify a control interval size of 4 KB, or it can be up to 128 TB if you specify a control interval size of 32 KB.

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, an 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	When used in this documentation, the term “front-end” refers to the driver in conjunction with the Natural parameter module.
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 data sets, 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.

29 Natural for VSAM Structure

- Components of Natural for VSAM 370
- Structure of the Natural Interface to VSAM 371

This section describes the components and the structure of the Natural interface to VSAM.

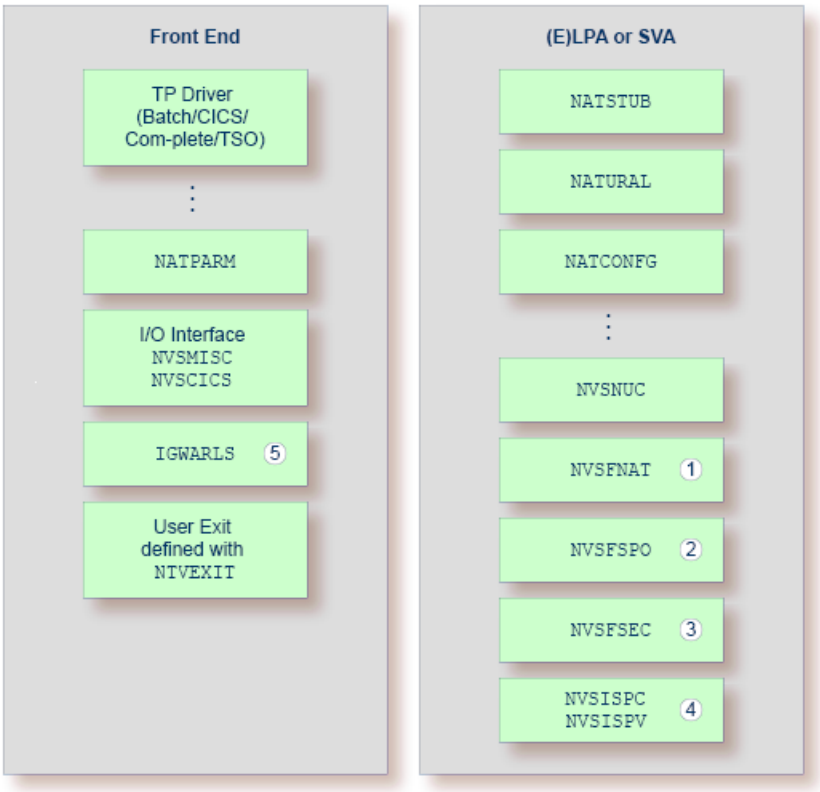
Components of Natural for VSAM

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 Natural parameters specific to VSAM, defined in the Natural parameter module.
- 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 Natural parameter module and the appropriate I/O module must be linked to the front-end module.

Structure of the Natural Interface to VSAM



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).

30 Customizing Natural for VSAM

- Customizing the Natural Parameter Module 374
- Assembling the VSAM-specific Natural Parameter Module 376
- Natural I/O Modules for VSAM 376

The Natural parameters in a VSAM environment are defined in one location:

- the Natural standard parameters, contained in the Natural parameter module; see *Building a Natural Parameter Module* in the *Operations* documentation,
- the Natural parameters specific to VSAM, also contained in the Natural parameter module; see parameter macro `NTVSAM` in the *Parameter Reference* documentation.

The Natural parameter module can be edited to conform to your site standards, and then assembled and linked using the appropriate jobs (see *Installing Natural for VSAM* in the *Installation for z/OS* documentation).

Customizing the Natural Parameter Module

To be able to run Natural in a VSAM environment, you must include the profile parameter `VSIZE`, the `NTDB` and the `NTVSAM` macro in your Natural parameter module (see the section *Installing Natural for VSAM* in the *Installation for z/OS* documentation).

For an Adabas system file:

```
VSIZE=72,
NTDB VSAM,vsam-dbid
NTVSAM
```

For a VSAM system file:

```
VSIZE=160,

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
NTVSAM ... SFILE=ON,...
```

`dd-name` is the logical name (DD or DLBL) of the system file; see also *Installing Natural for VSAM* in the *Installation for z/OS* documentation.

Note: If you use VSAM system files with Natural ISPF, see also the *Natural ISPF* documentation.

Below is information on:

- VSIZE Parameter
- NTDB Macro

- NTVSAM 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 the Natural parameter module (see ***Assembling the VSAM-specific Natural Parameter Module***).

Possible values are 0, 1 - 512 KB.

If you use the default values specified in the Natural parameter module, 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; that is, 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.

NTVSAM Macro

The `NTVSAM` macro is used to specify the VSAM specific parameters.

The value range of the `NTVSAM` keyword subparameters is described in the Natural *Parameter Reference* documentation

Assembling the VSAM-specific Natural Parameter Module

If the default values supplied in the Natural parameter module do not meet your requirements, you can change the parameter values to suit your environment. The individual VSAM-specific parameters contained in the Natural parameter module are described in the following section.

The VSAM-specific Natural parameter module is created by assembling the macro `NTVSAM`.

Optionally, one or more of the following macros:

- `NTVEXIT`
- `NTVLSR`
- `NTVTVSD`

If more than one macro is specified, the `NTVSAM` macro must be specified first; further macros after the `NTVSAM` macro can be specified in any order.

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 module must be linked to the Natural parameter module.

The I/O modules available are described below.

- NVSCICS Module
- NVSMISC Module

NVSCICS Module

The `NVSCICS` module is required for CICS under z/OS. 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 `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 individual parameters are described in the following section; specify these parameters according to your requirements.

NONRLS - Switch from RLS to Non-RLS Mode

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 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 latest version of IBM manual *z/OS DFSMS* Macro Instructions for Data Sets.

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 NTVLSR).

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)

The TVS parameter specifies the support of DFSMStvs.

Possible values	Default value
YES/NO	NO

31 Operation

- Invoking Natural for VSAM 382
- OPEN/CLOSE Processing 382
- Natural File Access 384
- Buffers for Memory Management 395
- Application Programming Interfaces 400

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:

```
                                  { I              } [,string; ...] }
OPRB = (DBID = nnn, { MODE = {                     }                } [, ...] )
                                  { 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                 { K }  }
{                                  { E }  }  { , O }  { , B }  [,R]
{ DD = dd-name , TYP =             { R }  }  { , I }  { , A }
{                                  { 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.

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 data sets (ESDS), key-sequenced data sets (KSDS), relative record data sets (RRDS), variable relative record data sets (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)
- SYSDDM Main Menu
- Catalog DDM

- Edit DDM
- Restrictions with DDM Generation as Compared to Adabas

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 create 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 (see also *Editor and System Commands* in the *SYSDDM Utility* documentation), 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 (see also *Editor and System Commands* in the *SYSDDM Utility* documentation).
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

Function	Explanation
	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 the Natural parameter module; see *Installing Natural for VSAM* in the *Installation for z/OS* documentation.

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:

```
13:11:33              ***** NATURAL SYSDDM UTILITY *****             2021-06-14
                         - Catalog a VSAM file/DDM -
DDM Name AUTOMOBILES-VS                    Def.Seq.        DBID   254 FNR     12


    VSAM file information

    VSAM file name ........... AUTO____
    VSAM View ................ N (Y/N)
    Logical related to FNR ... _____
    User defined prefix ...... _______________

    VSAM file organisation

    KSDS, ESDS, RRDS, VRDS ... K (K,E,R,V)
    Extended file ............ N (Y/N)

    Compress file ............ N (Y/N)
    Zones X'0C' / X'0F'....... F (C/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.

Option	Explanation	
		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 Data Set						
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
Extended file	Specifies whether the extended VSAM file (so the larger ISN) will be used or not. `N` Indicates that the file is not extended. `N` is the default value. `Y` Indicates that the file is extended.
Compress file	Specifies whether the file is to be compressed or not. `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. `N` is the default value. `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. 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.

Option	Explanation
	`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 the Natural parameter module; see *Installing Natural for VSAM* in the *Installation for z/OS* documentation.
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.
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).

Attribute	Explanation
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 .E*nnn* 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. **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.

Attribute	Explanation
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 the Natural parameter module. The different VSAM areas are split into fixed and variable buffer types. If there is insufficient space in the `VSIZE` buffer for all Natural parameter module 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 the Natural parameter module 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 `NTVSAM` 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 subparameter `ROLLSIZ` of macro `NTVSAM` in the Natural parameter 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

Where TSAE = TSA entry.

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 subparameter `UPDL` of macro `NTVSAM` in the Natural parameter 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 6744 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 data sets.

A short description of the APIs is provided in the following section; for more detailed information, log on to the system library `SYSEXT` and display the text object (`USR`*xxxx*`T`) that corresponds to the required API.

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 application programming interface USR1047N enables dynamic modification of DD/DLBL names within a Natural program if the DDSWITE subparameter is specified in the NTVSAM macro. 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 subparameter in macro NTVSAM.
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 application programming interface (API) is not applicable under Com-plete and CICS.

USR2008N supports dynamic OPEN calls during a Natural session if OPSUPP=ON is specified in the NTVSAM macro.

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.

32 Natural Statements and Transaction Logic with VSAM

- Natural Statements with VSAM 404
- Natural Transaction Logic with VSAM 409

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 data sets. For ESDS, an alternate index or a path for an alternate index must be defined. Relative record data sets (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 data sets. 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 data set 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.

IV Natural Messaging

This section describes the various aspects of Natural when used with messaging systems.

About Natural Messaging	Overview of Natural Messaging, components, and environment-specific considerations.
Customizing Natural Messaging	Description of the parameters related to Natural Messaging and DDM adaptions.
Working with the Natural Interface for Messaging	Information on operational aspects like how to invoke Natural Messaging, communication of Natural Messaging, and buffers for memory management.
Natural Statements and View Description with Natural Messaging	Description of Natural statements which can be used to access messaging systems and description of the provided views (DDMs).

Related Documentation

For installation instructions, see *Installing Natural Messaging* in the *Installation for z/OS* documentation.

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

For a list of the abend codes of Natural Messaging, refer to *Natural Messaging Abend Codes* (in the Natural *Messages and Codes* documentation).

33 About Natural Messaging

- What is Natural Messaging? 416
- Components of Natural Messaging 416
- Environment-Specific Considerations 417
- Terms Used in this Documentation 420

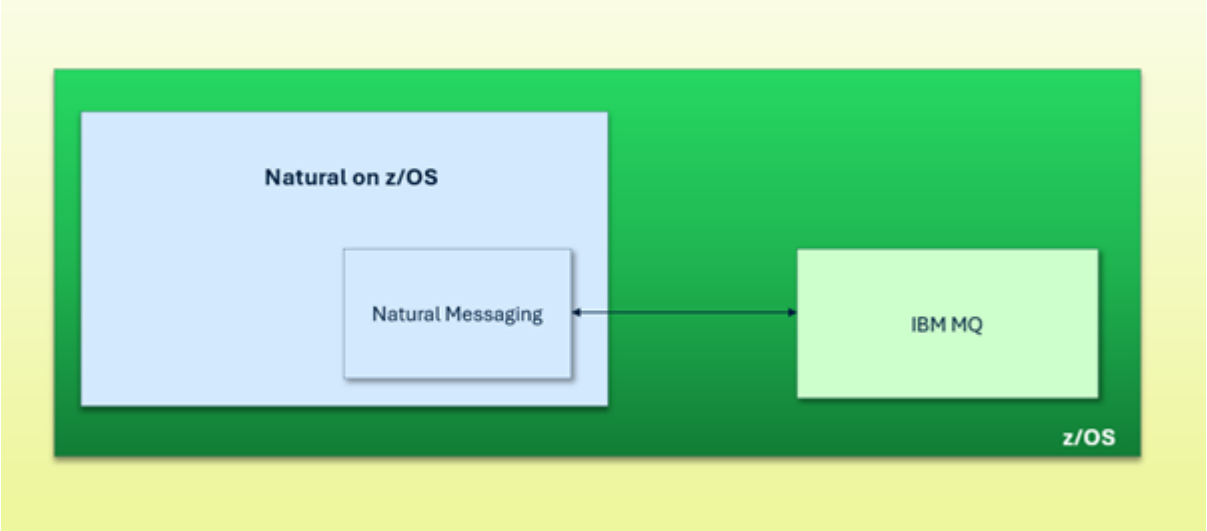
What is Natural Messaging?

Natural Messaging allows for direct integration with messaging systems, enabling Natural users to easily exchange data.

All interactions with IBM MQ are handled through the Natural Messaging interface.

- The `PROCESS` statement is used to put messages on queues or retrieve them.
- The `FIND` statement is used to browse queues.

Natural Messaging enables Natural on z/OS to seamlessly send and receive messages via IBM MQ, enabling smooth integration with other MQ-based systems and applications.



Components of Natural Messaging

The Natural interface for messaging consists of the following components:

- The `NMQNUC` module, which is mandatory, environment-independent, and delivered as a load module only. This module is linked to the shared nucleus.
- The `NMQTAB` module, which is also mandatory and delivered as a load module only. This module is linked to the frontend.
- DDMs for MQ access, which are delivered with the NMQ INPL file.

Environment-Specific Considerations

Natural Messaging provides seamless integration with IBM MQ, enabling Natural applications to send and receive messages via MQ queues. It is suitable for high-performance transactional applications running in z/OS environments.

Natural Messaging operates in the following environments:

- Com-plete
- CICS
- Batch
- TSO

Note: Under CICS, Natural Messaging integrates with IBM MQ via the MQ Adapter for CICS. Both conversational and pseudo-conversational modes are supported.

- Supported Queue Types
- Message Access Modes
- Performance and Optimization
- Linking Requirements for Natural Messaging with IBM MQ
- Natural Messaging under Com-plete
- Natural Messaging under CICS
- Natural Messaging under Batch and TSO
- Natural Messaging under Natural Development Server
- General Runtime Considerations for Natural Messaging

Supported Queue Types

Natural Messaging can access the following MQ object type: Local queues.

Natural Messaging supports both persistent and non-persistent messages, and can process messages in FIFO (First In First Out) or priority-based order depending on the queue configuration.

Message Access Modes

Natural Messaging supports:

- `GET` with `WAIT` and `NOWAIT` options.
- Browsing (read and keep message) and destructive `GET` (read and remove message).
- `CorrelId`- and `MsgId`-based filtering.

Performance and Optimization

Natural Messaging is optimized for high-performance messaging via:

- Connection reuse across MQ calls.
- Object handle reuse wherever possible.
- Efficient memory usage for message buffers.

Queue open and close operations are minimized through pooling.

Linking Requirements for Natural Messaging with IBM MQ

For Natural Messaging to interface with IBM MQ, the environment-dependent nucleus for each runtime environment must be linked with the following modules:

- NMQTAB (Natural Messaging interface configuration table)
- IBM MQ stub program (specific to the environment)

IBM MQ stub programs by environment:

Environment	Required IBM MQ Stub Program
Com-plete	CSQBSTUB (batch MQ stub program)
CICS	CSQCSTUB (CICS MQ stub program)
TSO	CSQBSTUB (batch MQ stub program)
Batch	CSQBSTUB (batch MQ stub program)

For detailed installation instructions, see *Installing Natural Messaging* in the *Installation for z/OS* documentation.

Natural Messaging under Com-plete

Task affinity is required in Com-plete during MQ operations (such as the execution of the `PROCESS` statement or within a `FIND` loop) to ensure correct execution. This is because MQ internally relies on the same task context to maintain consistency between requests and completions.

In Natural Messaging under Com-plete, task affinity is forced internally during MQ call operations.

When using MQ with Com-plete, configure a sufficient number of tasks to accommodate affinity requirements and avoid system slowdowns.

`PUT` and `GET` operations are performed immediately. They become permanent and cannot be rolled back.

Natural Messaging under CICS

The following runtime conditions must be met when using Natural Messaging under CICS:

- The CICS region must be connected to a queue manager through the MQ CICS adapter before any messaging operations can be performed.
- Transactional behavior: In the current version - particularly in CICS environments - `PUT` and `GET` operations are performed with a `SYNCPOINT`, making them transactional.

  Message operations are committed under the following circumstances:

  - Upon a terminal I/O in a pseudo conversation session where the end-of-transaction results in a `SYNCPOINT` commit.
  - By means of the `END TRANSACTION` statement. To use this option, you must set the parameter `ETSYNC=ON`.
  - At the end of the session.

Natural Messaging under Batch and TSO

There are no additional environment-specific considerations beyond the standard linking and runtime requirements, which are similar to those in other environments.

`PUT` and `GET` operations are performed immediately. They become permanent and cannot be rolled back.

Natural Messaging under Natural Development Server

When Natural Messaging runs under Natural Development Server (NDV) with `SECURITY_MODE=IMPERSONATE_LOCAL`, the NDV session executes under the local identity of the NaturalONE client user. In this mode, the MQ adapter must load within a stable user security context.

If the NDV server runs with `SECURITY_CACHING=NO`, the impersonation token is recreated for each request. This causes the MQ adapter to fail with NMQ2129 `MQRC_ADAPTER_CONN_LOAD_ERROR`. Therefore, `SECURITY_CACHING=YES` is required when `SECURITY_MODE` is set to `IMPERSONATE_LOCAL` to ensure consistent adapter loading and successful MQ connection establishment.

General Runtime Considerations for Natural Messaging

This section covers runtime behaviors across all supported environments (Batch, TSO, CICS, and Com-plete).

When a `BROWSE` operation is performed, an implicit internal commit is automatically triggered by Natural before executing the `BROWSE`, except in the CICS environment..

The message retrieved from or written to an MQ queue is held in one of the internal buffers managed by Natural Messaging. Therefore, ensure that the Natural thread size is configured sufficiently to accommodate the size of the message being processed.

Terms Used in this Documentation

Term	Explanation
MQ	MQ refers to IBM's MQ for z/OS.
DDM	Data definition module.
NMQ	This is the product code of Natural Messaging. In this documentation, the product code is often used as prefix in the names of data sets, modules, etc.

34 Customizing Natural Messaging

- Customizing the Natural Parameter Module 422
- Changing the DBID of the DDM Used for Natural Messaging 423
- Changing the Length of the MESSAGE Field in the MQ-QUEUE DDM 423
- Increasing the Natural Thread Size for Large MQ Payloads 424

Customizing the Natural Parameter Module

To configure Natural Messaging, specific Natural parameters must be defined in the Natural parameter module. This parameter module should be customized to meet your site's standards, then assembled and linked using the appropriate installation jobs.

For installation instructions, see *Installing Natural Messaging* in the *Installation for z/OS* documentation.

Defining the Database Type and Database ID (DBID)

To access messaging resources such as IBM MQ queues, Natural Messaging requires that a dedicated database ID (DBID) is defined as database type `MQ` . This logical assignment maps the DBID to the `MQ` database type, allowing Natural programs to interact with message queues through DDMs defined for IBM MQ queues.

This setup can be done in either of the following ways:

- Statically, using the `NTDB` macro in the Natural parameter module.

  Example:

  ```
  NTDB MQ, mq-dbid
  ```

- Dynamically, using the profile parameter `DB`.

  Example:

  ```
  DB=(MQ, mq-dbid)
  ```

Notes:

1. Ensure that the DBID specified in the `NTDB` macro for Natural Messaging does not conflict with DBIDs assigned to other database management systems. This helps prevent misrouting and access issues in environments where multiple DBMS types are used.
2. All `MQ` queue DDMs used in Natural applications must be associated with the same DBID defined in the `NTDB` macro or the `DB` parameter. This ensures consistent and correct access to messaging resources throughout the application.

Changing the DBID of the DDM Used for Natural Messaging

The provided DDM `MQ-QUEUE` enables Natural applications to interface with IBM MQ message queues. To integrate this DDM into a customer-specific environment, its DBID may need to be updated to match the DBID defined for messaging in your system configuration.

Step 1: Define the Desired DBID

Before updating the DDM, ensure that the required DBID is properly configured as described in *Defining the Database Type and Database ID (DBID)*.

Step 2: Update the DBID in the DDM

1. Start a Natural session and invoke the SYSDDM utility.
2. Select the Read function (code `R`) and enter `MQ-QUEUE` as the DDM name. This loads the DDM into the source area.
3. Change the `DBID` field to the required value to match your environment.
4. Use the `CATALOG REPLACE` command to save the updated DDM.
5. Once modified, the `MQ-QUEUE` DDM will be aligned with your Natural Messaging DBID, ensuring correct integration with your messaging setup.

Note: For more information, see *SYSDDM Utility* in the *Editors* documentation or contact support.

Changing the Length of the MESSAGE Field in the MQ-QUEUE DDM

To support larger message payloads in Natural Messaging, you may need to adjust the length of the `MESSAGE` field in the `MQ-QUEUE` DDM. Proceed as follows:

1. Launch the SYSDDM utility in your Natural session.
2. Select the Edit function (code `E`) and enter `MQ-QUEUE` as the DDM name.
3. In the field list, locate the `MESSAGE` field (typically an alphanumeric field named `MESSAGE (MG)`).
4. Update the field length to match the maximum message size required by your application.

Note: If your message content may exceed 253 characters, change the `MESSAGE` field using the `LB` (large binary) format instead of a standard `A` (alphanumeric) field. This enables support for large message payloads beyond the conventional field limits.

5. After making changes, use the `CHECK` command to validate the DDM, followed by `CATALOG REPLACE` to save the changes. The updated DDM will now support larger or customized MQ message sizes at runtime, ensuring compatibility with your messaging workload.

Increasing the Natural Thread Size for Large MQ Payloads

When retrieving messages from MQ, both the message data and the internal MQ buffer are stored within the Natural thread.

Insufficient thread size can lead to runtime errors. To prevent these issues, adjust the Natural thread size parameters to safely accommodate larger MQ payloads.

For details on configuring thread size, see the `THSIZE` parameter in the *Parameter Reference*.

35 Working with the Natural Interface for Messaging

- Invoking Natural Messaging 426
- Communication between Natural and Messaging Systems 426
- Buffers for Memory Management 426

This section provides information on various operational aspects of Natural Messaging.

Invoking Natural Messaging

If the Natural interface for messaging is available, the license check is performed when you start a Natural session. Buffers for Natural Messaging are allocated when the first message access takes place.

Communication between Natural and Messaging Systems

Accessing messaging systems from Natural works similarly to accessing a database. The Natural Messaging product is delivered with a predefined DDM called `MQ-QUEUE` (see ***Natural Statements and View Description with Natural Messaging***). The Natural `PROCESS` statement is used to get messages from a message queue or to put messages on a message queue. The `FIND` statement can be used to browse a message queue.

Natural handles all required calls to the messaging system internally (for example, connecting to a queue manager or opening a queue).

Buffers for Memory Management

Buffers for Natural Messaging calls are only allocated in the Natural thread when necessary. The payload of a message may become quite large. The predefined DDM `MQ-QUEUE` contains the `MESSAGE` field, which contains the payload. Multiple length options are provided (for example, `MESSAGE-10K` and `MESSAGE-100K`). Select the field that is suitable for your application. You must ensure that the selected `MESSAGE` field fits in your Natural thread.

36 Natural Statements and View Description with Natural Messaging

- Introduction 428
- Accessing Natural Messaging in Natural Programs 428
- View Description 435

Introduction

Natural Messaging is a software component that enables Natural applications to interact seamlessly with IBM MQ systems. It supports message-oriented middleware operations (`PUT`, `GET` and `BROWSE`) directly from Natural programs, eliminating the need for low-level MQ APIs.

This functionality is provided through structured views that define the necessary fields and parameters for MQ operations. These views can be accessed using standard Natural syntax, allowing messaging operations to integrate naturally into the programming environment.

Key features:

- `PUT`: Place messages in queues.
- `GET`: Retrieve messages from queues.
- `BROWSE`: Inspect messages without removing them from queues.

Accessing Natural Messaging in Natural Programs

Natural Messaging views are accessed using the following Natural statements:

- `PROCESS` to perform actions such as `PUT` or `GET`.
- `FIND` to browse messages (read-only access).

The statement used depends on the operation.

- PROCESS Statement
- FIND Statement
- System Variables
- Examples

PROCESS Statement

The `PROCESS` statement is used to perform MQ operations such as `PUT` and `GET`, with the specific operation determined by the `FUNCTION` field.

General syntax:

```
PROCESS MQ-QUEUE-VIEW USING
    FUNCTION     = 'PUT' | 'GET',
    QMANAGER     = queue-manager-name,
    QNAME        = queue-name,
    [optional control or message fields = value]
    [optional GIVING field-name]
```

PUT Operations

The `PUT` operation adds MQ messages to the queue.

- Set `FUNCTION = 'PUT'`.
- Enter the name of the target queue and queue manager.
- Populate any of the message content field depending on the size of the payload (`MESSAGE`, `MESSAGE-10K`, etc.).
- Optionally, set the following:
  - Message attributes, such as `PERSISTENCE`, `EXPIRY` and `MESSAGE-TYPE`.
  - Message identifiers, such as `MESSAGE-ID` and `CORRELATION-ID`.
  - Additional MQ `PUT` options if required.

Notes:

1. Before issuing a `PUT` operation, ensure that the `DATA-LENGTH` field is set to the actual size of the `MESSAGE`. This ensures that only the relevant portion of the message field is transmitted, even if the field is capable of holding larger messages.
2. If the `DATA-LENGTH` field is not set, the length of the `MESSAGE` will be calculated by removing trailing blanks for the Alpha field (x'40'), trailing blanks for the Unicode field (x'0020'), and the trailing x'00' for the Binary field.

GET Operations

The `GET` operation retrieves MQ messages and removes them from the queue ("destructive").

- Set `FUNCTION = 'GET'`.
- Enter the name of the target queue and queue manager.
- Optionally, apply filters using `MESSAGE-ID`, `CORRELATION-ID`, or other selection criteria.
- Set the relevant MQ `GET` options, such as `WAIT-INTERVAL` and `TRUNCATE`.
- The retrieved message content and related message properties will be returned in the fields defined in the `MQ-QUEUE` DDM.
- After a `GET` operation, check the `DATA-LENGTH` field to determine the actual size of the retrieved message.

Notes:

1. Always check the `ERROR-CODE` and `ERROR-TEXT` fields after a `PUT` or `GET` operation to verify success or identify any issues. When these fields are used, MQ-related errors are not raised as Natural runtime errors. Instead, they are suppressed, and the corresponding MQ reason code and its description are provided in `ERROR-CODE` and `ERROR-TEXT`, respectively.
2. After a `PUT` operation is issued, the `DATA-LENGTH` field is set to the actual size of the `MESSAGE`. If the message is truncated, then the `DATA-LENGTH` field will represent the size of the truncated message.

FIND Statement

The `FIND` statement is used to browse MQ messages without removing them from the queue ("non-destructive"). Browsing is the default behavior, so no `FUNCTION` assignment is necessary.

General syntax:

```
FIND MQ-QUEUE-VIEW WITH
    QMANAGER   = queue-manager-name AND
    QNAME      = queue-name AND
    [optional control or message filter fields = value]
```

- Supports message filtering through descriptors such as `MESSAGE-ID` and `CORRELATION-ID`, enabling message retrieval based on specific criteria.
- Messages are not consumed, so they remain in the queue after the operation.

System Variables

In Natural Messaging, the `*NUMBER` and `*ISN` system variables do not apply in the context of a `FIND` and `PROCESS` statement.

Examples

The following example programs can be found in the `SYSEXNMQ` library.

Example 1: Sample Natural program to retrieve and remove messages from an IBM MQ queue

```
** Example 'GETIBMMQ': Get MQ message from IBM-MQ queue.
************************************************************************
DEFINE DATA LOCAL
1 MQ-QUEUE-VIEW VIEW OF MQ-QUEUE
  2 ERROR-CODE                /* MQ reason code
  2 ERROR-TEXT                /* Text describing the reason code
  2 FUNCTION                  /* Operation: GET, PUT
  2 QMANAGER                  /* Queue manager name
  2 QNAME                     /* Queue name
  2 PRIORITY                  /* Priority (0=low, 9=high)
  2 MESSAGE-10K               /* Extended message field
  2 PUT-DATE                  /* Put date (YYYYMMDD)
  2 PUT-TIME                  /* Put time (HHMMSSTH)
  2 REPLY-TO-QNAME            /* Queue name for receiving reply
  2 REPLY-TO-QMANAGER         /* Queue manager to receive reply
  2 USER-ID                   /* User ID of PUT/GET requester
*
1 I          (I4)             /* Count number of messages read
1 I-MAX      (I4) INIT <10>   /* Default number of messages to be read
1 Q-MANAGER  (A48)
1 Q-NAME     (A48)
END-DEFINE
*
* The GET function is used to retrieve messages from the queue. Once a
* message is retrieved, it is removed from the queue.
*
SET KEY ALL
INPUT (AD=MITL'_' IP=OFF ZP=ON SG=OFF CD=TU)
  'GET information from Natural Messaging Queue' (I) /
  '---------------------------------------------' (I) //
  'Queue name ..................' Q-NAME         /
  'Queue manager name ..........' Q-MANAGER      /
  'Maximum number of messages ..' I-MAX (AD=M) ///
  'NOTE: Once a message is retrieved, it is removed from the queue.' ///
  'Press ENTER to continue or any PF-key to stop.'
*
IF *PF-KEY NE 'ENTR'
  ESCAPE ROUTINE
END-IF
*
FOR I = 1 TO I-MAX
*
* Perform function GET to retrieve information from the queue
*
  PROCESS MQ-QUEUE-VIEW USING
    MQ-QUEUE-VIEW.FUNCTION   = 'GET',     /* Function name : GET/PUT
    MQ-QUEUE-VIEW.QMANAGER   = Q-MANAGER, /* QUEUE manager name
    MQ-QUEUE-VIEW.QNAME      = Q-NAME     /* QUEUE Name
*
```

```
  PRINT 'Message count        :  ' I (AD=L)
  PRINT 'Message              :  ' MQ-QUEUE-VIEW.MESSAGE-10K
  PRINT 'Queue manager        :  ' MQ-QUEUE-VIEW.QMANAGER
  PRINT 'Queue name           :  ' MQ-QUEUE-VIEW.QNAME
  PRINT 'Priority             :  ' MQ-QUEUE-VIEW.PRIORITY (AD=L)
  PRINT 'Put date             :  ' MQ-QUEUE-VIEW.PUT-DATE
  PRINT 'Put time             :  ' MQ-QUEUE-VIEW.PUT-TIME
  PRINT 'User ID              :  ' MQ-QUEUE-VIEW.USER-ID
  PRINT 'Reply queue manager  :  ' MQ-QUEUE-VIEW.REPLY-TO-QMANAGER
  PRINT 'Reply queue name     :  ' MQ-QUEUE-VIEW.REPLY-TO-QNAME
  PRINT '*'(70)(I)
*
* Check for error
*
  IF ERROR-CODE NE 0
    PRINT / 'Error occurred while performing the GET function.' /
    PRINT 'Error code           :  ' ERROR-CODE (AD=L)
    PRINT 'Error text           :  ' ERROR-TEXT
    PRINT '*'(70)(I)
    ESCAPE BOTTOM                  /* Stop processing if error occurs
  END-IF
*
END-FOR
END
```

Example 2: Sample Natural program to put a message into an IBM MQ queue

```
** Example 'PUTIBMMQ': Put message to IBM-MQ queue.
************************************************************************
DEFINE DATA LOCAL
1 MQ-QUEUE-VIEW VIEW OF MQ-QUEUE
  2 ERROR-CODE                /* MQ reason code
  2 ERROR-TEXT                /* Text describing the reason code
  2 FUNCTION                  /* Operation: GET, PUT
  2 QMANAGER                  /* Queue manager name
  2 QNAME                     /* Queue name
  2 PRIORITY                  /* Priority (0=low, 9=high)
  2 MESSAGE-10K               /* Extended message field
  2 PUT-DATE                  /* Put date (YYYYMMDD)
  2 PUT-TIME                  /* Put time (HHMMSSTH)
  2 REPLY-TO-QNAME            /* Queue name for receiving reply
  2 REPLY-TO-QMANAGER         /* Queue manager to receive reply
  2 USER-ID                   /* User ID of PUT/GET requester
*
1 EMPLOY-VIEW VIEW OF EMPLOYEES
  2 NAME
*
1 DATE-A      (A8)
1 TIME-A      (A8)
1 USER1       (A8)
1 Q-MANAGER   (A48)
```

```
1 Q-NAME      (A48)
END-DEFINE
*
* The PUT function is used to send (or write) a message to a queue.
* The message remains in the queue until it is either retrieved
* (using GET) or expires whichever occurs first.
*
SET KEY ALL
INPUT (AD=MITL'_' IP=OFF ZP=ON SG=OFF CD=TU)
  'PUT information on Natural Messaging Queue' (I) /
  '-----------------------------------------' (I) //
  'Queue name ..............' Q-NAME         /
  'Queue manager name ......' Q-MANAGER      ///
  'Press ENTER to continue or any PF-key to stop.'
/*
IF *PF-KEY NE 'ENTR'
  ESCAPE ROUTINE
END-IF
*
* In the example below, EMPLOYEE-VIEW data will be written in MQ-QUEUE
*
READ EMPLOY-VIEW BY ISN STARTING FROM 1 ENDING AT 10
*
* Move current time, date and user to the queue
*
  MOVE EDITED *TIMX (EM=HHIISST'0') TO TIME-A
  MOVE *DATN TO DATE-A
  MOVE *USER TO USER1
*
* Move name of the employee to the queue
*
  MOVE NAME  TO MQ-QUEUE-VIEW.MESSAGE-10K
*
* Perform function PUT to write data into the queue
*
  PROCESS MQ-QUEUE-VIEW USING
    MQ-QUEUE-VIEW.FUNCTION             = 'PUT',
    MQ-QUEUE-VIEW.QMANAGER             = Q-MANAGER,
    MQ-QUEUE-VIEW.QNAME                = Q-NAME,
    MQ-QUEUE-VIEW.PRIORITY             = 1,
    MQ-QUEUE-VIEW.PUT-DATE             = DATE-A,
    MQ-QUEUE-VIEW.PUT-TIME             = TIME-A,
    MQ-QUEUE-VIEW.REPLY-TO-QMANAGER    = Q-MANAGER,
    MQ-QUEUE-VIEW.REPLY-TO-QNAME       = Q-NAME,
    MQ-QUEUE-VIEW.USER-ID              = USER1
*
  PRINT 'Message count        :  ' *COUNTER (AD=L)
  PRINT 'Message              :  ' MQ-QUEUE-VIEW.MESSAGE-10K
  PRINT 'Queue manager        :  ' MQ-QUEUE-VIEW.QMANAGER
  PRINT 'Queue name           :  ' MQ-QUEUE-VIEW.QNAME
  PRINT 'Priority             :  ' MQ-QUEUE-VIEW.PRIORITY (AD=L)
  PRINT 'Put date             :  ' MQ-QUEUE-VIEW.PUT-DATE
```

```
  PRINT 'Put time             :  ' MQ-QUEUE-VIEW.PUT-TIME
  PRINT 'User ID              :  ' MQ-QUEUE-VIEW.USER-ID
  PRINT 'Reply queue manager  :  ' MQ-QUEUE-VIEW.REPLY-TO-QMANAGER
  PRINT 'Reply queue name     :  ' MQ-QUEUE-VIEW.REPLY-TO-QNAME
  PRINT '*'(70)(I)
*
* Check for error
*
  IF ERROR-CODE NE 0
    PRINT / 'Error occurred while performing the PUT function.' /
    PRINT 'Error code          :  ' ERROR-CODE (AD=L)
    PRINT 'Error text          :  ' ERROR-TEXT
    PRINT '*'(70)(I)
    ESCAPE BOTTOM                  /* Stop processing if error occurs
  END-IF
*
END-READ
*
END
```

Example 3: Sample Natural program to browse and keep messages in an IBM MQ queue

```
** Example 'BRWIBMMQ': Browse MQ messages.
************************************************************************
DEFINE DATA LOCAL
1 MQ-QUEUE-VIEW VIEW OF MQ-QUEUE
  2 ERROR-CODE                /* MQ reason code
  2 ERROR-TEXT                /* Text describing the reason code
  2 FUNCTION                  /* Operation: GET, PUT
  2 QMANAGER                  /* Queue manager name
  2 QNAME                     /* Queue name
  2 PRIORITY                  /* Priority (0=low, 9=high)
  2 MESSAGE-10K               /* Extended message field
  2 PUT-DATE                  /* Put date (YYYYMMDD)
  2 PUT-TIME                  /* Put time (HHMMSSTH)
  2 REPLY-TO-QNAME            /* Queue name for receiving reply
  2 REPLY-TO-QMANAGER         /* Queue manager to receive reply
  2 USER-ID                   /* User ID of PUT/GET requester
*
1 I-MAX      (I4) INIT <10>   /* Default number of messages to be read
1 Q-MANAGER    (A48)
1 Q-NAME       (A48)
END-DEFINE
*
* The browse function lets you inspect the messages in the queue
* without removing them.
*
SET KEY ALL
INPUT (AD=MITL'_' IP=OFF ZP=ON SG=OFF CD=TU)
  'Browse Natural Messaging Queue' (I) /
  '------------------------------' (I) //
```

```
  'Queue name ..................' Q-NAME              /
  'Queue manager name ..........' Q-MANAGER           /
  'Maximum number of messages ..' I-MAX (AD=M) ///
  'Press ENTER to continue or any PF-key to stop.'
/*
*
IF *PF-KEY NE 'ENTR'
  ESCAPE ROUTINE
END-IF
*
FIND (I-MAX) MQ-QUEUE-VIEW WITH
    MQ-QUEUE-VIEW.QMANAGER = Q-MANAGER AND  /* Name of Queue Manager
    MQ-QUEUE-VIEW.QNAME    = Q-NAME         /* Name of the Queue
*
  PRINT 'Message count        :  ' *COUNTER (AD=L)
  PRINT 'Message              :  ' MQ-QUEUE-VIEW.MESSAGE-10K
  PRINT 'Queue manager        :  ' MQ-QUEUE-VIEW.QMANAGER
  PRINT 'Queue name           :  ' MQ-QUEUE-VIEW.QNAME
  PRINT 'Priority             :  ' MQ-QUEUE-VIEW.PRIORITY (AD=L)
  PRINT 'Put date             :  ' MQ-QUEUE-VIEW.PUT-DATE
  PRINT 'Put time             :  ' MQ-QUEUE-VIEW.PUT-TIME
  PRINT 'User ID              :  ' MQ-QUEUE-VIEW.USER-ID
  PRINT 'Reply queue manager  :  ' MQ-QUEUE-VIEW.REPLY-TO-QMANAGER
  PRINT 'Reply queue name     :  ' MQ-QUEUE-VIEW.REPLY-TO-QNAME
  PRINT '*'(70)(I)
*
* Check for error
*
  IF ERROR-CODE NE 0
    PRINT / 'Error occurred while performing the browse function.' /
    PRINT 'Error code          :  ' ERROR-CODE (AD=L)
    PRINT 'Error text          :  ' ERROR-TEXT
    PRINT '*'(70)(I)
    ESCAPE BOTTOM                  /* Stop processing if error occurs
  END-IF
*
END-FIND
*
END
```

View Description

The view description contains the following information for fields defined in the view:

Item	Meaning	
Field Name	The name of the field as used in Natural.	
F/L	Field format and length:	
	A	Alphanumeric.
	B	Binary.
	I	Integer.
DE	Descriptor. A D in this column means the field can be used in the WITH clause of a FIND statement or the USING clause of a PROCESS statement.	
Description	Brief explanation of the field's purpose or function.	
Operation	Applicable MQ operations (GET, PUT, BROWSE) where the field is relevant.	
Remark	Supplementary details, constraints or usage guidance related to the field.	

View Name: MQ-QUEUE

Used for sending (PUT), retrieving (GET), and browsing (BROWSE) MQ messages via PROCESS and FIND statements.

View field description:

Field Name	F/L	DE	Description	Operation	Remarks
ERROR-CODE	I/4		MQ reason code returned.	GET, PUT, BROWSE	Check after PROCESS and FIND.
ERROR-TEXT	A/58		Text describing the reason code.	GET, PUT, BROWSE	
FUNCTION	A/8	D	Operation to perform: GET or PUT .	GET, PUT	Not required for BROWSE.
QMANAGER	A/48	D	Queue manager name.	GET, PUT, BROWSE	Ignored in a CICS environment.
QNAME	A/48	D	Queue name.	GET, PUT, BROWSE	
MESSAGE-TYPE	A/8	D	Type of message (datagram, request, reply, report).	PUT	Default: datagram

Field Name	F/L	DE	Description	Operation	Remarks
PRIORITY	I/4	D	Priority of the message (0=low, 9= high).	PUT	
PERSISTENCE	A/1	D	Y/N/D flag for message persistence.	PUT	Default: D (depends on the queue definition)
PUT-DATE	A/8	D	Put date (YYYYMMDD).	PUT	Set by MQ on PUT.
PUT-TIME	A/8	D	Put time (HHMMSSTH).	PUT	Set by MQ on PUT.
EXPIRY	I/4	D	Expiry time in 1/10 of second.	PUT	
REPLY-TO_QMANAGER	A/48	D	Queue manager to receive reply.	PUT	
REPLY-TO-QNAME	A/48	D	Queue name for receiving reply.	PUT	
BACKOUT-COUNT	I/4	D	Number of times message was backed out.	GET, BROWSE	
MESSAGE-ID	B/24	D	Message ID.	GET, PUT, BROWSE	Used for message selection.
CORRELATION-ID	B/24	D	Correlation ID.	GET, PUT, BROWSE	Used in request/reply matching.
USER-ID	A/12	D	User ID of PUT/GET requester.	GET, PUT	
WAIT-INTERVAL	I/4	D	Wait time for GET (milliseconds).	GET, BROWSE	Used for synchronous GET.
LOCK	A/1	D	Y/N flag to indicate whether the browsed message should be locked.	GET, BROWSE	GET MESSAGE OPTION, Default: N. **Note:** 1. The LOCK option in a GET operation requires BROWSE-MSG-UNDER-CURSOR. 2. Can only be used when an active browse cursor exists (established via a FIND statement).

Field Name	F/L	DE	Description	Operation	Remarks
UNLOCK	A/1	D	Y/N flag to indicate whether a previously locked message should be unlocked.	GET	GET MESSAGE OPTION, Default: N. **Note:** 1. The UNLOCK option applies to a message that was previously locked using the LOCK option. 2. Can only be used when an active browse cursor exists (established via a FIND statement).
TRUNCATE	A/1	D	Y/N flag for truncation allowed.	GET, BROWSE	GET MESSAGE OPTION, Default: N
CONVERT	A/1	D	Y/N flag for CONVERT to a target CCSID.	GET, BROWSE	GET MESSAGE OPTION, Default: N
BROWSE-MSG-UNDER-CURSOR	A/1	D	Y/N flag to indicate whether the message at the current browse cursor position is to be retrieved non-destructively.	GET	GET MESSAGE OPTION, Default: N. **Note:** 1. This GET option requires an active browse cursor on the MQ object (established via a FIND statement). 2. The queue and queue manager names are implicitly derived from the active browse cursor. Any explicit queue definitions provided in the PROCESS statement are ignored. 3. A GET operation using the BROWSE-MSG-UNDER-CURSOR option applies directly to the browse cursor at the immediate preceding nesting level. 4. If no active browse cursor is available at that level, error NAT3398 is returned.

Field Name	F/L	DE	Description	Operation	Remarks
MSG-UNDER-CURSOR	A/1	D	Y/N flag to indicate whether the message at the current browse cursor position is to be retrieved destructively.	GET	GET MESSAGE OPTION, Default: N. **Note:** 1. This GET option requires an active browse cursor on the MQ object (established via a FIND statement). 2. The queue and queue manager names are implicitly derived from the active browse cursor. Any explicit queue definitions provided in the PROCESS statement are ignored. 3. A GET operation using the MSG-UNDER-CURSOR option applies directly to the browse cursor at the immediate preceding nesting level. 4. If no active browse cursor is available at that level, error NAT3398 is returned.
SYNC-RESPONSE	A/1	D	Y/N flag for Synchronous response from Queue Manager.	PUT	PUT MESSAGE OPTION, Default: N
NEW-MESSAGE-ID	A/1	D	Y/N flag for requesting Queue Manager for a new Message ID.	PUT	PUT MESSAGE OPTION, Default: N
NEW-CORRELATION-ID	A/1	D	Y/N flag for requesting Queue Manager for a new Correlation ID.	PUT	PUT MESSAGE OPTION, Default: N
DATA-LENGTH	I/4	D	Total length of message data.	PUT	Set before PUT.
FORMAT	A/8	D	Message format.	PUT	
CCSID	I/4	D	Character set identifier.	PUT, GET	
ENCODING	I/4	D	Numeric encoding format.	PUT	

Field Name	F/L	DE	Description	Operation	Remarks
MESSAGE	A/253		Standard message field.	PUT	Used for small messages.
MESSAGE-10K	A/10240		Extended message field up to 10KB.	PUT	
MESSAGE-100K	A/102400		Extended message field up to 100KB.	PUT	
MESSAGE-1000K	A/1024000		Extended message field up to 1MB.	PUT	

Notes:

1. For any given view used to access MQ, it is advisable to define a single message field only.
2. IBM MQ default values are applied to those view fields that are not explicitly set in the PROCESS or FIND statement.

Index

D

database management system interfaces, ix