Enterprise COBOL for z/OS 6.1

Migration Guide

GC27-8715-00

Note

Before using this information and the product it supports, be sure to read the general information under "Notices" on page 325.

First edition (30 Jnue 2022 update)

It is our intention to update the product documentation for this release periodically, without updating the order number. If you need to uniquely refer to the version of your product documentation, refer to the order number with the date of update.

This edition applies to Version 6 Release 1 of IBM® Enterprise COBOL for z/OS® (program number 5655-EC6) and to all subsequent releases and modifications until otherwise indicated in new editions. Make sure that you are using the correct edition for the level of the product.

You can view or download softcopy publications free of charge in the Enterprise COBOL for z/OS library. Because Enterprise COBOL for z/OS supports the continuous delivery (CD) model and publications are updated to document the features delivered under the CD model, it is a good idea to check for updates once every two months.

It is our intention to update the product documentation for this release periodically, without updating the order number. If you need to uniquely refer to the version of your product documentation, refer to the order number with the date of update.

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Preface

About this information

This information provides topics to help you move to IBM Enterprise COBOL Version 5 or Version 6.

Because the changes required during migration from Version 5 to Version 6 are small, this document assumes that you are migrating from Version 4 or earlier versions of the compiler to Version 5 or Version 6.

This information also assumes that you have completed your runtime migration to Language Environment®.

Terminology clarification

In this information, we use the term Enterprise COBOL as a general reference to:

- IBM Enterprise COBOL for z/OS and OS/390®, Version 3 Release 1
- IBM Enterprise COBOL for z/OS and OS/390, Version 3 Release 2
- IBM Enterprise COBOL for z/OS, Version 3 Release 3
- IBM Enterprise COBOL for z/OS, Version 3 Release 4
- IBM Enterprise COBOL for z/OS, Version 4 Release 1
- IBM Enterprise COBOL for z/OS, Version 4 Release 2
- IBM Enterprise COBOL for z/OS, Version 5 Release 1
- IBM Enterprise COBOL for z/OS, Version 5 Release 2
- Enterprise COBOL Value Unit Edition for z/OS, Version 5 Release 2
- IBM Enterprise COBOL for z/OS, Version 6 Release 1
- IBM Enterprise COBOL Value Unit Edition for z/OS, Version 6 Release 1

Note: Enterprise COBOL Value Unit Edition for z/OS is the same as Enterprise COBOL for z/OS made available under a different product number and pricing metric.

In this information, we use the term IBM COBOL as a general reference to:

- COBOL/370, Version 1 Release 1
- COBOL for MVS™ & VM, Version 1 Release 2
- COBOL for OS/390 & VM, Version 2 Release 1
- COBOL for OS/390 & VM, Version 2 Release 2

See “Summary of changes to the COBOL compilers” on page xxvi for further details.

IBM COBOL compilers by name and version

Table 1. COBOL compiler name, version, release, product numbers, GA and EOS dates

Compiler	Release level	Product number	General availability (GA) date (Year-Month-Day)	End of support (EOS) date (Year-Month-Day)
OS/VS COBOL	Version 1 Release 2 Modification 3	5740-CB1	1974-09-23	1999-12-31
OS/VS COBOL	Version 1 Release 2 Modification 4	5740-CB1	1976-09-23	1999-12-31

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Table 1. COBOL compiler name, version, release, product numbers, GA and EOS dates (continued)

Compiler	Release level	Product number	General availability (GA) date (Year-Month-Day)	End of support (EOS) date (Year-Month-Day)
VS COBOL II	Version 1 Release 3	5668-958	1988-12-16	1996-06-30
VS COBOL II	Version 1 Release 4	5668-958	1993-03-12	2001-03-31
COBOL/370	Version 1 Release 1	5688-197	1991-12-20	1997-09-30
COBOL for MVS & VM	Version 1 Release 2	5688-197	1995-10-27	2001-12-31
COBOL for OS/390 & VM	Version 2 Release 1	5648-A25	1997-05-23	2004-12-31
COBOL for OS/390 & VM	Version 2 Release 2	5648-A25	2000-09-29	2004-12-31
Enterprise COBOL for z/OS	Version 3 Release 1	5655-G53	2001-11-30	2004-04-04
Enterprise COBOL for z/OS	Version 3 Release 2	5655-G53	2002-09-27	2005-10-03
Enterprise COBOL for z/OS	Version 3 Release 3	5655-G53	2004-02-27	2007-04-30
Enterprise COBOL for z/OS	Version 3 Release 4	5655-G53	2005-07-01	2015-04-30
Enterprise COBOL for z/OS	Version 4 Release 1	5655-S71	2007-12-14	2014-04-30
Enterprise COBOL for z/OS	Version 4 Release 2	5655-S71	2009-08-28	2022-04-30
Enterprise COBOL for z/OS	Version 5 Release 1	5655-W32	2013-06-21	2020-04-30
Enterprise COBOL for z/OS	Version 5 Release 2	5655-W32	2015-02-27	2020-04-30
Enterprise COBOL Value Unit Edition for z/OS[1]	Version 5 Release 2	5697-ECV	2015-10-06	2020-04-30
Enterprise COBOL for z/OS	Version 6 Release 1	5655-EC6	2016-03-18	2022-09-30

Table 1. COBOL compiler name, version, release, product numbers, GA and EOS dates (continued)

Compiler	Release level	Product number	General availability (GA) date (Year-Month-Day)	End of support (EOS) date (Year-Month-Day)
Enterprise COBOL Value Unit Edition for z/OS[1]	Version 6 Release 1	5697-V61	2016-03-18	2022-09-30

Note:

1. Enterprise COBOL Value Unit Edition for z/OS is the same as Enterprise COBOL for z/OS made available under a different product number and pricing metric.

To check lifecycle details (lifecycle dates, announcement letters, and other information) for Enterprise COBOL for z/OS products, visit the lifecycle website at https://www.ibm.com/support/lifecycle/details?q45=R109684Z50598F65.

To aid in moving your runtime library to Language Environment, you can find information on how to run existing VS COBOL II and OS/VS COBOL load modules under Language Environment, including link-edit requirements for support and recommended runtime options for compatible behavior in the *Enterprise COBOL V4.2 Compiler and Runtime Migration Guide* at http://publibfp.dhe.ibm.com/epubs/pdf/igy3mg50.pdf.

To aid in moving from your older COBOL compiler to Enterprise COBOL, this information provides descriptions of the language differences between older COBOL compilers and Enterprise COBOL and describes the IBM conversion tools available to aid in converting your source programs to Enterprise COBOL programs. It also describes other differences that might require changes in your application development process in order to use Enterprise COBOL.

The following products or deliverables are also available to aid you in assessing the effort of moving from your older COBOL compiler to Enterprise COBOL:

- IBM Enterprise COBOL Developer Trial for z/OS, V6.1 (5655-TY6).

  Enterprise COBOL Developer Trial for z/OS comes with a no-charge 90-day evaluation license. With Enterprise COBOL Developer Trial for z/OS, V6.1, you can evaluate the latest capabilities of IBM Enterprise COBOL for z/OS, V6.1 in a non-production environment, before committing time and resources to a production migration project.
- IBM Enterprise COBOL for z/OS Migration Assistant.

  You can use the COBOL Migration Assistant to navigate through the compiler migration process from Enterprise COBOL V4 or earlier versions to Enterprise COBOL V5 or V6.
- IBM Enterprise COBOL for z/OS Migration Portal.

  Check case studies, COBOL experts interview videos, the cloud-based COBOL Migration Assistant, no-charge COBOL Migration and Performance Tuning Webinars, FAQs, other IBM products to support your migration, and many other resources to help ease your migration efforts from Enterprise COBOL V4 or earlier versions to Enterprise COBOL V5 or V6.

Acknowledgement

IBM would like to acknowledge the assistance of the GUIDE COBOL Migration Task Force in the preparation of the OS/VS COBOL to VS COBOL II Migration Guide. The task force provided ideas, experience-derived information, and perceptive comments on the subject of OS/VS COBOL to VS COBOL II conversion.

The information received from this previous conversion experience, as well as input from many experienced OS/VS COBOL and VS COBOL II IBM customers, aided in the development of this Migration Guide. Without such assistance, this information would have been much more difficult to develop.

Using your information

The information provided with Enterprise COBOL and Language Environment is designed to help you do COBOL programming under z/OS.

Enterprise COBOL for z/OS publications

Table 2. The Enterprise COBOL for z/OS publications

Task	Information
Understand warranty information	*Licensed Program Specifications*
Install the compiler under z/OS	*Program Directory for Enterprise COBOL*
Understand product changes and upgrade source to the latest version of Enterprise COBOL for z/OS	*Migration Guide*
Upgrade run time environment to Language Environment	**Note:** If you have not yet migrated your runtime library to Language Environment, consult the *Enterprise COBOL V4.2 Compiler and Runtime Migration Guide* at http://publibfp.dhe.ibm.com/epubs/pdf/igy3mg50.pdf for help.
Customize Enterprise COBOL for z/OS	*Enterprise COBOL Customization Guide*
Prepare and test your programs and get details about compiler options	*Enterprise COBOL Programming Guide*
Get details about COBOL syntax and specifications of language elements	*Enterprise COBOL Language Reference*

Language Environment element of z/OS

Table 3. The Language Environment element of z/OS publications

Task	Information
Evaluate the product	*Language Environment Concepts Guide*
Install Language Environment	*z/OS Program Directory*
Understand Language Environment program models and concepts	*Language Environment Programming Guide*
Find syntax for Language Environment runtime options and callable services	*Language Environment Programming Reference*
Debug applications that run with Language Environment, get details about runtime messages, and diagnose problems with Language Environment	*Language Environment Debugging Guide and Run-Time Messages*
Migrate applications from one release of Language Environment to another.	*Language Environment Run-Time Migration Guide*

Table 3. The Language Environment element of z/OS publications (continued)

Task	Information
Develop interlanguage communication (ILC) applications	*Language Environment Writing Interlanguage Communication Applications*
Learn about the concepts and use of Common Debug Architecture (CDA)	*Common Debug Architecture User's Guide*
Get details about APIs in the Debug Data Program Information library (llibddpi).	*Common Debug Architecture Library Reference*
Get details about the IBM extensions to the DWARF and ELF APIs in the DWARF 4 standard.	*DWARF/ELF Extensions Library Reference*

Summary of changes to this information

This section lists the major changes that have been made to each edition of this migration guide since IBM COBOL for OS/390 & VM Version 2 Release 1.

Changes in GC27-8715-00 (December 2021)

Changes in GC27-8715-00 (December 2021)

- Clarified the performance impact of decimal overflows in "Performance of decimal overflows" on page 14.

Changes in GC27-8715-00 (February 2021)

- The installation customization for placing compiler phases into shared storage is removed.
- Added General Availability (GA) and End of Support (EOS) dates for each COBOL compiler version in "IBM COBOL compilers by name and version" on page xiii.

Changes in GC27-8715-00 (December 2020)

- Clarified that TRAP(ON) must be in effect when messages IGZ0268W and IGZ0269W have been issued in "Taking an inventory of your applications" on page 31.

Changes in GC27-8715-00 (August 2020)

- Updated the INSPECT...TALLYING behavior example in "COBOL source code differences in Enterprise COBOL Version 5 and Version 6" on page 177.
- Added frequently asked questions (FAQs) and their answers in "Compatibility" on page 230, "Compiling with Enterprise COBOL" on page 232, "Subsystems" on page 236, and "Performance" on page 238.

Changes in GC27-8715-00 (June 2020)

- A new option `QSAMBUFFINITCHAR` is added to the `IGZUOPT` module that allows you to control the initial character used for QSAM buffer initialization. For details, see Appendix K, "Controlling initialization of QSAM buffer (IGZ4OPT)," on page 321. This support can be obtained in Enterprise COBOL Version 6 Release 1 with runtime LE PTF for APAR PH25917 installed.
- Updated the references to PPA4 layout and WORKING-STORAGE location in "WORKING-STORAGE SECTION changes" on page 171.
- Clarified the background of IBM Report Writer, and added support details and version requirement in "COBOL Report Writer Precompiler" on page 269.

Changes in GC27-8715-00 (April 2020)

- New suboptions LAX | STRICT are added to the INITCHECK option to control whether the compiler will issue warning messages for data items unless they are initialized on at least one, or on all, logical paths to a statement. For details, see "Compiler option changes in Enterprise COBOL Version 5 and Version 6" on page 178. This change is introduced in Enterprise COBOL Version 6 Release 1 with PTF for APAR PH24414 installed.
- Clarified INSPECT...TALLYING behavior changes in "COBOL source code differences in Enterprise COBOL Version 5 and Version 6" on page 177.
- Provided details about migrating from PDS data sets to PDSE data sets in Chapter 3, "Compiler upgrade checklist," on page 25.
- Clarified that programs compiled with TEST(...,NOSEPARATE) under CICS® require read access to DFHRPL libraries in "DFHRPL setup differences with Enterprise COBOL V5 and V6" on page 213.
- Added a link to the COBOL Migration Information Portal, where you can find information about COBOL migration all in one place. For details, see "IBM COBOL compilers by name and version" on page xiii.
- Updated "IBM Developer for z Systems®" to "IBM Developer for z/OS" in Appendix L, "Accessibility features for Enterprise COBOL for z/OS," on page 323.

Changes in GC27-8715-00 (February 2020)

- The support for NOBLKSET and the conventional merge method for Enterprise COBOL V5 or later versions is obtained with runtime LE PTFs UI67483(V2R2)/UI67485(V2R3)/UI67486(V2R4) installed. For details, see "Using DFSORT option NOBLKSET" on page 194.
- Added questions frequently asked before migration and their answers in FAQs before migration.

Changes in GC27-8715-00 (March 2019)

- Added an FAQ and answer about the changes in compiler generated symbols between Enterprise COBOL V4 and V5 or V6 in "Binding (link-editing) Enterprise COBOL programs " on page 234.
- Added a support page link where lists the Enterprise COBOL V4 PTFs to support the migration to Enterprise COBOL V5 or V6. For details, see Chapter 14, "Upgrading from Enterprise COBOL Version 4," on page 155.

Changes in GC27-8715-00 (September 2018)

- Added information about two new suboptions ALPHNUM and NOALPHNUM of the NUMCHECK(ZON) compiler option, which control whether the compiler will generate code for an implicit numeric class test for zoned decimal data items that are being compared with an alphanumeric data item, alphanumeric literal or alphanumeric figurative constant. The changes are introduced in Enterprise COBOL Version 6 Release 1 with PTF for APAR PH01251 installed.
- Updated and further clarified how to find WORKING-STORAGE SECTION in Enterprise COBOL V5 and V6. For details, see "WORKING-STORAGE SECTION changes" on page 171.

Changes in GC27-8715-00 (July 2018)

- Replaced the Edge Portfolio Analyzer with a free and open source COBOL Analyzer. For details, see "Free and open source COBOL Analyzer" on page 270.
- Clarified that compiler migration is required for OS/VS COBOL programs and VS COBOL II programs compiled with NORES in "Compiler migration" on page 20.

Changes in GC27-8715-00 (May 2018)

- Added information about the new COPYLOC compiler option in ""Compiler option changes in Enterprise COBOL Version 5 and Version 6" on page 178". The changes are introduced in Enterprise COBOL Version 6 Release 1 with PTF for APAR PI96231 installed.

- Updated information in “CSD setup differences with Enterprise COBOL V5 and V6” on page 213 because certain CICS TS versions provide the *system autoinstall* capability for LE programs and CICS will create the program definition automatically when the programs are first loaded.
- Clarified that the separate CICS translator is still shipped with current CICS products but is no longer being enhanced in “Migrating from the separate CICS translator to the integrated translator” on page 216.

Changes in GC27-8715-00 (March 2018)

- Removed OMVS segment requirements from "“Prerequisite software and service for Enterprise COBOL Version 5 and Version 6” on page 175".

Changes in GC27-8715-00 (November 2017)

- Updated behaviour of the ZONEDATA compiler option in "“Compiler option changes in Enterprise COBOL Version 5 and Version 6” on page 178". This change is introduced in Enterprise COBOL Version 6 Release 1 with PTF for APAR PI88271 installed.
- Clarified the IGZEBST requirements in Chapter 1, “Introducing the new compiler and run time,” on page 3 and several other topics.

Changes in GC27-8715-00 (June 2017)

- Updated behaviour of the NOSTGOPT compiler option in "“Compiler options for converted programs” on page 85". This change is introduced in Enterprise COBOL Version 6 Release 1 with PTF for APAR PI81838 installed.

Changes in GC27-8715-00 (April 2017)

- Added information about a new PARMCHECK compiler option that can discover parameter mismatches, that is, if programs pass arguments to subprograms that are then misused as parameters. The PARMCHECK option can help with your migration to Enterprise COBOL V6 and check for good programming practices. The PARMCHECK option is introduced in Enterprise COBOL Version 6 Release 1 with PTF for APAR PI78089 installed.
- Added information about a new INLNE compiler option that controls whether the inlining of procedures (paragraphs or sections) referenced by PERFORM statements in the source program is allowed. The INLINE option is introduced in Enterprise COBOL Version 6 Release 1 with PTF for APAR PI77981 installed.
- Added information about the interprocess communication (IPC) message queues in "“Debug information changes with Enterprise COBOL Version 5 and Version 6” on page 153".
- Updated the code sample and further clarified the behavior changes in Enterprise COBOL V5 and V6 for programs with parameter length mismatches in "“Error behavior changes for incorrect programs” on page 192".
- Added information that in V4, when a COMP-5 data-item value (signed or unsigned) is moved into a PIC X(n) data item, an incorrect value will be moved. This is corrected in Enterprise COBOL V5 and V6. See "“COBOL source code differences in Enterprise COBOL Version 5 and Version 6” on page 177".
- Updated information about calling a ILBOABN0 callable service with Enterprise COBOL V5 and later versions in "“Changes at run time with Enterprise COBOL Version 5 and Version 6” on page 188".
- Added information about using the XML System Services parser to transforms some characters or character combinations to x'15' when parsing EBCDIC documents in "Appendix J, “Migrating from XMLPARSE(COMPAT) to XMLPARSE(XMLSS),” on page 313".

Changes in GC27-8715-00 (February 2017)

- Added information about a new NUMCHECK compiler option that controls whether to generate extra code to validate data items when they are used as sending data items. The NUMCHECK option is introduced in Enterprise COBOL Version 6 Release 1 with PTF for APAR PI71625 installed.
- Added information about a new warning message that will be issued when a call to ILBOABN0 callable service is encountered in the source program in "“Changes at run time with Enterprise COBOL Version 5 and Version 6” on page 188".
- Added two new suboptions MSG and ABD to the SSRANGE compiler option to control the runtime behavior of the COBOL program when a range check fails.

Changes in GC27-8715-00 (September 2016)

- Added information to highlight the Enterprise COBOL V6 changes in "Chapter 16, “Changes with Enterprise COBOL Version 6,” on page 167".
- Added information about a new INITCHECK compiler option that controls whether to check for uninitialized data items and issue warning messages when they are used without being initialized. The INITCHECK option is introduced in Enterprise COBOL Version 6 Release 1 with PTF for APAR PI68226 installed.

Changes in GC27-8715-00 (March 2016)

- Added information about Enterprise COBOL V6 changes in "Part 4, “What is new and different with Enterprise COBOL Version 5 and Version 6?,” on page 165", and the V6 changes mainly fall into the following topics:
  - Prerequisite software level changes
  - COBOL source code differences
  - Compiler option changes
  - Dependence on system MEMLIMIT setting for large programs
  - Runtime changes
  - Changes that might affect vendor tools
- Added new reserved words:
  - ALLOCATE
  - DEFAULT
  - END-JSON
  - FREE
  - JSON
  - JSON-CODE
- Added a topic of "Chapter 4, “Migration recommendations to Enterprise COBOL V5 and V6,” on page 27", including special considerations when migrating from earlier versions to Enterprise COBOL V5 and V6.

Changes in GC14-7383-03 (March 2019)

Changes in GC14-7383-03 (March 2019)

- Added a support page link where lists the Enterprise COBOL V4 PTFs to support the migration to Enterprise COBOL V5 or V6. For details, see Chapter 14, “Upgrading from Enterprise COBOL Version 4,” on page 155.

Changes in GC14-7383-03 (September 2018)

- Added information about two new suboptions ALPHNUM and NOALPHNUM of the NUMCHECK(ZON) compiler option, which control whether the compiler will generate code for an implicit numeric class test for zoned decimal data items that are being compared with an alphanumeric data item, alphanumeric literal or alphanumeric figurative constant. The changes are introduced in Enterprise COBOL Version 5 Release 2 with PTF for APAR PH01241 installed.
- Added information about how to find WORKING-STORAGE SECTION in Enterprise COBOL V5. For details, see "WORKING-STORAGE SECTION changes" on page 171.

Changes in GC14-7383-03 (July 2018)

- Replaced the Edge Portfolio Analyzer with a free and open source COBOL Analyzer. For details, see "Free and open source COBOL Analyzer" on page 270.
- Clarified that compiler migration is required for OS/VS COBOL programs and VS COBOL II programs compiled with NORES in "Compiler migration" on page 20.

Changes in GC14-7383-03 (May 2018)

- Updated information in "CSD setup differences with Enterprise COBOL V5 and V6" on page 213 because certain CICS TS versions provide the *system autoinstall* capability for LE programs and CICS will create the program definition automatically when the programs are first loaded.
- Clarified that the separate CICS translator is still shipped with current CICS products but is no longer being enhanced in "Migrating from the separate CICS translator to the integrated translator" on page 216.

Changes in GC14-7383-03 (November 2017)

- Updated behaviour of the ZONEDATA compiler option in "Compiler option changes in Enterprise COBOL Version 5 and Version 6" on page 178. This change is introduced in Enterprise COBOL Version 5 Release 2 with PTF for APAR PI90458 installed.
- Clarified the IGZEBST requirements in Chapter 1, "Introducing the new compiler and run time," on page 3 and several other topics.

Changes in GC14-7383-03 (September 2017)

- Added information about a new VSAMOPENFS compiler option that affects the user file status reported from successful VSAM OPEN statements that require verified file integrity check. The VSAMOPENFS option is introduced in Enterprise COBOL Version 5 Release 2 with PTF for APAR PI85868 installed.
- Added information about two new suboptions MSG and ABD of the SSRANGE compiler option, which control the runtime behavior of the COBOL program when a range check fails. MSG and ABD are introduced in Enterprise COBOL Version 5 Release 2 with PTF for APAR PI86343 installed.

Changes in GC14-7383-03 (June 2017)

- Added information about a new NUMCHECK compiler option that controls whether to generate extra code to validate data items when they are used as sending data items. The NUMCHECK option is introduced in Enterprise COBOL Version 5 Release 2 with PTF for APAR PI81006 installed.

Changes in GC14-7383-03 (April 2017)

- Updated the code sample and further clarified the behavior changes in Enterprise COBOL V5 and V6 for programs with parameter length mismatches. See ""Error behavior changes for incorrect programs" on page 192".

- Added information that in V4, when a COMP-5 data-item value (signed or unsigned) is moved into a PIC X(n) data item, an incorrect value will be moved. This is corrected in Enterprise COBOL V5 and V6. See ""COBOL source code differences in Enterprise COBOL Version 5 and Version 6" on page 177".
- Updated information about calling a `ILBOABN0` callable service with Enterprise COBOL V5 and later versions in ""Changes at run time with Enterprise COBOL Version 5 and Version 6" on page 188".
- Added information about using the XML System Services parser to transforms some characters or character combinations to x'15' when parsing EBCDIC documents in "Appendix J, "Migrating from XMLPARSE(COMPAT) to XMLPARSE(XMLSS)," on page 313".

Changes in GC14-7383-03 (January 2017)

- Added information about a new warning message that will be issued when a call to `ILBOABN0` callable service is encountered in the source program in ""Changes at run time with Enterprise COBOL Version 5 and Version 6" on page 188".

Changes in GC14-7383-03 (September 2016)

- Added information about a new INITCHECK compiler option that controls whether to check for uninitialized data items and issue warning messages when they are used without being initialized. The INITCHECK option is introduced in Enterprise COBOL Version 5 Release 2 with PTF for APAR PI69197 installed.

Changes in GC14-7383-03 (July 2015)

Added information about compiler option changes:

- New option: `ZONECHECK(MSG|ABD)`
- Modified option: `ZONEDATA`. New suboption of `NOPFD` is added to the `ZONEDATA` compiler option. `ZONEDATA(NOPFD)` lets the compiler generate code that performs comparisons of zoned decimal data in the same manner as COBOL V4 does when using `NUMPROC(NOPFD|PFD)` with COBOL V4.

Changes in GC14-7383-03 (February 2015)

- Added information about Enterprise COBOL V5.2 changes to the chapter "What is new and different with Enterprise COBOL Version 5", and the changes mainly fall into the following topics:
  - Source code differences
  - Compiler options changes
  - Compilation restrictions for user-written condition handlers
  - Variable length records - wrong length READ
  - Using object oriented COBOL or interoperating with C programs
- Added information about upgrading Enterprise COBOL Version 3 or Version 4 programs that have XML PARSE statements
- Added information about accessing VSAM data sets with the extended addressability attribute, including for existing COBOL programs compiled with earlier versions than Enterprise COBOL for z/OS, V5.2.
- Added information to appendix on how to save and restore the high halves of General Purpose Registers (GPRs) in assembler programs that will call or be called by Enterprise COBOL V5.

Changes in GC14-7383-02 (March 2019)

Changes in GC14-7383-02 (March 2019)

- Added a support page link where lists the Enterprise COBOL V4 PTFs to support the migration to Enterprise COBOL V5 or V6. For details, see Chapter 14, “Upgrading from Enterprise COBOL Version 4,” on page 155.

Changes in GC14-7383-02 (September 2018)

- Added information about how to find WORKING-STORAGE SECTION in Enterprise COBOL V5. For details, see “WORKING-STORAGE SECTION changes” on page 171.

Changes in GC14-7383-02 (May 2018)

- Updated information in “CSD setup differences with Enterprise COBOL V5 and V6” on page 213 because certain CICS TS versions provide the *system autoinstall* capability for LE programs and CICS will create the program definition automatically when the programs are first loaded.
- Clarified that the separate CICS translator is still shipped with current CICS products but is no longer being enhanced in “Migrating from the separate CICS translator to the integrated translator” on page 216.

Changes in GC14-7383-02 (April 2017)

- Updated information about calling a `ILBOABN0` callable service with Enterprise COBOL V5 and later versions in “Changes at run time with Enterprise COBOL Version 5 and Version 6” on page 188.

Changes in GC14-7383-02 (February 2017)

- Added information about a new warning message that will be issued when a call to `ILBOABN0` callable service is encountered in the source program in “Changes at run time with Enterprise COBOL Version 5 and Version 6” on page 188.

Changes in GC14-7383-02 (March 2014)

Added back the support for AMODE 24 execution of COBOL programs, except for a few exception cases. Many programs that are compiled by Enterprise COBOL 5.1.1 execute in either AMODE 31 or AMODE 24.

Changes in GC14-7383-00 (June 2013)

This migration guide has been reorganized for Enterprise COBOL Version 5.1. If you have not yet completed your runtime migration to Language Environment, please refer to the previous version of this information. You can use the *Enterprise COBOL V4.2 Compiler and Runtime Migration Guide* at http://publibfp.dhe.ibm.com/epubs/pdf/igy3mg50.pdf for help in completing your runtime migration.

Primarily, the following changes have been made to this Migration Guide:

- Removal of the information related to Language Environment
- Addition of specific chapters for migrating from Enterprise COBOL Version 3 and Enterprise COBOL Version 4
- Addition of a section on Enterprise COBOL Version 5
- Addition of a section on upgrading your COBOL compiler along with other IBM products. That includes information about Debug Tool, CICS, and DB2®. Please see Part 5, “Enterprise COBOL migration and other IBM products,” on page 205 for more information.

There is a lot of information in this guide but most of it is not needed by most customers. For example, if you are moving from Enterprise COBOL Version 4 and you have completed your runtime migration

for all applications, you only need to look at a few sections. For details, see Chapter 14, “Upgrading from Enterprise COBOL Version 4,” on page 155, Chapter 15, “Compiling Enterprise COBOL Version 4 programs,” on page 161, and Chapter 17, “Changes with Enterprise COBOL Version 5 and Version 6,” on page 175.

Changes in GC23-8527-01 (August 2009)

Compiler

- Added information about integrated DB2 coprocessor
- Updated information about migrating from XMLPARSE(COMPAT) to XMLPARSE(XMLSS), for example, changes in the handling of several XML events
- Updated information about the differences in parsing behavior when you compile using XMLPARSE(XMLSS)
- Added new reserved words
- Added new compiler options
- Added information to appendix on commonly asked questions and answers:
  - Information about COBOL program calls
  - Information about running existing COBOL applications with Java™ 5 or Java 6

Run time

- Updated information about region-wide defaults
- Updated information about TEST option
- Updated information about Language Environment STORAGE(00) option

Information about CICS has been corrected.

Miscellaneous maintenance and editorial changes have been made; for example, Appendix B, “COBOL reserved word comparison,” on page 241 and Appendix F, “Compiler limit comparison,” on page 299 have been updated.

Changes in GC23-8527-00 (December 2007)

Compiler

- Added section on migrating XML PARSE from Enterprise COBOL Version 3 to Enterprise COBOL Version 4 (Migrating from XMLPARSE(COMPAT) to XMLPARSE(XMLSS)).
- Added information about the new TEST suboptions of Enterprise COBOL Version 4
- Added new reserved words
- Added information to section on migrating from CMPR2 to NOCMPR2:
  - Fixed file attributes and DCB= parameters of JCL
  - OPEN statement failing for QSAM files (FILE STATUS 39)
  - OPEN statement failing for VSAM files (FILE STATUS 39)
- Added information to appendix on DB2 coprocessor integration
  - Additional differences from separate precompiler

Run time

- Added information about removal of SIMVRD runtime option support for Enterprise COBOL Version 4 Release 1 programs.

Changes in GC27-1409-05 (November 2006)

- Updated the documentation of differences between DB2 precompiler and coprocessor.
- Added compiler option SQLCCSID.

Changes in GC27-1409-04 (March 2006)

- Added to the documentation of differences between DB2 precompiler and coprocessor.
- Added a section on migrating SEARCH ALL statements to V3R4.

Changes in GC27-1409-03 (July 2005)

- Added compiler option MDECK.
- Added new reserved words.
- Added SQL code differences between DB2 precompiler and coprocessor.
- Changes to data-item sizes.

Changes in GC27-1409-02 (December 2003)

- Applied service updates to the information

Changes in GC27-1409-01 (September 2002)

Compiler

- Added information about the use of the SEPARATE suboption with the TEST(. . .,SYM,. . .) compiler option.

Run time

- Clarified the information about file handling for COBOL programs with RECORDING MODE U under OS/390, Version 2 Release 10.
- Added information about the change in the amount of space that is used for an output file that is defined as RECFM=U under OS/390, Version 2 Release 10.
- Added information about dynamic calls to assembler programs under Language Environment for z/OS, Version 1 Release 2 and later.

Changes in GC27-1409-00 (November 2001)

Compiler

- Removed various compiler options, including the CMPR2 compiler option
- Added new reserved words
- Added information about the new integrated CICS translator
- Removed OO COBOL syntax and programming model based on SOM
- Added information about migrating to the Enterprise COBOL compiler

Run time

- Added information about the change in behavior for DATA(31) programs
- Added information about CEEDUMP absent from applications with assembler programs that use the DUMP macro
- Added information about the change in file handling for COBOL programs with RECORDING MODE U

- Added information about calling between assembler and COBOL

Changes in GC26-4764-05 (September 2000)

Compiler

- Added newly discovered undocumented extensions and improved many existing entries in Chapter 6, "Upgrading OS/VS COBOL source programs," on page 45
- Added new reserved words
- Added information about migrating to the V2R2 compiler

Run time

- Added description of the new default for runtime option ABTERMENC (ABEND for Language Environment for OS/390 V2R9 and later) and the new suboptions for TERMTHDACT available in Language Environment for OS/390 V2R7 and later
- Added information about Language Environment region-wide runtime options
- Updated the virtual storage requirements
- Updated the CICS considerations:
  - Performance
  - SORT interface change
  - DISPLAY statement
- Updated information about upgrading Language Environment release levels

Miscellaneous maintenance and editorial changes have been made.

Summary of changes to the COBOL compilers

This section lists the main changes that have been made to IBM host COBOL compilers.

Changes in IBM Enterprise COBOL for z/OS, Version 6 Release 1 with PTFs installed

New, changed, and removed compiler options

- The following compiler options are new:
  - PI68226: `INITCHECK`
  - PI71625: `NUMCHECK`
  - PI78089: `PARMCHECK`
  - PI77981: `INLINE`
  - PI96231: `COPYLOC`
- The following compiler options are modified:
  - PI68023 and PI81838: `NOSTGOPT`: The default behaviour of the `NOSTGOPT` compiler option has been changed.
  - PI74933: `SSRANGE`: New suboptions `MSG` and `ABD` are added to the `SSRANGE` compiler option to control how the compiler checks reference modification lengths.
  - PI98996: `NUMCHECK(PAC)`: For packed decimal (`COMP-3`) data items that have an even number of digits, the unused bits are checked for zeros.
  - PH01251: `NUMCHECK(ZON)`: New suboptions `ALPHNUM | NOALPHNUM` are added to the `NUMCHECK(ZON)` option to control whether the compiler will generate code for an implicit numeric

class test for zoned decimal data items that are being compared with an alphanumeric data item, alphanumeric literal or alphanumeric figurative constant.
  - PH13943: `NUMCHECK(BIN)`: `NUMCHECK(BIN)` will check for binary data items (`COMP`, `COMP-4`, and `USAGE BINARY`) even when `TRUNC(BIN)` is in effect.
  - PH24414: `INITCHECK`: New suboptions `LAX | STRICT` are added to the `INITCHECK` option to control whether the compiler will issue warning messages for data items unless they are initialized on at least one, or on all, logical paths to a statement.
  - Runtime APAR PH20569(V2R2/V2R3/V2R4): The included DWARF diagnostic information when `TEST(NOSEPARATE)` is effect can be extracted from the LLA/VLF managed programs.
  - Runtime APAR PH34885 (V2R3/V2R4): The UUID4 randomness and UUID4 intrinsic function requires significant CPU usage.
- The following compiler option is removed:
  - PI71625: `ZONECHECK` is deprecated but is tolerated for compatibility, and it is replaced by `NUMCHECK(ZON)`.

New and changed statements

- PI71621: The JSON GENERATE statement is redesigned and improved.
- PI92944: A new LOC(24|31) phrase is added to the ALLOCATE statement to control the location of dynamic storage that is acquired, which overrides the influence of the DATA compiler option when determining the location of dynamic storage that is acquired.
- PI96231: As the new compiler option COPYLOC is introduced, the COPY statement is updated.
- Runtime APARs PH20569(V2R2) and PH21261(V2R3/V2R4): A new runtime option (IGZCOMPAT) for MERGE statement is introduced to obtain support for DFSORT option NOBLKSET and the conventional merge method for Enterprise COBOL V5 or later versions.

Migration assistance

- Runtime APAR PH25917: A new option QSAMBUFFINITCHAR is added to the IGZUOPT module that allows you to control the initial character used for QSAM buffer initialization. (Appendix K, “Controlling initialization of QSAM buffer (IGZ4OPT),” on page 321)

COBOL/JNI interface enhancement

Runtime APAR PH37101(V2R3/V2R4): An enhancement is made to assist COBOL programs running in AMODE 31 to interact with Java programs in AMODE 64.

Note: IBM SDK, Java Technology Edition V8.0.6.35 (JVM) is needed for this enhancement.

Changes in IBM Enterprise COBOL for z/OS, Version 6 Release 1

New and changed options

- The following compiler options are new:
  - `SUPPRESS`
  - `VSAMOPENFS`
- The following compiler options are modified:
  - `LANGUAGE`
  - `SSRANGE`

Removed options

The LVLINFO installation option is removed. The build level information is put where LVLINFO used to be, and the SERVICE compiler option can be used for user service level information in place of LVLINFO.

New and changed statements

- The new ALLOCATE statement obtains dynamic storage, while the new FREE statement releases dynamic storage that was previously obtained with an ALLOCATE statement. Both statements are part of the 2002 COBOL Standard.
- Enhancements are made to the INITIALIZE statement as part of the 2002 COBOL Standard:
  - A new FILLER phrase is added so that FILLER data items can be initialized with the INITIALIZE statement.
  - A new VALUE phrase is added so that elementary data items can be initialized to the literal specified in the VALUE clause.
- The new JSON GENERATE statement converts data to JSON format.

Compiler behavior changes

In Enterprise COBOL V6, the compiler may start using storage above the 2 GB BAR to compile very large programs. This means that the z/OS MEMLIMIT parameter would have to be set to a nonzero value. The z/OS default for MEMLIMIT is 2 GB, but if you compile a very large program and your z/OS setting for MEMLIMIT is not high enough, you could get this compiler message: `IGYCB7145-U Insufficient memory in the compiler to continue compilation`.

Debugging changes

The allocation and management of WORKING-STORAGE SECTION have been changed in Enterprise COBOL V6. This does not affect the execution of the COBOL program. Tools or programs that need to locate the starting address of the WORKING-STORAGE SECTION might be affected.

JCL changes

To specify the language of compiler messages, you must use the LANGUAGE compiler option and also set the Language Environment runtime option NATLANG at compile time. We recommend using CEEOPTS DD in the compile JCL.

Changes in IBM Enterprise COBOL for z/OS, Version 5 Release 2 with PTFs installed

New, changed, and removed compiler options

- The following compiler options are new:
  - PI40822: `ZONECHECK`
  - PI69197: `INITCHECK`
  - PI81006: `NUMCHECK`
  - PI85868: `VSAMOPENFS`
- The following compiler options are modified:
  - PI40853: `ZONEDATA`: New suboption of `NOPFD` is added to the `ZONEDATA` compiler option. `ZONEDATA=NOPFD` lets the compiler generate code that performs comparisons of zoned decimal data in the same manner as COBOL V4 does when using `NUMPROC=NOPFD | PFD` with COBOL V4.
  - PI53044: `SSRANGE`: New suboptions `ZLEN` and `NOZLEN` are added to the `SSRANGE` compiler option to control how the compiler checks reference modification lengths.

  - PI86343: SSRANGE: New suboptions MSG and ABD are added to the SSRANGE compiler option to control how the compiler checks reference modification lengths.
  - PI90458: ZONEDATA: The ZONEDATA option is updated to affect the behaviour of MOVE statements, comparisons, and computations for USAGE DISPLAY or PACKED-DECIMAL data items that could contain invalid digits, an invalid sign code, or invalid zone bits.
  - PI97835: NUMCHECK(PAC): For packed decimal (COMP-3) data items that have an even number of digits, the unused bits are checked for zeros.
  - PH01241: NUMCHECK(ZON): New suboptions ALPHNUM | NOALPHNUM are added to the NUMCHECK(ZON) option to control whether the compiler will generate code for an implicit numeric class test for zoned decimal data items that are being compared with an alphanumeric data item, alphanumeric literal or alphanumeric figurative constant.
- The following compiler option is removed:
  - PI81006: ZONECHECK is deprecated and can no longer be specified in IGYCDOPT. NUMCHECK=(ZON) gives the same results as ZONECHECK used to.

Changes in IBM Enterprise COBOL for z/OS, Version 5 Release 2

New and changed options

- The following compiler options are new:
  - COPYRIGHT
  - QUALIFY(COMPAT|EXTEND)
  - SERVICE
  - SQLIMS
  - VLR(COMPAT|STANDARD)
  - XMLPARSE(XMLSS|COMPAT)
  - ZONEDATA(PFD|MIG)
- The following compiler options are modified:
  - ARCH: ARCH(6) is no longer accepted. A new higher level of ARCH(11) is accepted, and ARCH(7) is the default.
  - MAP: New suboptions HEX and DEC are added to the MAP compiler option to control whether hexadecimal or decimal offsets are shown for MAP output in the compiler listing. It eases your migration to Enterprise COBOL V5.2 if your programs are compiled with Enterprise COBOL V4 or earlier versions.
- The following compiler option is removed:
  - SIZE

New and changed functions

- The compatibility-mode COBOL XML parser from the COBOL library is supported. You can specify the XMLPARSE(XMLSS|COMPAT) compiler option to choose between parsing with the z/OS XML System Services parser, or with the compatibility-mode COBOL XML parser. This feature can ease the migration to the Enterprise COBOL V5 compiler for programs with XML PARSE statements that were compiled with Enterprise COBOL V3, or with V4 compiler with the XMLPARSE(COMPAT) compiler option.
- Enterprise COBOL applications that use object-oriented syntax for Java interoperability are now supported with Java 6, Java 7 and Java 8. Java SDK 1.4.2 and Java 5 are no longer supported.

New and changed statements

- The new CALLINTERFACE directive specifies the interface convention for CALL and SET statements. The convention specified stays in effect until another CALLINTERFACE directive is encountered in the source. The CALLINTERFACE directive has three suboptions: DLL, DYNAMIC, and STATIC.
- The EXIT statement includes the following new formats, which provide a structured way to exit without using a GO TO statement. The new formats are part of the 2002 COBOL Standard.
  - EXIT PERFORM for exiting from an inline PERFORM statement
  - EXIT PARAGRAPH for exiting from the middle of a paragraph
  - EXIT SECTION for exiting from a section
- A new format of the SORT statement, the table SORT statement, arranges table elements in a user-specified sequence. It is part of the 2002 COBOL Standard.
- New keywords LEADING and TRAILING are added to the REPLACING phrase of the COPY statement and the REPLACE statement to improve partial-word replacement operations. The new keywords are part of the 2002 COBOL Standard.
- A new keyword VOLATILE is added to the format 1 data description entry. The VOLATILE clause indicates that a data item's value can be modified or referenced in ways that the compiler cannot detect, such as by a Language Environment (LE) condition handler routine or by some other asynchronous process or thread. Thus, optimization is restricted for the data item.
- New syntaxes are introduced to the XML GENERATE statement. The WHEN phrase from the explicit form of the SUPPRESS phrase can be omitted to unconditionally suppress *identifier-8* in the output of the XML Generate statement. If the WHEN phrase is omitted, *identifier-8* can be a group data item. In addition, the *generic-suppression-phrase* of the XML GENERATE statement provides a convenient way to exclude entire classes and categories of data items from the generated XML output based on suppression criteria. The data items to which the suppression specifications apply and that meet the criteria at run time will be excluded. CONTENT is treated as a distinct type for suppression.

Changes in IBM Enterprise COBOL for z/OS, Version 5 Release 1 Modification 1

- Except for a few exception cases, AMODE 24 execution of COBOL programs is supported. Many programs compiled by IBM Enterprise COBOL for z/OS V5.1.1 will execute in AMODE 31 or AMODE 24.
- A new compiler option, SQLIMS, enables the new IMS SQL coprocessor (called SQL statement coprocessor by IMS). The new coprocessor handles your source programs that contain embedded SQLIMS statements.
- New fatal and warning exception codes are added for XML PARSE exceptions.
- The LIST option output in the compiler listing contains a new Special Register Table that provides the location information for all the COBOL Special Register variables.

With current service applied, Enterprise COBOL V5.1.0 appears to be V5.1.1 and has the following new compiler options:

- `SQLIMS`
- `VLR(COMPAT|STANDARD)`
- `XMLPARSE(XMLSS|COMPAT)`
- New suboptions HEX and DEC are added to the `MAP` compiler option to control whether hexadecimal or decimal offsets are shown for `MAP` output in the compiler listing.

Changes in IBM Enterprise COBOL for z/OS, Version 5 Release 1

New and changed COBOL function

The XML function supported by IBM Enterprise COBOL for z/OS has been enhanced:

- The XML GENERATE statement has been extended with new syntax that gives the programmer more flexibility and control over the form of the XML document that is generated:
  - The NAME phrase has been added to allow user-supplied element and attribute names.
  - The TYPE phrase has been added to give the user control of attribute and element generation.
  - The SUPPRESS phrase has been added to allow suppression of empty attributes and elements.
- XML parsing support has been enhanced with a special register, XML-INFORMATION, to easily determine whether the XML content delivered for an XML event is complete or will be continued on the next event.
- The compatibility-mode COBOL XML parser from the COBOL library is no longer supported for use by Enterprise COBOL V5 programs. XML PARSE statements in V5 programs always use the XML parser in z/OS XML System Services.

New support for UNBOUNDED tables and groups enables top-down mapping of data structures between XML and COBOL applications

Unicode support has been enhanced in this release with the addition of 6 new intrinsic function:

- ULENGTH
- UPOS
- USUBSTR
- USUPPLEMENTERY
- UVALID
- UWIDTH

A new inline comment indicator (the character string '*>') can be coded to indicate that the ensuing text on a line is a comment.

Enterprise COBOL Version 5.1 corrects READ statement processing of wrong-length records.

The Millennium Language Extensions are no longer supported, and the removed elements are:

- DATEVAL intrinsic function
- UNDATE intrinsic function
- YEARWINDOW intrinsic function
- DATEPROC compiler option
- YEARWINDOW compiler option

To be compatible with the convention used by C and C++, the linkage convention for returning a doubleword binary item specified in the `RETURNING` phrase `PROCEDURE DIVISION` header and the `CALL` statement is changed. If a COBOL program returns a doubleword binary item via a PROCEDURE DIVISION RETURNING header to a calling COBOL program with a CALL ... RETURNING statement, an issue occurs if only one of the programs is recompiled with Enterprise COBOL V5. Both the called and calling programs must be recompiled with Enterprise COBOL V5 together, so that the linkage convention for the RETURNING item is consistent.

Format 2 declarative syntax: `USE...AFTER...LABEL PROCEDURE...`, and the syntax: `GO TO MORE-LABELS` are no longer supported.

Option changes

- The following compiler options are new:

  - AFP(*VOLATILE* | *NOVOLATILE*)
  - ARCH(*n*)
  - DISPSIGN(*SEP* | *COMPAT*)
  - HGPR(*PRESERVE* | *NOPRESERVE*)
  - MAXPCF(*nnn*)
  - STGOPT | NOSTGOPT
- The following compiler options are modified:
  - The MDECK option no longer has a dependency on the LIB option, as the compiler behaves as though the LIB option is always enabled.
  - The MIG suboption of the NUMPROC compiler option is no longer supported
  - The compiled-in range checks cannot be disabled at run time using the runtime option CHECK(OFF).
  - Execution of NORENT programs above the 16 MB line is not supported.
  - The HOOK | NOHOOK and SEPARATE | NOSEPARATE suboptions of the TEST compiler option are no longer supported. Those suboptions continue to be tolerated to ease migration. New suboptions SOURCE and NOSOURCE are added to the TEST compiler option.
  - The NOTEST option is enhanced to include the suboptions DWARF and NODWARF.
  - The EXIT compiler option is no longer mutually exclusive with the DUMP compiler option, and the compiler exits rules are updated.
  - The OPTIMIZE option is modified to allow several level of optimization. The previous OPTIMIZE option format is deprecated but is tolerated for compatibility.
  - The format and contents of listing generated from the LIST option are new
  - The format and contents of the listing output generated from the MAP option are changed
- Support for the following compiler options has been removed:
  - DATEPROC
  - LIB
  - SIZE(MAX)
  - YEARWINDOW
  - XMLPARSE

Compiler behavior changes

There have been a number of changes to Enterprise COBOL V5.1 that result in different behaviors.

- AMODE 24 execution of programs compiled with Enterprise COBOL V5.1.0 is no longer supported. Enterprise COBOL V5.1.0 executable modules must be AMODE 31.
- The IGZERRE and ILBOSTP0 interfaces for managing a reusable COBOL environment are not supported for applications containing programs compiled with Enterprise COBOL V5.
- The IGZBRDGE macro, for converting static calls to dynamic calls, is not supported for programs compiled with Enterprise COBOL V5.
- The compatibility-mode COBOL XML parser from the COBOL library, the old parser from Enterprise COBOL V3, is no longer supported for use by Enterprise COBOL V5 programs. XML PARSE statements in V5 programs always use the z/OS System Services XML parser (XMLSS).
- Enterprise COBOL Version 5 now requires Language Environment at compilation time. If the Language Environment data sets SCEERUN and SCEERUN2 are not installed in the MVS LNKLST or LPALST, they must be included in the STEPLIB or JOBLIB concatenation for the compilation.
- Enterprise COBOL Version 5.1 has a new Language Environment member ID, 4. Prior versions of COBOL use ID 5.

- Enterprise COBOL Version 5 programs have some restrictions with interoperability with older versions of COBOL. For details see, "Interoperability with older levels of IBM COBOL programs" on page 21.
- COBOL programs with the following characteristics may behave differently with Enterprise COBOL V5 than with prior versions:
  - Programs that use unsupported COBOL language syntax.
  - Programs referencing data items that, at run time, contain values not conforming to the PICTURE clause on the data description entry. For example:
    - a fullword binary item with picture `S9(6) USAGE BINARY`, containing an oversize value of +123456789 (unless the `TRUNC(BIN)` option was specified)
    - a two-byte PACKED-DECIMAL item with picture S99, containing an oversize value of 123 (such as, 123C in hexadecimal).
    - a packed decimal or zoned decimal item containing an invalid or non-preferred sign, that does not conform to the sign requirements of the data description entry and the NUMPROC(PFD) compiler option setting in effect.
  - Programs with undiagnosed subscript range errors (when the SSRANGE compiler option was not specified), that reference storage outside the storage allocation for the base data item.
  - Applications with low-level dependencies on specific generated code sequences, register conventions, or internal IBM control blocks may behave differently with Enterprise COBOL V5 than with prior versions.
  - It is illegal to specify a value greater than integer-2 for the object of an OCCURS DEPENDING ON clause, and thus the behavior is undefined. However, Enterprise COBOL V5.1 behaves differently than prior versions when it occurs.
- VSAM record areas for reentrant COBOL programs are allocated above 16 MB if `DATA(31)` is enabled. Programs that pass data in VSAM file records as `CALL ... USING BY REFERENCE` parameters to `AMODE 24` subprograms may be impacted. Such programs can be recompiled with the `DATA(24)` compiler option, or the Language Environment `HEAP(BELOW)` option can be used, to ensure that the records are addressable by the `AMODE 24` programs.
- Compile-time storage requirements are substantially increased, compared to prior versions of Enterprise COBOL. See the discussion of the SIZE option. This is particularly true at higher optimization levels, that is, programs compiled with the `OPT(1)` or `OPT(2)` compiler option.
- Compile-time CPU time requirements are substantially increased, compared to prior versions of Enterprise COBOL.
- Compile time and run time diagnostic messages may differ, and may be generated at different times or locations.
  - Presence or absence of informational and warning level diagnostics may differ
  - Diagnostics for programs that define excessive and unsupported amounts of storage may be diagnosed either by the binder at bind time, or by Language Environment at run time, instead of by the compiler at compilation time.
- Compiler listing format and contents differ from prior versions of Enterprise COBOL.

Application performance changes

The `OPTIMIZE` option has been changed to support several levels of performance optimization for your application. The suboptions have also been changed. The previous `OPTIMIZE` option format is deprecated but is tolerated for compatibility.

Note: Although `OPT(0)` is equivalent to the old `NOOPTIMIZE` option in most ways, `OPT(0)` removes some unreachable code that was not previously removed with `NOOPTIMIZE`.

Debugging changes

When the TEST option is specified, DWARF debugging information is included in the application module.

With NOLOAD debug segments in the program object, Enterprise COBOL V5 debug data always matches the executable file, and is always available without giving lists of data sets to search, and does not increase the size of the loaded program.

If you specify the TEST(SOURCE) option, the DWARF debug information includes the expanded source code, and the compiler listing is not needed by IBM Debug Tool. When the TEST(NOSOURCE) is specified, the generated DWARF debugging information does not include the expanded source code.

You can use the NOTEST(DWARF) option to include basic DWARF diagnostic information in the application module. This enables application failure analysis tools, such as CEEDUMP and IBM Fault Analyzer.

Packaging and JCL changes

There have been a number of changes to the packaging, installation and JCL with Enterprise COBOL V5.1.

The SIGYCOMP data set is now a PDSE, rather than a PDS data set as in prior versions.

Enterprise COBOL Version 5.1 requires additional data sets

- When compiling under z/OS TSO or batch, the COBOL compiler now requires 15 utility data sets, SYSUT1 to SYSUT15
- The SYSMDECK data set is now required for all compilations. SYSMDECK may be specified as a utility (temporary) data set if the NOMDECK option is specified. When MDECK(...) is specified, the SYSMDECK DD allocation must specify a permanent data set.
- The alternate DDNAME list parameter used when the COBOL compiler is invoked from an assembly language program has been expanded with entries for the additional work data sets.

The catalogued procedures that ship with Enterprise COBOL Version 5.1 have been modified.

- IGYWC
- IGYWCL
- IGYWCLG

The following JCL catalogued procedures are no longer supported. Because they all use the Language Environment Prelinker or the DFSMS Loader, which are no longer supported.

- IGYWCG
- IGYWCPG
- IGYWCPL
- IGYWCPLG
- IGYWPL

Restrictions

If you use COBOL for IMS exit routines, Enterprise COBOL V5.1 can compile programs only when the exit is an assembler program in a PDS data set that LOADs and calls a COBOL V5.1 program in a PDSE. For workarounds to handle the restriction, see Chapter 22, “Moving IMS programs to Enterprise COBOL V5 or V6,” on page 225.

Changes in IBM Enterprise COBOL for z/OS, Version 4 Release 2

- New and enhanced XML PARSE capabilities are available when you use the z/OS System Services XML parser:
  - You can parse documents with validation against an XML schema when you use the VALIDATING phrase of the XML PARSE statement.
  - The performance of nonvalidating parsing with the XMLPARSE(XMLSS) compiler option is improved compared to the performance of nonvalidating parsing with the XMLPARSE(XMLSS) compiler option in Enterprise COBOL Version 4 Release 1.

  - Character processing is enhanced for any XML document that contains a reference to a character that is not included in the single-byte EBCDIC code page of the document.
- A facility for customizing compiler messages (changing their severity or suppressing them), including FIPS (FLAGSTD) messages, is made possible by a new suboption, MSGEXIT, of the EXIT compiler option.
- A new compiler option, BLOCK0, activates an implicit BLOCK CONTAINS 0 clause for all eligible QSAM files in your program.
- The underscore character (_) is now supported in user-defined words such as data-names and program-names. Underscores are also supported in the literal form of program-names.
- If you use the integrated CICS translator, the compiler listing will now show the CICS options that are in effect.
- Enterprise COBOL applications that use object-oriented syntax for Java interoperability are now supported with Java 5 and Java 6 in addition to the Java SDK 1.4.2.

Changes in IBM Enterprise COBOL for z/OS, Version 4 Release 1

- The XML GENERATE statement has been extended with new syntax that gives the programmer more flexibility and control over the form of the XML document that is generated:
  - The WITH ATTRIBUTES phrase, which causes eligible items in the XML document to be generated as XML attributes instead of as elements.
  - The WITH ENCODING phrase, which allows the user to specify the encoding of the generated document.
  - The WITH XML-DECLARATION phrase, which causes the version and encoding information to be generated in the document.
  - The NAMESPACE and NAMESPACE-PREFIX phrases, which allow generation of XML documents that use XML namespaces.
  - The XML GENERATE statement now supports generation of XML documents encoded in UTF-8 Unicode.
- XML PARSE support has been enhanced:
  - The z/OS System Services XML parser is now supported as an alternative to the existing XML parser that is part of the COBOL library
  - The z/OS System Services XML parser provides the following benefits:
    - Availability of the latest IBM parsing technology for COBOL users.
    - Offloading of COBOL XML parsing to zAAP specialty processors.
    - Improved support for parsing XML documents that use XML namespaces.
    - Direct support for parsing XML documents that are encoded in UTF-8 Unicode.
    - Support for parsing very large XML documents, a buffer at a time.
  - Four new special registers are introduced for namespace processing during execution of XML PARSE statements.
  - The XML PARSE statement has been extended with new syntax. The new WITH ENCODING and RETURNING NATIONAL phrases give the programmer control over the assumed encoding of input XML documents, to facilitate parsing in Unicode.
  - A new compiler option, XMLPARSE, has been created to control whether the z/OS System Services parser or the existing COBOL parser is used for XML PARSE statements. With the XMLPARSE(COMPAT) option, XML parsing is fully compatible with Enterprise COBOL Version 3. With the default XMLPARSE(XMLSS) option, the z/OS System Services parser is used and new XML parsing capabilities are enabled.
- Performance of COBOL application programs has been enhanced by exploitation of new z/Architecture® instructions. The performance of COBOL Unicode support (USAGE NATIONAL data) has been significantly improved.

- DB2 support has been enhanced in this release, including DB2 V9 exploitation and improvements in coprocessor integration and usability:
  - Support for new SQL data types and new SQL syntax provided by DB2 V9
  - DB2 precompiler options are shown in the compiler listing (DB2 V9 only)
  - SQLCA and SQLDA control blocks are expanded in the compiler listing (all DB2 releases)
  - A new compiler option SQLCCSID is provided to coordinate the coded character set id (CCSID) between COBOL and DB2
- Support for DFSMS large-format data sets
- Debugging enhancements:
  - Debug Tool V8 enablement, new debugging commands
  - GOTO/JUMPTO in optimized code, new TEST suboption EJPD
- Compiler options can be specified in a data set (OPTFILE option)
- Cross-reference of COPY statements, libraries, and data sets in compiler listing

Changes in IBM Enterprise COBOL for z/OS, Version 3 Release 4: service updates, November 2006

- PK31411: A new compiler option, SQLCCSID, which works in conjunction with the DB2 coprocessor, determines whether the CODEPAGE compiler option influences the processing of SQL statements in COBOL programs. SQLCCSID was added via APAR PK31411.
- PK16765: Corrections to the behavior of the SEARCH ALL statement have been made.

  With current service applied, specifically the PTF for APAR PK16765, new compiler diagnostic messages and runtime diagnostic messages have been added to assist in identifying programs and SEARCH ALL statements that are potentially impacted by these corrections and may require modification in order to migrate to V3R4. If you have this PTF on your compiler, the listing header and object program will show Version 3 Release 4 Modification 1.

Changes in IBM Enterprise COBOL for z/OS, Version 3 Release 4

- Several limits on COBOL data-item size have been significantly raised, for example:
  - The maximum data-item size has been raised from 16 MB to 128 MB.
  - The maximum PICTURE symbol replication has been raised to 134,217,727.
  - The maximum OCCURS integer has been raised to 134,217,727.

  (For full details about changed compiler limits, see the COBOL Language Reference.) This support facilitates programming with large amounts of data, for example:
  - DB2/COBOL applications that use DB2 BLOB and CLOB data types
  - COBOL XML applications that parse or generate large XML documents
- Support for national (Unicode UTF-16) data has been enhanced. Several additional kinds of data items can now be described implicitly or explicitly as USAGE NATIONAL:
  - External decimal (*national decimal*) items
  - External floating-point (*national floating-point*) items
  - Numeric-edited items
  - National-edited items
  - Group (*national group*) items, supported by the GROUP-USAGE NATIONAL clause
- Many COBOL language elements support the new kinds of UTF-16 data, or newly support the processing of national data:

  - Numeric data with USAGE NATIONAL (national decimal and national floating point) can be used in arithmetic operations and in any language constructs that support numeric operands .
  - Edited data with USAGE NATIONAL is supported in the same language constructs as any existing edited type, including editing and de-editing operations associated with moves.
  - Group items that contain all national data can be defined with the GROUP-USAGE NATIONAL clause, which results in the group behaving as an elementary item in most language constructs. This support facilitates use of national groups in statements such as STRING, UNSTRING, and INSPECT.
  - The XML GENERATE statement supports national groups as receiving data items, and national-edited, numeric-edited of USAGE NATIONAL, national decimal, national floating-point, and national group items as sending data items.
  - The NUMVAL and NUMVAL-C intrinsic functions can take a national literal or national data item as an argument.

  Using these new national data capabilities, it is now practical to develop COBOL programs that exclusively use Unicode for all application data.
- The REDEFINES clause has been enhanced such that for data items that are not level 01, the subject of the entry can be larger than the data item being redefined.
- A new compiler option, MDECK, causes the output from library-processing statements to be written to a file .
- DB2 coprocessor support has been enhanced: XREF is improved.
- The literal in a VALUE clause for a data item of class national can be alphanumeric .

These terminology changes were also made in this release:

- The term *alphanumeric group* is introduced to refer specifically to groups other than national groups.
- The term *group* means both alphanumeric groups and national groups except when used in a context that obviously refers to only an alphanumeric group or only a national group.
- The term *external decimal* refers to both zoned decimal items and national decimal items.
- The term *alphanumeric floating point* is introduced to refer to an external floating-point item that has USAGE DISPLAY.
- The term *external floating point* refers to both alphanumeric floating-point items and national floating-point items.

Changes in IBM Enterprise COBOL for z/OS, Version 3 Release 3

- XML support has been enhanced. A new statement, XML GENERATE, converts the content of COBOL data records to XML format. XML GENERATE creates XML documents encoded in Unicode UTF-16 or in one of several single-byte EBCDIC code pages.
- There are new and improved features of the Debug Tool:
  - Performance is improved when you use COBOL SYSDEBUG files.
  - You can more easily debug programs that use national data: When you display national data in a formatted dump or by using the Debug Tool LIST command, the data is automatically converted to EBCDIC representation using the code page specified in the CODEPAGE compiler option. You can use the Debug Tool MOVE command to assign values to national data items, and you can move national data items to or from group data items. You can use national data as a comparand in Debug Tool conditional commands such as IF or EVALUATE.
  - You can debug mixed COBOL-Java applications, COBOL class definitions, and COBOL programs that contain object-oriented syntax.

  For further details about these enhancements to debugging support, see the *Debug Tool User's Guide*.
- DB2 Version 8 SQL features are supported when you use the integrated DB2 coprocessor.
- The syntax for specifying options in the COBJVMINITOPTIONS environment variable has changed.

Changes in IBM Enterprise COBOL for z/OS and OS/390, Version 3 Release 2

- The compiler has been enhanced to support new features of Debug Tool:
  - Playback support lets you record and replay application execution paths and data values.
  - Automonitor support displays the values of variables that are referenced in the current statement during debugging.
  - Programs that have been compiled with the OPTIMIZE and TEST(NONE,SYM,. . .) options are supported for debugging.
  - The Debug Tool GOTO command is enabled for programs that have been compiled with the NOOPTIMIZE option and TEST option with any of its suboptions. (In earlier releases, the GOTO command was not supported for programs compiled with TEST(NONE, . . .).)

  For further details about these enhancements to debugging support, see the *Debug Tool User's Guide*.
- Extending Java interoperability to IMS : Object-oriented COBOL programs can run in an IMS Java dependent region. The object-oriented COBOL and Java languages can be mixed in a single application.
- Enhanced support for Java interoperability:
  - The OPTIMIZE compiler option is fully supported for programs that contain OO syntax for Java interoperability.
  - Object references of type jobjectArray are supported for interoperation between COBOL and Java.
  - OO applications that begin with a COBOL main factory method can be invoked with the java command.
  - A new environment variable, COBJVMINITOPTIONS, is provided for initializing the Java virtual machine for OO applications that start with a COBOL program.
  - OO applications that begin with a COBOL program can, with some limitations, be bound as modules in a PDSE and run using batch JCL.
- Unicode enhancement for working with DB2: The code pages for host variables are handled implicitly when you use the DB2 integrated coprocessor. SQL DECLARE statements are necessary only for variables described with USAGE DISPLAY or USAGE DISPLAY-1 when COBOL and DB2 code pages do not match.

Changes in IBM Enterprise COBOL for z/OS and OS/390, Version 3 Release 1

- Multithreading support: toleration of POSIX threads and signals, permitting applications with COBOL programs to run on multiple threads within a process
- Interoperation of COBOL and Java by means of object-oriented syntax, permitting COBOL programs to instantiate Java classes, invoke methods on Java objects, and define Java classes that can be instantiated in Java or COBOL and whose methods can be invoked in Java or COBOL
- Ability to call services provided by the Java Native Interface (JNI) to obtain additional Java capabilities, with a copybook JNI.cpy and special register JNIENVPTR to facilitate access
- Basic support for Unicode provided by NATIONAL data type and national (N, NX) literals, intrinsic functions DISPLAY-OF and NATIONAL-OF for character conversions, and compiler options NSYMBOL and CODEPAGE
  - Compiler option CODEPAGE to specify the code page used for encoding national literals, and alphanumeric and DBCS data items and literals
  - Compiler option NSYMBOL to control whether national or DBCS processing should be in effect for literals and data items that use the N symbol
- Basic XML support, including a high-speed XML parser that allows programs to consume inbound XML messages, verify that they are well formed, and transform their contents into COBOL data structures; with support for XML documents encoded in Unicode UTF-16 or several single-byte EBCDIC code pages
- Support for compilation of programs that contain CICS statements, without the need for a separate translation step

  - Compiler option CICS, enabling integrated CICS translation and specification of CICS options
- VALUE clauses for BINARY data items that permit numeric literals to have a value of magnitude up to the capacity of the native binary representation, rather than being limited to the value implied by the number of 9s in the PICTURE clause
- A 4-byte FUNCTION-POINTER data item that can contain the address of a COBOL or non-COBOL entry point, providing easier interoperability with C function pointers
- The following support is no longer provided (as documented in this *Migration Guide*):
  - SOM-based object-oriented syntax and services
  - Compiler options CMPR2, ANALYZE, FLAGMIG, TYPECHK, and IDLGEN
- Changed default values for the following compiler options: DBCS, FLAG(I,I), RENT, and XREF(FULL).

Changes in COBOL for OS/390 & VM, Version 2 Release 2

- Enhanced support for decimal data, raising the maximum number of decimal digits from 18 to 31 and providing an extended-precision mode for arithmetic calculations
- Enhanced production debugging using overlay hooks rather than compiled in hooks, with symbolic debugging information optionally in a separate file
- Support for compiling, linking, and running in the OS/390 UNIX System Services environment, with COBOL files able to reside in the hierarchical file system (HFS)
- Toleration of fork(), exec(), and spawn(); and the ability to call UNIX/POSIX functions
- Enhanced input-output function, permitting dynamic file allocation by means of an environment variable named in SELECT. . . ASSIGN, and the accessing of sequentially organized HFS files including by means of ACCEPT and DISPLAY
- Support for line-sequential file organization for accessing HFS files that contain text data, with records delimited by the new-line character
- COMP-5 data type, new to host COBOL, allowing values of magnitude up to the capacity of the native binary representation
- Significant performance improvement in processing binary data with the TRUNC(BIN) compiler option
- Support for linking of COBOL applications using the OS/390 DFSMS binder alone, with the prelinker required only in exceptional cases under CICS
- Diagnosis of moves (implicit or explicit) that result in numeric truncation enabled through compiler option DIAGTRUNC
- System-determined block size for the listing data set available by specifying BLKSIZE=0
- Limit on block size of QSAM tape files raised to 2 GB
- Support under CICS for DISPLAY to the system logical output device and ACCEPT for obtaining date and time
- Support for the DB2 coprocessor enabled through the SQL compiler option, eliminating the need for a separate precompile step and permitting SQL statements in nested programs and copybooks
- Support for the millennium language extensions now included in the base COBOL product

Changes in COBOL for OS/390 & VM V2 R1 Modification 2

- New compiler option ANALYZE to check the syntax of embedded SQL and CICS statements
- Extension of the ACCEPT statement to cover the recommendation in the Working Draft for Proposed Revision of ISO 1989:1985 Programming Language COBOL
- New intrinsic date functions to convert to dates with a four-digit year
- The millennium language extensions, enabling compiler-assisted date processing for dates containing two-digit and four-digit years

Requires IBM VisualAge® Millennium Language Extensions for OS/390 & VM (program number 5648-MLE) to be installed with your compiler.

Changes in COBOL for OS/390 & VM V2 R1 Modification 1

- Extensions to currency support for displaying financial data, including:
  - Support for currency signs of more than one character
  - Support for more than one type of currency sign in the same program
  - Support for the euro currency sign, as defined by the Economic and Monetary Union (EMU)

Changes in COBOL for OS/390 & VM, Version 2 Release 1

- Support has been added for dynamic link libraries (DLLs)
- Due to changes in the SOMobjects product that is delivered with OS/390 Release 3, changes in the JCL for building object-oriented COBOL applications were required.
- The INTDATE compiler option is no longer an installation option only. It can now be specified as an option when invoking the compiler.

How to send your comments

Your feedback is important in helping us to provide accurate, high-quality information. If you have comments about this information or any other Enterprise COBOL documentation, send your comments to: compinfo@cn.ibm.com.

Be sure to include the name of the documentation, the publication number of the documentation, the version of Enterprise COBOL, and, if applicable, the specific location (for example, page number) of the text that you are commenting on.

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Part 1. Overview

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Chapter 1. Introducing the new compiler and run time

This section provides an overview of the Enterprise COBOL compiler (IBM Enterprise COBOL for z/OS), and the common run time (Language Environment) and introduces you to the terminology used throughout this information.

Enterprise COBOL Version 5 or Version 6 executables are Program Objects and can reside only in PDSE data sets. If your COBOL load libraries are in PDS data sets, copy the member to PDSE data sets and use PDSE data sets for your load libraries. IBM recommends that you allocate your PDSE load library data sets with RECFM=U, DSNTYPE=LIBRARY, and VERSION=2, and leave all the other attributes blank, like this in ISPF:

```
Record format . . . . U
Record length . . . .
Block size  . . . . .
Data set name type    LIBRARY
Data set version  . : 2
```

This manual assumes that you have completed your runtime migration to Language Environment. What does this mean? Briefly these are the conditions to be met before a COBOL runtime migration is complete:

- The Language Environment data set SCEERUN is installed in LNKLST or LPALST.
- There are no instances of COBLIB, VSCLLIB, or COB2LIB in LNKLST or LPALST.
- There are no instances of COBLIB, VSCLLIB, or COB2LIB in JCL STEPLIB or JOBLIB statements or in CICS startup JCL.
- All statically bound runtime library routines for programs that are compiled with NORES have been REPLACEd with routines from Language Environment.
- IGZEBST bootstrap modules for VS COBOL II programs that are compiled with RES were either linked with the VS COBOL II runtime version of IGZEBST that has APAR PN74000 applied, or IGZEBST was REPLACEd with IGZEBST from Language Environment.

If you understand these conditions, but your shop has not completed its runtime library migration, you must complete that migration before using this book. You can use the *Enterprise COBOL V4.2 Compiler and Runtime Migration Guide* at http://publibfp.dhe.ibm.com/epubs/pdf/igy3mg50.pdf for help in completing your migration to Language Environment.

Using Language Environment with Enterprise COBOL V5 or V6 and VS COBOL II programs

When running a mixture of VS COBOL II programs and Enterprise COBOL V5 or V6 programs:

- A current version of IGZEBST is required:
  - For statically CALLed programs in CICS, you will need to replace IGZEBST in applications with VS COBOL II programs with the IGZEBST from LE with the PTFs for APAR PI33330 installed.

    Note: IGZEBST from LE with the PTFs for APAR PI33330 installed can also be used with any COBOL programs VS COBOL II and later without COBOL V5 or V6 programs.
  - For dynamically CALLed CICS programs, you just need to install the PTFs for APAR PI25079 on SCEERUN.

    Note: For statically CALLed programs in non-CICS, performance will be better if you replace IGZEBST in applications with VS COBOL II programs with the IGZEBST from LE with the PTFs for APAR PI33330 installed. It is not required. There is no issue with IGZEBST for dynamically called programs in non-CICS for calling VS COBOL II programs from COBOL V5 or V6 programs.

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- A current version of CEEBETBL, the Language Environment externals table, is required. If you are including object code bound some time ago with your new COBOL V5 or V6 object code, you might be indirectly including an old version of CEEBETBL.

  If the length of CEEBETBL you bind is less than x'28' (or the length of the CEEBETBL in the current SCEELKED library), it is old and needs to be replaced, or you will encounter runtime abends or a terminating runtime message.

  If you rebind older object code with COBOL V5 or V6 as part of your migration, it is recommended that you specifically INCLUDE a current copy of CEEBETBL prior to INCLUDEs of the older object code, taking care that you do not inadvertently make CEEBETBL the entry point.

If you understand these conditions, and meet them all, you can skip to Chapter 5, “Planning to upgrade source programs,” on page 29.

If you do not understand these conditions, then please continue reading these overview chapters. If you then discover that your shop has not completed its runtime library migration, use the *Enterprise COBOL V4.2 Compiler and Runtime Migration Guide* at http://publibfp.dhe.ibm.com/epubs/pdf/igy3mg50.pdf for help in completing your runtime library migration.

This section provides an overview of the Enterprise COBOL compiler (IBM Enterprise COBOL for z/OS), and the common run time (Language Environment) and introduces you to the terminology used throughout this information. This section includes the following information:

- Product relationships: compiler, run time, debug
- Comparison of COBOL compilers
- Language Environment's runtime support for different compilers
- Advantages of the new compiler and run time
- Changes with the new compiler and run time
- General conversion tasks

See “Summary of changes to the COBOL compilers” on page xxvi for further details.

Product relationships: compiler, runtime library, debug

IBM Enterprise COBOL for z/OS is IBM's strategic COBOL compiler for the zSeries platform. Enterprise COBOL is comprised of features from IBM COBOL, VS COBOL II, and OS/VS COBOL with additional features such as multithread enablement, Unicode, XML capabilities, object-oriented COBOL syntax for Java interoperability, integrated CICS translator, and integrated DB2 coprocessor. Enterprise COBOL, as well as IBM COBOL and VS COBOL II, supports 85 COBOL Standard. Some features such as the CMPR2 compiler option and SOM-based object-oriented COBOL syntax that IBM COBOL supported are not available with Enterprise COBOL.

Language Environment provides a single language runtime library for COBOL, PL/I, C/C++, and FORTRAN. In addition to support for existing applications, Language Environment also provides common condition handling, improved interlanguage communication (ILC), reusable libraries, and more efficient application development. Application development is simplified by the use of common conventions, common runtime facilities, and a set of shared callable services. Language Environment is required to run Enterprise COBOL programs.

Debugging capabilities are provided by Debug Tool. Debug Tool provides significantly improved debugging function over previous COBOL debugging tools, and can be used to debug Enterprise COBOL programs, IBM COBOL programs, VS COBOL II programs running under Language Environment, and other programs including assembler, PL/I, and C/C++.

With OS/VS COBOL and VS COBOL II, the runtime library was included with the compiler. In addition, the debug component was also an optional part of a single COBOL product. In Enterprise COBOL Version 3 Debug Tool was included with the full-function version of the compiler.

With Enterprise COBOL Version 5 and Version 6, the compiler, the debugging component, and the runtime library are all separate, although the runtime library (Language Environment) is included with the z/OS operating system and does not need to be purchased separately.

Comparison of COBOL compilers

Table 4 on page 5 gives an overview of the functions available with the latest releases of OS/VS COBOL, VS COBOL II, COBOL for MVS & VM, COBOL for OS/390 & VM, and shows the new functions available with the Enterprise COBOL compiler.

Table 4. Comparison of COBOL compilers

OS/VS COBOL	VS COBOL II	COBOL for MVS & VM	COBOL for OS/390 & VM	Enterprise COBOL for z/OS
				Support for: XML, Java interoperability under IMS, OO, integrated CICS translator, multithreading, Unicode, generation of JSON texts
			Support for: DLLs, 31 digits, Db2® coprocessor, OS/390 UNIX, Enhanced support for Debug Tool	Support for: DLLs, 31 digits, Db2 coprocessor, OS/390 UNIX, Enhanced support for Debug Tool
		Extensions for: Object-oriented COBOL, C interoperability, Intrinsic functions, Amendment to '85 Std, Support for: Language Environment Debug Tool	Extensions for: Object-oriented COBOL, C interoperability, Intrinsic functions, Amendment to '85 Std, Support for: Language Environment Debug Tool	Extensions for: C interoperability, Intrinsic functions, Amendment to 85 COBOL Standard, Support for: Language Environment Debug Tool

Table 4. Comparison of COBOL compilers (continued)				
OS/VS COBOL	**VS COBOL II**	**COBOL for MVS & VM**	**COBOL for OS/390 & VM**	**Enterprise COBOL for z/OS**
	85 COBOL Standard, No intrinsic functions, Structured programming, DBCS National language, Improved CICS interface, 31-bit addressing, Reentrancy, Fast Sort Optimizer, Interactive debugging (full-screen mode)	85 COBOL Standard, Structured programming, DBCS National language, Improved CICS interface, 31-bit addressing, Reentrancy, Fast Sort Optimizer, Interactive debugging (full-screen mode)	85 COBOL Standard, Structured programming, DBCS National language, Improved CICS interface, 31-bit addressing, Reentrancy, Fast Sort Optimizer, Interactive debugging (full-screen mode)	85 COBOL Standard, Structured programming, DBCS National language, Improved CICS interface, 31-bit addressing, Reentrancy, Fast Sort Optimizer, Interactive debugging (full-screen mode)
74 COBOL Standard, 74 STD FIPS flagging, Dynamic loading, Batch debugging, Interactive debugging (line mode)	COBOL 74 compatibility, 85 STD FIPS flagging, Dynamic loading, Batch debugging, Interactive debugging	COBOL 74 compatibility, 85 STD FIPS flagging, Dynamic loading, Batch debugging, Interactive debugging	COBOL 74 compatibility, 85 STD FIPS flagging, Dynamic loading, Batch debugging, Interactive debugging	85 STD FIPS flagging, Dynamic loading, Batch debugging, Interactive debugging

For a complete list of host versions and releases, see the *Licensed Program Specifications* for Language Environment and for the compiler that you are using.

Language Environment's runtime support for different compilers

The OS/VS COBOL runtime library provided support for only OS/VS COBOL programs. Assembler programs could be included, but not VS COBOL II programs.

The VS COBOL II runtime library provided support for both OS/VS COBOL and VS COBOL II programs. Assembler programs could also be included.

Language Environment provides support for OS/VS COBOL programs, and VS COBOL II programs, as well as IBM COBOL and Enterprise COBOL programs. In addition, Language Environment provides support for other high-level languages, including PL/I, C/C++ and Fortran. Like its predecessors, assembler programs can be included in applications that run under Language Environment

Different versions of Enterprise COBOL have different minimum release level requirements for Language Environment. For example, Enterprise COBOL for z/OS, Version 4.2 required a minimum level of z/OS Version 1 Release 9; Enterprise COBOL for z/OS, Version 5.1 and 5.2 requires a minimum level of z/OS Version 1 Release 13; Enterprise COBOL for z/OS, Version 6.1 requires a minimum level of z/OS Version 2 Release 1.

Advantages of the new compiler and run time

The Enterprise COBOL compiler and Language Environment run time provide additional functions over OS/VS COBOL, VS COBOL II, and IBM COBOL. Table 5 on page 7 lists the advantages of the new compiler and run time and indicates whether they apply to VS COBOL II, OS/VS COBOL, IBM COBOL, or all three.

Table 5. Advantages of Enterprise COBOL and Language Environment

Advantage	Notes	Advantage over		
		OS/VS COBOL	VS COBOL II	IBM COBOL
XML support	Enterprise COBOL provides new statements for parsing and generating XML documents. These statements allow programs to transform XML content into COBOL data structures and COBOL data structures into XML documents.	X	X	X
Java interoperation	Enterprise COBOL includes object-oriented COBOL syntax that enables COBOL to interoperate with Java. This Java interoperation is also supported under IMS.	X	X	X
Support to run in multiple threads	Enterprise COBOL has a toleration level of support for POSIX threads and signals. With Enterprise COBOL, an application can contain COBOL programs running on multiple threads within a process.	X	X	X
Support for Unicode	The COBOL Unicode support uses the product *z/OS Support for Unicode*.	X	X	X
Improved DB2 function	Enterprise COBOL includes support for DB2 stored procedures.	X	X	
	Support for the DB2 coprocessor	X	X	*
Improved CICS function	Enterprise COBOL includes CALL statement support (for faster CICS performance than when using EXEC CICS LINK) and eliminates the need for user-coded BLL cells.	X		
	Increased WORKING-STORAGE space for DATA(24) and DATA(31) programs. For DATA(31), the limit is 2GB. For DATA(24), the limit is the available space below the 16-MB line.	X	X	X
	Support for the Integrated CICS translator	X	X	*
JSON support	Starting in Enterprise COBOL V6.1, support for generation of JSON texts	X	X	
Usability enhancements	These enhancements include: • Large literals in VALUE clauses on COMP-5 items or BINARY items with TRUNC(BIN) • Function-pointer data type • Arguments specifying ADDRESS OF	X	X	X
COBOL language improvements	Ability to perform math and financial functions in COBOL, using Intrinsic Functions. You can replace current routines written in FORTRAN or C with native COBOL code, thus simplifying your application logic.	X	X	
Above-the-line support	Virtual Storage Constraint Relief (VSCR) allows your programs to reside, compile, and access programs below or above the 16-MB line.	X		
	QSAM buffers can be above the 16-MB line for optimal support of DFSMS and data striping.	X	X	
	COBOL EXTERNAL data can now be above the line.	N/A	X	

Table 5. Advantages of Enterprise COBOL and Language Environment (continued)

Advantage	Notes	Advantage over		
		OS/VS COBOL	VS COBOL II	IBM COBOL
31-digit support	Enterprise COBOL added support for numbers up to 31 digits when the ARITH(EXTEND) option is used.	X	X	*
z/OS UNIX system services support	The cob2 command can be used to compile and link COBOL programs in the z/OS UNIX shell. COBOL programs can call most of the C language functions defined in the POSIX standard.	X	X	
Error recovery options	Programmers now have the ability to have application-specific error-handling routines intercept program interrupts, abends, and other software-generated conditions for error recovery. This is done using Enterprise COBOL programs with Language Environment callable services to register the user-written condition handlers. Language Environment handles all condition management.	X	X	
High-precision math routines	Using Language Environment callable services, your programs can return the most accurate results.	X	X	
Support for multiple MVS tasks	RES applications can now execute independently under multiple MVS tasks. (For example, running two Enterprise COBOL programs at the same time from ISPF split screens.)	X	X	
Performance	Faster arithmetic computations	X		
	Faster dynamic and static CALL statements		X	
	Improved performance of variable-length MOVEs		X	
	Faster CICS performance if using the Language Environment CBLPSHPOP runtime option to prevent PUSH HANDLE and POP HANDLE for CALL statements.	X		
	Improved performance for programs compiled with TRUNC(BIN). COBOL for OS/390 & VM Release 2 added support to generate more efficient code when the TRUNC(BIN) compiler option is used.	N/A	X	
Improved ILC	With the common Language Environment library, ILC is improved between COBOL and other Language Environment-conforming languages. For example, interlanguage calls between COBOL and other languages are faster under Language Environment, because there is significantly less overhead for each CALL statement. Additionally, under CICS, you can use the CALL statement to call PL/I or C programs in place of EXEC CICS LINK.	X	X	
Character manipulation	Improved bit and character manipulation using hex literals. Improved flexibility with character manipulation using reference modification	X		
Top-down modular program development	Support for top-down modular program development through nesting of programs and improved CALL and COPY functions	X		

Table 5. Advantages of Enterprise COBOL and Language Environment (continued)

Advantage	Notes	Advantage over		
		OS/VS COBOL	VS COBOL II	IBM COBOL
Structured Programming Support	Support for structured programming coding through: • Inline PERFORM statements • The CONTINUE place-holder statement • The EVALUATE statement • Explicit scope terminators (for example: END-IF, END-PERFORM, END-READ)	X		
85 COBOL Standard conformance	Support for 85 COBOL Standard	X		
	Support for Amendment 1 (Intrinsic Functions Module) of 85 COBOL Standard	X	X	
Subsystem support	Improved support for IMS, ISPF, DFSORT, DB2, WAS	X		
Support for reentrancy	All OS/VS COBOL programs are nonreentrant. Only reentrant programs can be loaded into shared storage (LPA or Shared Segments).	X		
Support for Debug Tool	Debug Tool provides the following benefits: • Interactive debugging of CICS and non-CICS applications • Interactive debugging of batch applications • Full-screen debugging for CICS and non-CICS applications • Debugging of mixed languages in the same debug session • Ability to debug programs that run on the host • Working in conjunction with IBM Developer for z/OS, the ability to debug host programs from the workstation using a graphical user interface	X	X	
	For COBOL for OS/390 & VM and later programs only: • Dynamic Debug feature which allows COBOL programs compiled without hooks to be debugged.	X	X	
	For Enterprise COBOL Version 4 or later programs: • Compiler TEST suboption EJPD enables predictable GOTO/JUMPTO in programs also compiled with a non-zero OPTIMIZE level. **Note:** Unpredictable GOTO/JUMPTO in programs compiled with a non-zero OPTIMIZE level and TEST(NOJEPD) is available with the Debug Tool SET WARNING OFF command.	X	X	X

Table 5. Advantages of Enterprise COBOL and Language Environment (continued)

Advantage	Notes	Advantage over		
		OS/VS COBOL	VS COBOL II	IBM COBOL
Runtime options	ABTERMENC and TERMTHDACT- allow you to control error behavior.	X	X	
	CBLQDA - allows you to control dynamic allocation of QSAM files.		X	
	LANGUAGE - allows you to change language of runtime error messages.	X		
	RPTSTG - allows you to obtain storage usage reports.	X		
	Storage options - allow you to control where storage is obtained and the amount of storage used.	X	X	
Compiler options for Enterprise COBOL Version 6	The following compiler options are available to Enterprise COBOL Version 6 programs only. For details about those changes, see "Compiler option changes in Enterprise COBOL V6" on page 167. • `INLINE|NOINLINE` • `NUMCHECK | NONUMCHECK` • `SSRANGE(MSG|ABD)` • `SUPPRESS | NOSUPPRESS` • `VSAMOPENFS(COMPAT|SUCC)` **Note:** • The `INLINE|NOINLINE`, `NUMCHECK` and `SSRANGE(MSG|ABD)` options are available in Enterprise COBOL V6.1 with the service PTFs.	X	X	X
Compiler options for Enterprise COBOL Version 5 and Version 6	There have been many changes to compiler options and suboptions for Enterprise COBOL Version 5 and Version 6. For details about those changes, see "Compiler option changes in Enterprise COBOL Version 5 and Version 6" on page 178.	X	X	X

Table 5. Advantages of Enterprise COBOL and Language Environment (continued)

Advantage	Notes	Advantage over		
		OS/VS COBOL	VS COBOL II	IBM COBOL
Compiler options for Enterprise COBOL Version 4	The following compiler options are available to Enterprise COBOL Version 4 programs and later programs only: • XMLPARSE - controls whether the z/OS XML System Services parser or the existing COBOL parser is used for XML PARSE statements. With the XMLPARSE(COMPAT) option, XML parsing is compatible with Enterprise COBOL Version 3. With the XMLPARSE(XMLSS) options, the z/OS System Services parser is used and new XML parsing capabilities are enabled. **Note:** The XMLPARSE option was originally removed in Enterprise COBOL V5.1, but was restored to V5.1 via service and is included in V5.2 and V6. • OPTFILE - controls whether compiler options are read from a data set specified in a SYSOPTF DD statement. • SQLCCSID - controls coordination of the coded character set ID (CCSID) between COBOL and DB2. • BLOCK0 - activates an implicit BLOCK CONTAINS 0 clause for all eligible QSAM files in a program. • MSGEXIT - The MSGEXIT suboption of the EXIT compiler option provides a facility for customizing compiler messages (changing their severity or suppressing them), including FIPS (FLAGSTD) messages.	X	X	X
Compiler options for Enterprise COBOL Version 3	The following compiler options are available to Enterprise COBOL Version 3 and later programs only: • CICS - enables the integrated CICS translator capability and specifies CICS options. NOCICS is the default. • CODEPAGE - specifies the code page used for encoding contents of alphanumeric and DBCS data items at run time as well as alphanumeric, national, and DBCS literals in a COBOL source program. • MDECK(COMPILE, NOCOMPILE) - controls whether output from library processing is written to a file and whether compilation continues normally after library processing and the generation of the output file. • NSYMBOL(NATIONAL, DBCS) - controls the interpretation of the "N" symbol used in literals and picture clauses, indicating whether national or DBCS processing is assumed. • THREAD - indicates that the COBOL program is to be enabled for execution in a Language Environment enclave with multiple POSIX threads or PL/I tasks. The default is NOTHREAD.	X	X	X

Table 5. Advantages of Enterprise COBOL and Language Environment (continued)				
Advantage	**Notes**	**Advantage over**		
		OS/VS COBOL	**VS COBOL II**	**IBM COBOL**
Compiler options for COBOL for OS/390 & VM	The following compiler options are available to COBOL for OS/390 & VM and later programs only: • DLL - enables the compiler to generate an object module that is enabled for Dynamic Link Library (DLL) support. • EXPORTALL - instructs the compiler to automatically export certain symbols when the object deck is link-edited to form a DLL.	X	X	
Compiler options for COBOL for MVS & VM	The following compiler options are available to COBOL for MVS & VM and later programs: • CURRENCY - allows you to define a default currency symbol for COBOL programs. • OPTIMIZE(FULL) - OPTIMIZE with the new suboption of FULL optimizes object programs and provides improved runtime performance over both the OS/VS COBOL and VS COBOL II OPTIMIZE options. The compiler discards unused data items and does not generate code for any VALUE clauses for the discarded data items. • PGMNAME(COMPAT,LONGUPPER,LONGMIXED) controls the handling of program names in relation to length and case. • RMODE(AUTO,24,ANY) - allows NORENT programs to reside above the 16-MB line.	X	X	
* The integrated DB2 coprocessor, integrated CICS translator, and 31-digit support were added as new features to COBOL for OS/390 & VM, Version 2 Release 2.				

Changes with the new compiler and run time

With Enterprise COBOL, you may find that recompiling existing COBOL applications is affected by several areas such as the removal of compiler options, different default compiler options, unsupported SOM-based OO COBOL, and an integrated DB2 coprocessor, and an integrated CICS translator. The following information is a brief description of the removed or improved element and the actions required to ensure compatibility.

CMPR2 compiler option not available

Enterprise COBOL does not provide the CMPR2 compiler option. Existing programs compiled with CMPR2 must be converted to NOCMPR2 (85 COBOL Standard) in order to compile them with Enterprise COBOL.

For additional details, see:

- Chapter 6, “Upgrading OS/VS COBOL source programs,” on page 45
- Chapter 8, “Upgrading VS COBOL II source programs,” on page 89
- Chapter 10, “Upgrading IBM COBOL source programs,” on page 99

FLAGMIG compiler option

Enterprise COBOL V5 and V6 does not provide the FLAGMIG compiler option.

To aid you with migration to Enterprise COBOL V5 or V6, there is a new option in Enterprise COBOL V4.2 , FLAGMIG4, to flag source code syntax-related changes required to move to Enterprise COBOL V5 or V6.

Note: The source code changes for COBOL V5 and V6 are rarely used COBOL language features and do not affect 99% of COBOL users.

For additional details about the FLAGMIG option, see:

- Chapter 6, “Upgrading OS/VS COBOL source programs,” on page 45
- Chapter 8, “Upgrading VS COBOL II source programs,” on page 89
- Chapter 10, “Upgrading IBM COBOL source programs,” on page 99

FLAGMIG4 compiler option

The FLAGMIG4 option helps you migrate to Enterprise COBOL V5 or V6. FLAGMIG4 is available in Enterprise COBOL V4.2 with PTF for APAR PM93450 installed. It is also recommended that you install PTFs for APARs PI12240, PI26838, and PI58762 as these contain updates to the FLAGMIG4 option.

The FLAGMIG4 option identifies language elements in Enterprise COBOL V4 programs that are not supported, or that are supported differently in Enterprise COBOL V5 or V6. The compiler generates a warning diagnostic message for all such language elements.

Note: The source code changes for COBOL V5 and V6 are rarely used COBOL language features and do not affect 99% of COBOL users.

SOM-based object-oriented COBOL not available

Enterprise COBOL does not support SOM-based OO COBOL; however, Enterprise COBOL provides OO syntax to facilitate the interoperation of COBOL and Java programs. The removal of SOM-based OO COBOL from Enterprise COBOL included the removal of the compiler options TYPECHK and IDLGEN because they require SOM to run. Applications utilizing SOM-based OO COBOL must be redesigned to upgrade to Java-based OO COBOL syntax or redesigned as procedural (non-OO) COBOL.

For additional details and compatibility considerations, see “Upgrading SOM-based object-oriented (OO) COBOL programs” on page 136.

Integrated DB2 coprocessor available

Enterprise COBOL provides an integrated DB2 coprocessor that allows the Enterprise COBOL compiler to handle both native COBOL statements and embedded SQL statements in a source program. You can choose to migrate from the separate DB2 precompiler to the integrated DB2 coprocessor, or you can choose to continue using the separate DB2 precompiler.

The SQL compiler option must be specified to enable the DB2 coprocessor to process a COBOL source program that contains SQL statements.

For additional details and compatibility considerations, see Chapter 21, “DB2 coprocessor conversion considerations,” on page 219.

Integrated CICS translator available

Enterprise COBOL provides an integrated CICS translator that allows the Enterprise COBOL compiler to handle both native COBOL statements and embedded CICS statements in a source program. You can choose to migrate from the separate CICS translator to the integrated CICS translator, or to continue using the separate CICS translator.

The CICS compiler option must be specified to enable the CICS translator to process a COBOL source program that contains CICS statements.

For additional details and compatibility considerations, see Chapter 20, “CICS conversion considerations,” on page 213.

Performance of decimal overflows

The optimizer in Enterprise COBOL 6 was designed to truncate values at the earliest opportunity, provided that early truncation would not remove digits that would affect the remainder of a computation. This sometimes allowed the code generator to use smaller data types or avoid generating instructions that would not have any impact on the final result. Truncating in the middle of a computation is often done with packed-decimal instructions on the hardware, which can generate decimal overflows.

Normally, Enterprise COBOL programs do not set or alter the hardware's overflow mask. Without the overflow mask being set, an overflow is suppressed at the hardware level. However, certain COBOL features or other languages in an Interlanguage communication (ILC) application may set the overflow mask so that a hardware exception is not suppressed when an overflow occurs. For details, see *Decimal overflow implications in ILC Applications* in the *Enterprise COBOL Performance Tuning Guide*. When the unsuppressed overflow exception occurs in a COBOL program, the LE condition handler is invoked, and consequently the exception is ignored, as COBOL programs should not overflow. But the time taken to invoke LE and transfer control back to the COBOL program decreases performance.

In addition, for ARCH(10) and ARCH(11) with the availability of the decimal floating point (DFP) facility, the compiler uses the truncation capabilities of these facilities to further improve performance. However, this can lead to more potential overflows than previous architecture levels (of COBOL 4.2 and earlier compilers), and thus lead to performance issues as described above. The changes in COBOL 6 to truncate earlier and using different instructions do not change the behavior of Enterprise COBOL 6 programs compared to Enterprise COBOL 4. The only impact is the possible performance issues, and those only affect ILC applications.

General migration tasks

Depending on your shop's programming environment, you will likely have to complete one or more migration tasks to move to the new compiler and run time.

These tasks include:

- Planning your strategy
- Upgrading your source to Enterprise COBOL
- Adding Enterprise COBOL programs to existing applications

Planning your strategy

Before upgrading your source programs to Enterprise COBOL, develop a conversion strategy. For help in completing your runtime library migration to Language Environment, see the *Enterprise COBOL V4.2 Compiler and Runtime Migration Guide* at http://publibfp.dhe.ibm.com/epubs/pdf/igy3mg50.pdf

Your migration strategy might be to gradually recompile entire existing applications with Enterprise COBOL as needed. You may also decide to recompile individual programs as you go.

Upgrading your source to Enterprise COBOL

The effort required to upgrade your source programs is dependent on the compiler used and the language level used for those programs.

OS/VS COBOL

OS/VS COBOL programs compiled with either LANGLVL(1) or LANGLVL(2) can contain either 68 COBOL Standard or 74 COBOL Standard elements. Conversion is required in order for these programs to compile with Enterprise COBOL. You should use conversion tools to aid in this conversion. For details, see “Converting to 85 COBOL Standard” on page 53.

VS COBOL II

From a conversion standpoint, VS COBOL II and Enterprise COBOL Version 5 or Version 6 have the following language differences:

- Removal of CMPR2 support
- Behavior of some SEARCH ALL statements
- New reserved words
- Simplified TEST compiler option
- Removal of runtime support for SIMVRD
- Removal of support for the format 2 declarative syntax: USE...AFTER...LABEL PROCEDURE..., and the syntax: GO TO MORE-LABELS.

A complete list of reserved words, including those reserved for object-oriented COBOL is included in Appendix B, "COBOL reserved word comparison," on page 241.

If upgrading from VS COBOL II Release 3, there are also three minor language differences due to ANSI interpretation changes. Aside from these small differences, you can compile with Enterprise COBOL without change and receive the same results. For details, see Chapter 8, "Upgrading VS COBOL II source programs," on page 89.

VS COBOL II Release 2 programs are coded to the 74 COBOL Standard as are VS COBOL II programs compiled with the CMPR2 compiler option. The CMPR2 compiler option is not supported by Enterprise COBOL, requiring source conversion for all VS COBOL II Release 1 or 2 programs as well as any VS COBOL II Release 3 or 4 programs that were compiled with CMPR2. Conversion tools can help you upgrade your source programs to 85 COBOL Standard. Details of language differences between CMPR2 and NOCMPR2 are included in "Migrating from the CMPR2 compiler option to NOCMPR2" on page 104.

For details about the conversion tools available to upgrade source programs, see Appendix C, "Conversion tools for source programs," on page 263.

IBM COBOL

Many IBM COBOL programs will compile without change under Enterprise COBOL.

The following programs, however, will need to be upgraded before compiling with Enterprise COBOL:

- Programs compiled with the CMPR2 compiler option
- Programs that have SOM-based object-oriented COBOL syntax
- Programs that use words which are now reserved in Enterprise COBOL
- Programs that have undocumented IBM COBOL extensions
- Programs that contain the format 2 declarative syntax: USE...AFTER...LABEL PROCEDURE..., and optionally the syntax: GO TO MORE-LABELS.

For details, see Chapter 10, "Upgrading IBM COBOL source programs," on page 99.

Enterprise COBOL Version 3

Most Enterprise COBOL Version 3 programs will compile without change under Enterprise COBOL Version 5 or Version 6.

The following programs, however, will need to be upgraded:

- Programs that use words which are now reserved in Enterprise COBOL
- Programs that contain the format 2 declarative syntax: USE...AFTER...LABEL PROCEDURE..., and the syntax: GO TO MORE-LABELS.
- Programs that contain XML PARSE statements.

For details, see Chapter 12, "Upgrading programs from Enterprise COBOL Version 3," on page 143.

Enterprise COBOL Version 4

Most Enterprise COBOL Version 4 programs will compile without change under Enterprise COBOL Version 5 or Version 6.

The following programs, however, will need to be upgraded:

- Programs that use words which are now reserved in Enterprise COBOL
- Programs that contain the format 2 declarative syntax: USE...AFTER...LABEL PROCEDURE..., and the syntax: GO TO MORE-LABELS.
- Programs that contain XML PARSE statements and were compiled with the XMLPARSE(COMPAT) compiler option.

For details, see Chapter 14, "Upgrading from Enterprise COBOL Version 4," on page 155.

Adding Enterprise COBOL programs to existing applications

You can create new Enterprise COBOL programs (or recompile existing programs with Enterprise COBOL) and run them with existing applications under Language Environment.

Note: You should use this Migration Guide only if you have completed the runtime migration to Language Environment. This means that the following conditions have been met:

- The Language Environment data set SCEERUN is installed in LNKLST or LPALST.
- There are no instances of COBLIB, VSCLLIB, or COB2LIB in LNKLST or LPALST.
- There are no instances of COBLIB, VSCLLIB, or COB2LIB in JCL STEPLIB or JOBLIB statements or in CICS startup JCL.
- All statically bound runtime library routines for programs that are compiled with NORES have been REPLACEd with routines from Language Environment.
- IGZEBST bootstrap modules for VS COBOL II programs that are compiled with RES were either linked with the VS COBOL II runtime version of IGZEBST that has APAR PN74000 applied, or IGZEBST was REPLACEd with IGZEBST from Language Environment.

If these steps have not been completed, please first complete all runtime migration activities in the *Enterprise COBOL V4.2 Compiler and Runtime Migration Guide* at http://publibfp.dhe.ibm.com/epubs/pdf/igy3mg50.pdf prior to following the steps here.

When running a mixture of VS COBOL II programs and Enterprise COBOL V5 or V6 programs:

- A current version of IGZEBST is required:
  - For statically CALLed programs in CICS, you will need to replace IGZEBST in applications with VS COBOL II programs with the IGZEBST from LE with the PTFs for APAR PI33330 installed.

    Note: IGZEBST from LE with the PTFs for APAR PI33330 installed can also be used with any COBOL programs VS COBOL II and later without COBOL V5 or V6 programs.
  - For dynamically CALLed CICS programs, you just need to install the PTFs for APAR PI25079 on SCEERUN.

    Note: For statically CALLed programs in non-CICS, performance will be better if you replace IGZEBST in applications with VS COBOL II programs with the IGZEBST from LE with the PTFs for APAR PI33330 installed. It is not required. There is no issue with IGZEBST for dynamically called programs in non-CICS for calling VS COBOL II programs from COBOL V5 or V6 programs.
- A current version of CEEBETBL, the Language Environment externals table, is required. If you are including object code bound some time ago with your new COBOL V5 or V6 object code, you might be indirectly including an old version of CEEBETBL.

  If the length of CEEBETBL you bind is less than x'28' (or the length of the CEEBETBL in the current SCEELKED library), it is old and needs to be replaced, or you will encounter runtime abends or a terminating runtime message.

If you rebind older object code with COBOL V5 or V6 as part of your migration, it is recommended that you specifically INCLUDE a current copy of CEEBETBL prior to INCLUDEs of the older object code, taking care that you do not inadvertently make CEEBETBL the entry point.

When adding Enterprise COBOL programs to existing applications, you must be aware of the following items:

- Restrictions of running programs with certain old COBOL programs
- Acquiring WORKING-STORAGE both above and below the 16-MB line
- Effect of compiler option changes
- Reserved word changes
- Other behavior differences with Enterprise COBOL V5 and V6

For details, see Chapter 18, “Adding Enterprise COBOL Version 5 or Version 6 programs to existing COBOL applications,” on page 201.

Restriction: You cannot mix Enterprise COBOL V5 or V6 programs with:

- OS/VS COBOL programs. You must migrate them to Enterprise COBOL.
- VS COBOL II NORES programs. You must migrate them to Enterprise COBOL.

Chapter 2. Do I need to recompile?

Ideally, programs should be compiled with a supported compiler (currently only IBM Enterprise COBOL for z/OS is supported) and run with a supported runtime library (Language Environment). You can migrate programs gradually, in two stages:

- Stage 1: Runtime migration. You can use the *Enterprise COBOL V4.2 Compiler and Runtime Migration Guide* at http://publibfp.dhe.ibm.com/epubs/pdf/igy3mg50.pdf for help in completing your runtime library migration.
- Stage 2: Compiler migration (you may compile only one or many programs in existing applications)

The remainder of this section explains when and why you might want to migrate your applications (run time or source). It includes the following topics:

Migration basics

The migration process involves compiler migration (recompiling source programs with the new compiler) and might involve a runtime migration (moving your applications to a new runtime library) as well. As part of the migration process, you will also need to do inventory assessment and testing. As stated previously, you are not required to do your recompilation and runtime migration concurrently.

For more details about the migration process, see “General migration tasks” on page 14.

Runtime migration

Every COBOL program requires runtime library routines to execute. With the older compilers OS/VS COBOL and VS COBOL II, there was an option to have the runtime routines statically linked to the load modules (the NORES compiler option) or dynamically accessed at run time (the RES compiler option). Since COBOL/370 V1 in 1991, all COBOL compilers default to the RES behavior.

Moving to Language Environment

If you are starting with load modules consisting of programs that are compiled with the NORES option and link-edited with the OS/VS COBOL runtime library or the VS COBOL II runtime library, then you will need to use REPLACE linkage-editor control statements to replace the existing runtime library routines with the Language Environment versions. If you start with object programs (non-linked), then you just need to link-edit with Language Environment.

Note: If your IGZEBST bootstrap routine from VS COBOL II has PN74000 installed, you do not need to REPLACE this IGZEBST with the Language Environment version of IGZEBST.

If the programs are compiled with the RES option, make the Language Environment library routines available at run time in place of the OS/VS COBOL or VS COBOL II library routines by using LNKLST, LPALST, JOBLIB, or STEPLIB.

Do not make more than one COBOL runtime library available to your applications at run time. For example, there should be one and only one COBOL runtime library, such as SCEERUN for Language Environment, in LNKLST. If you have more than one, you will either get hard-to-find errors or you will have an unused load library in your concatenation. In addition, if you have more than one runtime library in your concatenation, then you have an invalid configuration that is not supported by IBM.

If you have not yet completed your runtime library migration, you must complete that migration before using this book. You can use the *Enterprise COBOL V4.2 Compiler and Runtime Migration Guide* at http://publibfp.dhe.ibm.com/epubs/pdf/igy3mg50.pdf for help in completing your runtime library migration.

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Compiler migration

Compiler migration is not required for most programs and can occur after you have moved your OS/VS COBOL or VS COBOL II programs to run with Language Environment. Compiler migration is required for OS/VS COBOL programs and VS COBOL II programs compiled with NORES.

Source code changes are not required for most programs when recompiling with Enterprise COBOL V5 or V6. Although we recommend recompiling all programs in each application as you migrate to Enterprise COBOL V5 or V6, it is not required. Source code changes will be required for programs that were compiled with OS/VS COBOL or were compiled with a later compiler using the old CMPR2 compiler option.

Compiler migration and recompilation is required for OS/VS COBOL programs and VS COBOL II NORES programs if they are to be called by (or need to call) Enterprise COBOL V5 or V6 programs. Enterprise COBOL V5 and V6 programs can dynamically call (and be dynamically called by) VS COBOL II RES programs.

Compiler migration usually consists of upgrading the source language level that is used (such as from 74 Standard COBOL supported by OS/VS COBOL to 85 Standard COBOL supported by Enterprise COBOL). Compiler migration is also required in a few instances to enable your applications to run under Language Environment.

Many conversion tools exist to aid in upgrading your source code. For details, see Appendix C, “Conversion tools for source programs,” on page 263.

Service support for OS/VS COBOL and VS COBOL II programs

In some cases IBM will continue to provide support for OS/VS COBOL and VS COBOL II programs that run under Language Environment.

IBM will continue to provide service support for the running of programs compiled with the OS/VS COBOL Release 2 and VS COBOL II Release 3 and higher compilers when these programs use the Language Environment runtime library versions of the COBOL library routines with the following exceptions:

- OS/VS COBOL programs running under CICS Transaction Server
- OS/VS COBOL programs interoperating with Enterprise COBOL V5 or V6 programs
- VS COBOL II programs compiled with the NORES option interoperating with Enterprise COBOL V5 or V6 programs

For example, the library routines for OS/VS COBOL programs exist in the OS/VS COBOL, the VS COBOL II, and the Language Environment runtime libraries. OS/VS COBOL programs running with the OS/VS COBOL runtime library or the VS COBOL II runtime library are not supported by IBM Service. If your OS/VS COBOL programs are running using a supported release of the Language Environment runtime library, your programs are supported by IBM Service but they cannot interoperate with Enterprise COBOL V5 or V6 programs. .

In CICS TS (Transaction Server), you can no longer run OS/VS COBOL programs.

Changing OS/VS COBOL programs

Although the OS/VS COBOL compiler is no longer supported, the programs that were generated by it are supported if they are running under Language Environment and not interoperating with Enterprise COBOL V5 or V6 programs. Once you have migrated your runtime library to Language Environment, you can run your source code through a source conversion tool, such as the COBOL and CICS Conversion Aid (CCCA) and then compile using the Enterprise COBOL compiler.

For more information about CCCA, see Appendix C, “Conversion tools for source programs,” on page 263.

Interoperability with older levels of IBM COBOL programs

There are some restrictions for Enterprise COBOL V5 and V6 programs to call or be called by (interoperate with) programs compiled with earlier versions of COBOL.

Enterprise COBOL V5 and V6 programs interoperability

Enterprise COBOL V5 and V6 programs cannot interoperate with OS/VS COBOL or VS COBOL II NORES programs in a single application. A COBOL run unit (Language Environment enclave) that contains an Enterprise COBOL V5 or V6 compiled program must not contain any OS/VS COBOL or VS COBOL II NORES programs.

Note: Run units that contain only COBOL programs compiled with Enterprise COBOL V4 or earlier versions can interoperate with OS/VS COBOL and VS COBOL II NORES programs.

Programs compiled with Enterprise COBOL V5 or V6 can interoperate with programs compiled with VS COBOL II or later, based on the following conditions and CALL types:

- Static calls. Enterprise COBOL V5 or V6 compiled programs can be bound (link-edited) with the following object modules or programs to form a single program object. The programs within the program object can specify static calls to and from each other.
  - Programs that are compiled with VS COBOL II with the RES compiler option
  - Programs that are compiled with any IBM COBOL compiler versions subsequent to VS COBOL II
  - Programs that are compiled with Enterprise COBOL V3 or V4

  Note: Programs that were compiled with VS COBOL II with the NORES compiler option in effect cannot interoperate with programs compiled with Enterprise COBOL V5 or V6.
- Dynamic calls. Program modules that contain programs compiled with VS COBOL II with the RES option, or subsequent versions of COBOL can also interoperate with Enterprise COBOL V5 or V6 program objects by using dynamic CALL statements.
- DLL calls. Program modules that are compiled with earlier versions of COBOL that supported DLL linkage can interoperate with Enterprise COBOL V5 or V6 program objects by using DLL linkage.

Part 2. Migration strategies

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Chapter 3. Compiler upgrade checklist

To upgrade your programs to Enterprise COBOL, use the following checklist.

Do these tasks:

1. If your COBOL executables (load modules or program objects) are in PDS data sets (also known as load libraries), copy the members to PDSE data sets and use PDSE data sets for your load libraries. IBM recommends that you allocate your PDSE load library data sets with RECFM=U, DSNTYPE=LIBRARY, and VERSION=2, and leave all the other attributes blank, like this in ISPF:

   ```
   Record format . . . . U
   Record length . . . .
   Block size  . . . . .
   Data set name type    LIBRARY
   Data set version  . : 2
   ```

2. Complete your runtime migration, which means:
   - The Language Environment data set SCEERUN is installed in LNKLST or LPALST.
   - There are no instances of COBLIB, VSCLLIB, or COB2LIB in LNKLST or LPALST.
   - There are no instances of COBLIB, VSCLLIB, or COB2LIB in JCL STEPLIB or JOBLIB statements or in CICS startup JCL.
   - All statically bound runtime library routines for programs that are compiled with NORES have been REPLACEd with routines from Language Environment.
   - IGZEBST bootstrap modules for VS COBOL II programs that are compiled with RES were either linked with the VS COBOL II runtime version of IGZEBST that has APAR PN74000 applied, or IGZEBST was REPLACEd with IGZEBST from Language Environment.

   When running a mixture of VS COBOL II programs and Enterprise COBOL V5 or V6 programs:

   - A current version of IGZEBST is required:
     - For statically CALLed programs in CICS, you will need to replace IGZEBST in applications with VS COBOL II programs with the IGZEBST from LE with the PTFs for APAR PI33330 installed.

       Note: IGZEBST from LE with the PTFs for APAR PI33330 installed can also be used with any COBOL programs VS COBOL II and later without COBOL V5 or V6 programs.
     - For dynamically CALLed CICS programs, you just need to install the PTFs for APAR PI25079 on SCEERUN.

       Note: For statically CALLed programs in non-CICS, performance will be better if you replace IGZEBST in applications with VS COBOL II programs with the IGZEBST from LE with the PTFs for APAR PI33330 installed. It is not required. There is no issue with IGZEBST for dynamically called programs in non-CICS for calling VS COBOL II programs from COBOL V5 or V6 programs.
   - A current version of CEEBETBL, the Language Environment externals table, is required. If you are including object code bound some time ago with your new COBOL V5 or V6 object code, you might be indirectly including an old version of CEEBETBL.

     If the length of CEEBETBL you bind is less than x'28' (or the length of the CEEBETBL in the current SCEELKED library), it is old and needs to be replaced, or you will encounter runtime abends or a terminating runtime message.

     If you rebind older object code with COBOL V5 or V6 as part of your migration, it is recommended that you specifically INCLUDE a current copy of CEEBETBL prior to INCLUDEs of the older object code, taking care that you do not inadvertently make CEEBETBL the entry point.
3. Ensure that all software and hardware prerequisites as defined in the *Licensed Program Specifications* Enterprise COBOL are satisfied. (Get the *Licensed Program Specifications* from the Enterprise COBOL for z/OS library.)

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4. Install prerequisite PTFs for the Language Environment runtime library on all systems where COBOL programs might be compiled or run, including on all production systems. To find the required PTFs for COBOL V5 and V6, use the FIXCAT feature of SMP/E. See "Prerequisite software and service for Enterprise COBOL Version 5 and Version 6" on page 175.
5. Ensure that all systems on which COBOL will run, and all software that needs to work with COBOL (for example z/OS, Debug Tool, Fault Analyzer, and DB2), are ready for programs compiled with the new COBOL compiler. For CICS, to make CSD setup and DFHRPL setup changes, see Chapter 20, "CICS conversion considerations," on page 213. For a list of APARs, see "Prerequisite software and service for Enterprise COBOL Version 5 and Version 6" on page 175.
6. Save the old COBOL compiler for emergency use.
7. Purchase and install the new Enterprise COBOL compiler.
8. Set up the default compiler options and your library control system options for the new compiler to be compatible with the old compiler. For future reuse, document any customization or set up that you do.
9. Depending on which COBOL compiler you are migrating from, you might need to make COBOL source-code changes. For details, see the topic in the *Upgrading programs* section of this information which applies to your current compiler.
10. The recommended migration strategy for Enterprise COBOL V5 and V6 is to compile each application (group of programs) with COBOL V5 or V6 using INITCHECK, NUMCHECK, PARMCHECK, and SSRANGE, and regression test the application alongside the same application in its current form (that is, compiled with Enterprise COBOL V4 or earlier compilers). If you do not get any INITCHECK, NUMCHECK, PARMCHECK, or SSRANGE errors, and you are sure that you get the same results with the new compiler as with the earlier compilers, recompile with NOINITCHECK, NONUMCHECK, NOPARMCHECK, and NOSSRANGE, and move the application into production. The reason for compiling with INITCHECK, NUMCHECK, PARMCHECK, and SSRANGE is that some customers have found that they have invalid COBOL data that gets different results with COBOL V5 or V6.

    If, after a while, you have not found any INITCHECK, NUMCHECK, PARMCHECK, or SSRANGE errors, then you might consider skipping this step for future migrations. You might not have any invalid data usage. In addition, this step is only recommended for the first time that a program is compiled with V5 or V6. Once you have compiled with V5 or V6, you do not have to worry about migration problems for that program.
11. After all programs have been compiled with the new compiler, uninstall the old compiler. That way, you save license fees!

Chapter 4. Migration recommendations to Enterprise COBOL V5 and V6

Migration to Enterprise COBOL V5 and V6 is more difficult than earlier COBOL compiler migrations (except for the OS/VS COBOL to Enterprise COBOL migration), and it is recommended that you read this section before you migrate to Enterprise COBOL V5 or V6.

Regression tests

The recommended migration strategy for Enterprise COBOL V5 and V6 is to compile each application (group of programs) with COBOL V5 or V6 using INITCHECK, NUMCHECK, PARMCHECK, and SSRANGE, and regression test the application alongside the same application in its current form (that is, compiled with Enterprise COBOL V4 or earlier compilers). If you do not get any INITCHECK, NUMCHECK, PARMCHECK, or SSRANGE errors, and you are sure that you get the same results with the new compiler as with the earlier compilers, recompile with NOINITCHECK, NONUMCHECK, NOPARMCHECK, and NOSSRANGE, and move the application into production. The reason for compiling with INITCHECK, NUMCHECK, PARMCHECK, and SSRANGE is that some customers have found that they have invalid COBOL data that gets different results with COBOL V5 or V6.

Note: You do not have to do this extra testing for programs that have already been compiled with Enterprise COBOL V5 or V6.

Best practices

Instead of treating Enterprise COBOL V5 and V6 like business as usual, consider having a team identified to migrate each application completely, rather than migrating one or two programs at a time. In this way, all programs in an application will be migrated, so that future updates or fixes will not also involve a migration. You can save costs in the long run because more programs can take advantage of the 'million instructions per second (MIPS)' savings with Enterprise COBOL V5 and V6.

Common problems and solutions

Some customers have reported problems caused by 'invalid COBOL data' that cannot be detected by inspecting source code when they migrate to Enterprise COBOL V5 or V6, and the most common problems are as follows:

- Invalid data in numeric USAGE DISPLAY data items
- Parameter/argument size mismatches
- Overpopulated binary data items, with values that have more digits than are defined in the data definitions in programs compiled with TRUNC(STD) or TRUNC(OPT)

To identify these problems more easily, consider the following solutions:

- Always compile with RULES(NOEVENPACK) and DIAGTRUNC.
- Use the "Scanning COBOL programs for compatibility" feature of IBM Developer for z/OS to check parameters and arguments. For details, see Scanning COBOL programs for compatibility.
- Compile with INITCHECK, NUMCHECK, PARMCHECK, and SSRANGE for initial code changes and unit tests.
- Recompile with NOINITCHECK, NONUMCHECK, NOPARMCHECK, and NOSSRANGE for quality assurance tests and production.

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Chapter 5. Planning to upgrade source programs

You can follow a general strategy for upgrading source programs to Enterprise COBOL.

For programs that were compiled with OS/VS COBOL or with VS COBOL II through IBM COBOL with the CMPR2 compiler option, source changes will be necessary before recompiling with Enterprise COBOL V5 or V6. If you have such programs, you can follow a general strategy for upgrading source programs to Enterprise COBOL.

Note: If your programs were compiled with NOCMPR2 or with Enterprise COBOL V3 or V4, no source changes will be necessary (in most cases) to compile with Enterprise COBOL V5 or V6. Go to the appropriate chapters in the "Upgrading programs" part of this manual.

The following tasks are necessary, and should be performed in roughly the following order:

1. Preparing to upgrade your source
2. Taking an inventory of your applications
3. Prioritizing your applications
4. Setting up a conversion procedure
5. Making application program updates

Because of the loss of service support for older COBOL compilers, you should eventually upgrade all of your COBOL source programs. Although this is not an immediate requirement, at some future date the older compilers and any supported fixes will not be available. At that point, you will be forced to do a 'quick' migration, and this might be at a very inconvenient time.

Preparing to upgrade your source

In preparing to upgrade your source to Enterprise COBOL, you need to perform the following tasks, which can be done concurrently:

- Installing Enterprise COBOL
- Assessing storage requirements
- Deciding which conversion tools to use
- Educating your programmers on new compiler features

Installing Enterprise COBOL

If you haven't already done so, install the compiler; see the *Program Directory for Enterprise COBOL*. (Get the *Program Directory for Enterprise COBOL* from the Enterprise COBOL for z/OS library.) Be sure to set your default compiler options in Enterprise COBOL Version 5 or Version 6 to the same installation default settings that you used with earlier compilers.

Assessing storage requirements

You can load most of the Enterprise COBOL compiler above the 16 MB line. In addition, Enterprise COBOL object programs execute in 31-bit addressing mode and can reside above the 16-MB line, which frees storage below the 16 MB line. You can use the freed storage for programs or data that must reside below the 16-MB line.

During conversion, you will need DASD storage for your current COBOL compilers as well as for the Enterprise COBOL compiler. When you have completed conversion, and if you have upgraded all of your OS/VS COBOL, VS COBOL II, or IBM COBOL programs to Enterprise COBOL, you will be able to free the storage reserved for your current COBOL compiler.

The program object produced from the same source code when compiled with Enterprise COBOL V5 or V6 will be larger than the load module produced when compiled with all earlier versions of COBOL.

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Deciding which conversion tools to use and install them

If you use the available conversion tools, you will find that upgrading can be a very simple procedure. The following conversion tools can help in upgrading your source programs to Enterprise COBOL programs:

COBOL Conversion Tool (CCCA)
The COBOL and CICS/VS Command Level Conversion Aid (CCCA) automatically converts your old COBOL source programs, either OS/VS COBOL, VS COBOL II, or IBM COBOL with CMPR2, into 85 COBOL Standard code that you can compile with Enterprise COBOL. It also provides you with reports of the statements that were changed. CCCA is included with the IBM Debug Tool product.

For more information about CCCA, see Appendix C, "Conversion tools for source programs," on page 263.

OS/VS COBOL MIGR compiler option
The MIGR option identifies source statements that need to be converted to compile under Enterprise COBOL.

CMPR2, FLAGMIG, and NOCOMPILE compiler options

The COBOL CMPR2, FLAGMIG, and NOCOMPILE options identify source statements that need to be converted to compile under Enterprise COBOL. The CMPR2 and FLAGMIG options are not available in Enterprise COBOL, but you can use your older compilers with these options to flag the statements that need to be changed in order to compile with Enterprise COBOL.

Enterprise COBOL V4.2 FLAGMIG4 compiler option
A new compiler option, FLAGMIG4, is available with APAR PM93450 for Enterprise COBOL V4.2 to help you migrate to Enterprise COBOL V5 or V6. The FLAGMIG4 option identifies language elements in Enterprise COBOL V4 programs that are not supported, or that are supported differently in Enterprise COBOL V5 or V6. The compiler generates a warning diagnostic message for all such language elements.

Note: The source code changes for COBOL V5 and V6 are rarely used COBOL language features and do not affect 99% of COBOL users.

Another conversion tool you might want to use is COBOL Report Writer Precompiler. It enables you to either continue using Report Writer code or convert your Report Writer code to non-Report Writer code. The Report Writer Precompiler is product number 5798-DYR.

These conversion tools are fully described in Appendix C, "Conversion tools for source programs," on page 263.

If you plan to use CCCA or COBOL Report Writer Precompiler, install it at this time. For installation instructions, see the documentation for the conversion tool(s) you plan to use.

Educating your programmers on new compiler features

Early in the conversion effort, ensure that your application programmers are familiar with the features of Enterprise COBOL and the relationship and interdependencies between Enterprise COBOL, Language Environment, and Debug Tool and any other application productivity tools your shop uses.

In addition to source language differences between Standard COBOL 68, Standard COBOL 74, and Standard COBOL 85, your programmers will need to be familiar with Language Environment condition handling and Language Environment callable services.

For information about Enterprise COBOL and Language Environment education available through IBM, you can call 1-800-IBM-TEACH (1-800-426-8322). You can also get information directly from Language Environment publications or technical conferences such as SHARE, www.share.org.

After your programmers are familiar with Enterprise COBOL features, they can assist you in taking the inventory of programs as described in "Taking an inventory of your applications" on page 31.

Taking an inventory of your applications

In planning the upgrade to Enterprise COBOL, you need to take a comprehensive inventory of applications in which you have programs that you intend to compile with Enterprise COBOL.

The Debug Tool Load Module Analyzer can determine the language translator that was used for each object in your program objects. See “Debug Tool Load Module Analyzer” on page 270 for more information.

The free and open source COBOL Analyzer can provide assistance in taking an inventory of your existing program objects by reporting the compiler, compiler release, and compiler options used. See “Free and open source COBOL Analyzer” on page 270 for more information.

Language Environment can help you find out whether you are ever running OS/VS COBOL programs from your inventory. Install the fix for APAR PM86742 to your Language Environment and look for one of these warning messages about detected OS/VS COBOL programs at run time:

Note: For your programs to continue running after the following warning messages have been issued, you must be running with the TRAP(ON) runtime option. For details, see TRAP in the *z/OS Language Environment Programming Reference*.

IGZ0268W
An invocation was made of OS/VS COBOL program "program-name".

IGZ0269W
"program-lang" version "program-version" program "program-name" made a call to OS/VS COBOL program "program-name".

Rational® Asset Analyzer for z/OS can aid by analyzing the impact of a code change for an application. See “IBM Application Discovery and Delivery Intelligence” on page 267 for more information.

Taking an inventory of vendor tools, packages, and products

Before you can begin upgrading your source, you must know whether your vendor tools, packages, and products are designed to work with Enterprise COBOL. Verify:

- COBOL code generators generate 85 COBOL Standard programs that can be compiled with Enterprise COBOL.
- COBOL packages are written in 85 COBOL Standard language that can be compiled with Enterprise COBOL.
- Third-party tools such as debuggers and databases support Enterprise COBOL.

Taking an inventory of COBOL applications

For each program in your COBOL applications, include at least the following information in your inventory:

For all previous versions of COBOL:

- Programmer responsible
- COBOL Standard level of source program (68, 74, 85)
- Compiler used (ANS COBOL V4, OS/VS COBOL, VS COBOL II, IBM COBOL, Enterprise COBOL V3, Enterprise COBOL V4)
- Compiler options used, especially CMPR2, NORES, XMLPARSE
- Precompiler options used
- Postprocessing options used
- COBOL modules
- COPY library members used in COBOL programs
- Called subprograms
- Calling programs

- Frequency of execution
- Test cases required and available
- Programs containing Report Writer statements
- Use of SIMVRDS, SOM-based OO, Millennium Language Extensions, or LABEL declaratives

This information is useful to you in the next step of your planning task, “Prioritizing your applications” on page 32.

Prioritizing your applications

Using the complete inventory, you can now prioritize the conversion effort as described below.

1. Assign complexity ratings to each item in your completed inventory and determine each program or application's resulting overall complexity rating.
2. Determine the conversion priority of each program or application.

Assigning complexity ratings

Complexity ratings are defined based on the effort required to convert, test, and coordinate a construct or program. The ratings used in Table 6 on page 33 are defined as:

Complexity rating	Requirement
0	All code converted by CCCA without error; code compiles correctly under Enterprise COBOL
1-3	Most code converted without error by CCCA Requires moderate testing Requires moderate coordination Most code converted without error by CCCA
4	Requires CCCA and possible manual conversion Requires special testing considerations
5-6	Requires moderate to high degree of coordination Requires moderate to high degree of testing for functional equivalence Requires conversion in addition to CCCA (manual or automated)
7-8	Requires high degree of coordination Requires high degree of testing for functional equivalence
9	Requires very high degree of coordination Requires very high degree of testing for functional equivalence
10	Requires rewrite of module

Based on the complexity ratings shown above (or your own defined complexity ratings), you can now assign a complexity rating to each attribute within a program. Use the highest complexity rating listed as the overall rating for that program. For an application, the highest complexity rating that you assign for any program within the application is the complexity rating for the entire application.

Table 6 on page 33 shows estimated complexity ratings for conversions of specific program attributes.

Table 6. Complexity ratings for program attribute conversions

Program attribute	Description of attribute	Complexity rating		
Lines of source code	1000 or less	0		
	5000 to 10,000	3		
	10,000 to 20,000 +	5		
Fixed file attribute mismatch (FS 39)[1]		4		
VS COBOL II or later compiled with CMPR2	Compiler option CMPR2 not supported	1		C
74 COBOL Standard COPY library members		1	M	C
ANS COBOL V4 COPY library members	1 to 10	2	M	C
	10 to 20	5	M	C
	20 +	6	M	C
Stability	Program with no plans for changes	0		
	Program changes twice a year	3		
	Program changes every month or more often	8+		
Files accessed	1 to 3	1	M	C
	3 to 5	2	M	C
	6 +	3	M	C
No source code for module	Module needs rewrite	10[2]		
	Module does not need to be upgraded	6		
CICS macro level program		10		
Compiled by Full ANS COBOL V4 compiler (pre- compiler)		4		C
Compiled by OS/VS COBOL Release 2 compiler	LANGLVL(2) no manual changes	1	M	C
	LANGLVL(1) no manual changes	1	M	C
	LANGLVL(2) manual changes	4	M	C
	LANGLVL(1) manual changes	4	M	C
Uses language with changed results	Complex OCCURS DEPENDING ON	4		C
	Combined abbreviated relation conditions	6	M	
	Floating-point arithmetic	6	M	
	Exponentiation	6	M	
	Signed data	2		
	Binary data	2		
Access methods used	ISAM[3]	10	M	C
	BDAM	10		C[4]
	TCAM	10		

Table 6. Complexity ratings for program attribute conversions (continued)

Program attribute	Description of attribute	Complexity rating		
Uses Report Writer language (if not using Report Writer Precompiler)		6	M	C
Uses Report Writer language (if using Report Writer Precompiler)		0		
CICS		4		
SIMVRD		3		
SOM-based OO		8		
LABEL declaratives		3		
XMLPARSE(COMPAT)		7		

1. For additional information, see Appendix G, “Preventing file status 39 for QSAM files,” on page 305.
2. Non-IBM vendors can recreate COBOL source code from object code.
3. Support for ISAM was removed with z/OS 1.7.
4. This is a partial conversion.

On categories marked **M** you can gather information using the OS/VS COBOL MIGR option. On categories marked **C** you can gather information using the COBOL conversion tool (CCCA).

Determining conversion priority

After you have determined the complexity rating for each program in your inventory, you can make informed decisions about the programs that you want to upgrade, and the order in which you want to upgrade them.

Table 7 on page 34 shows one method of relating program complexity ratings to conversion priorities. (The highest priority is “1” and the lowest priority is “6”.)

Table 7. Assigning program conversion priorities

Conversion priority	Complexity rating	Other considerations
1	0 to 3	Great importance to your organization Low conversion effort using conversion tools
2	4 to 6	Great importance to your organization Medium conversion effort using conversion tools
	0 to 3	Medium importance to your organization Low conversion effort using conversion tools

Table 7. Assigning program conversion priorities (continued)

Conversion priority	Complexity rating	Other considerations
3	7 to 8	Great importance to your organization High conversion effort using conversion tools
	3 to 6	Medium importance to your organization Medium conversion effort using conversion tools
	0 to 3	Small importance to your organization Low conversion effort using conversion tools
4	9 to 10	Great importance to your organization Very high conversion effort
	7 to 8	Medium importance to your organization High conversion effort using conversion tools
	3 to 6	Small importance to your organization Medium conversion effort using conversion tools
5	9 to 10	Medium importance to your organization Very high conversion effort
	7 to 8	Small importance to your organization High conversion effort using conversion tools
6	9 to 10	Small importance to your organization Very high conversion effort

Consider the following situations when deciding on conversion priorities:

- If your application is at the limits of the storage available below the 16-MB line, it is a prime candidate for conversion to Enterprise COBOL. With z/OS architecture you can obtain virtual storage constraint relief.

After you determine the priority of each program that you need to upgrade and the effort required to upgrade those programs, you can decide the order in which you want to convert your applications and programs.

There might be some programs that you do not want to convert at all, such as:

- Programs for which you have no source code, that will never need recompilation, and that run correctly under Language Environment
- Programs of low importance to your organization that run correctly under Language Environment and that would take a very high conversion effort
- Programs that are being phased out of production

Note, however, that there might be restrictions on running existing modules mixed with upgraded programs. See Chapter 18, “Adding Enterprise COBOL Version 5 or Version 6 programs to existing COBOL applications,” on page 201.

Setting up a conversion procedure

The summaries and diagrams on the following pages outline the steps required to upgrade five types of programs:

- Programs without CICS or Report Writer
- Programs converted to structured programming code
- Programs with CICS
- Programs with Report Writer statements to be discarded
- Programs with Report Writer statements to be retained

In the following flowcharts, you are directed to manually upgrade your programs if you are not using CCCA. If you do not want to use CCCA, you should consider using a non-IBM vendor's conversion tool before attempting a manual conversion.

Programs without CICS or Report Writer

To convert an OS/VS COBOL program that contains neither CICS commands nor Report Writer statements to an Enterprise COBOL program, do the steps shown in the flowchart below.

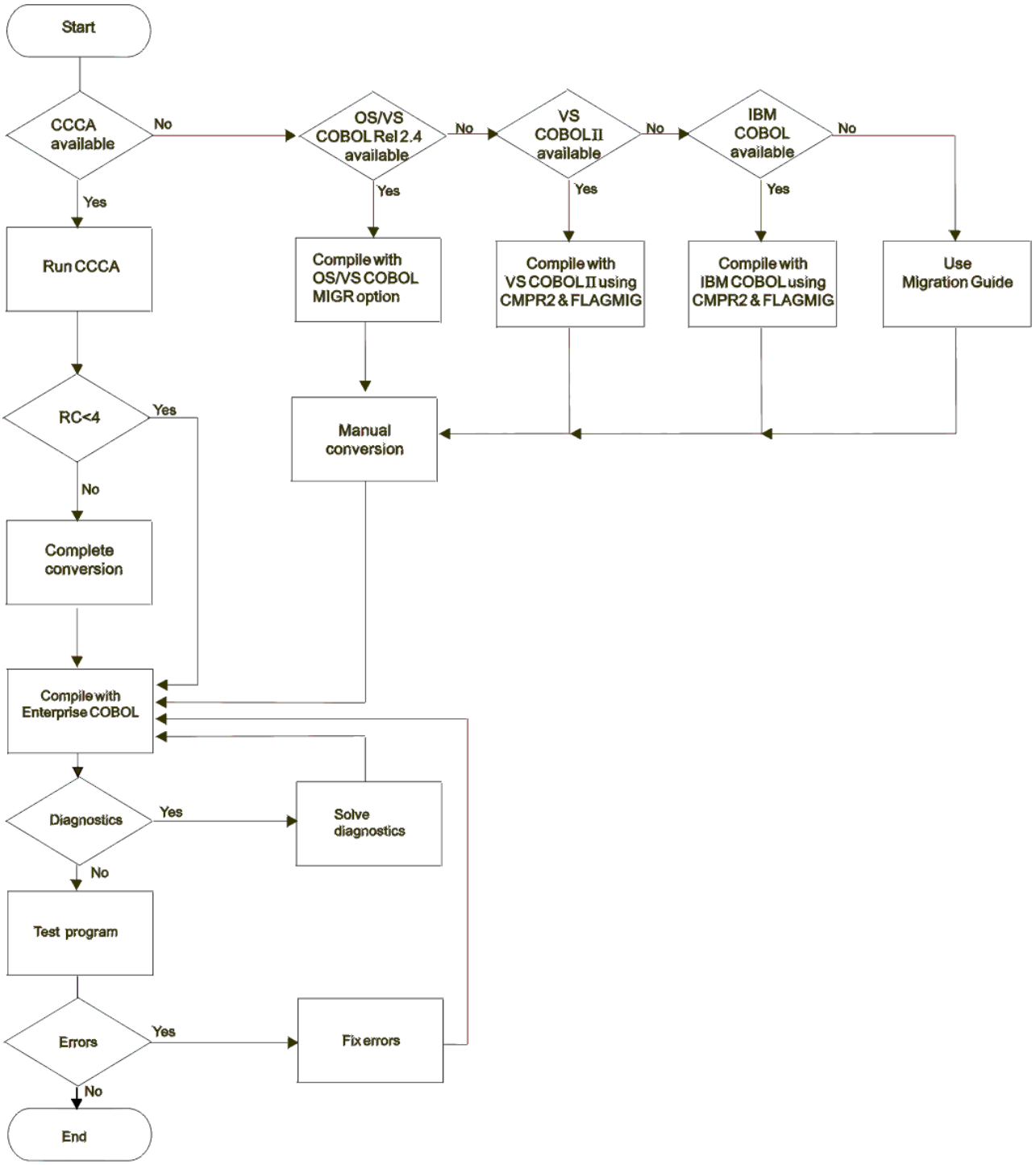

Figure 1. Steps for converting an OS/VS COBOL program to an Enterprise COBOL program

Programs with CICS

To convert an OS/VS COBOL program that contains CICS commands to an Enterprise COBOL program, do the steps shown in the flowchart below.

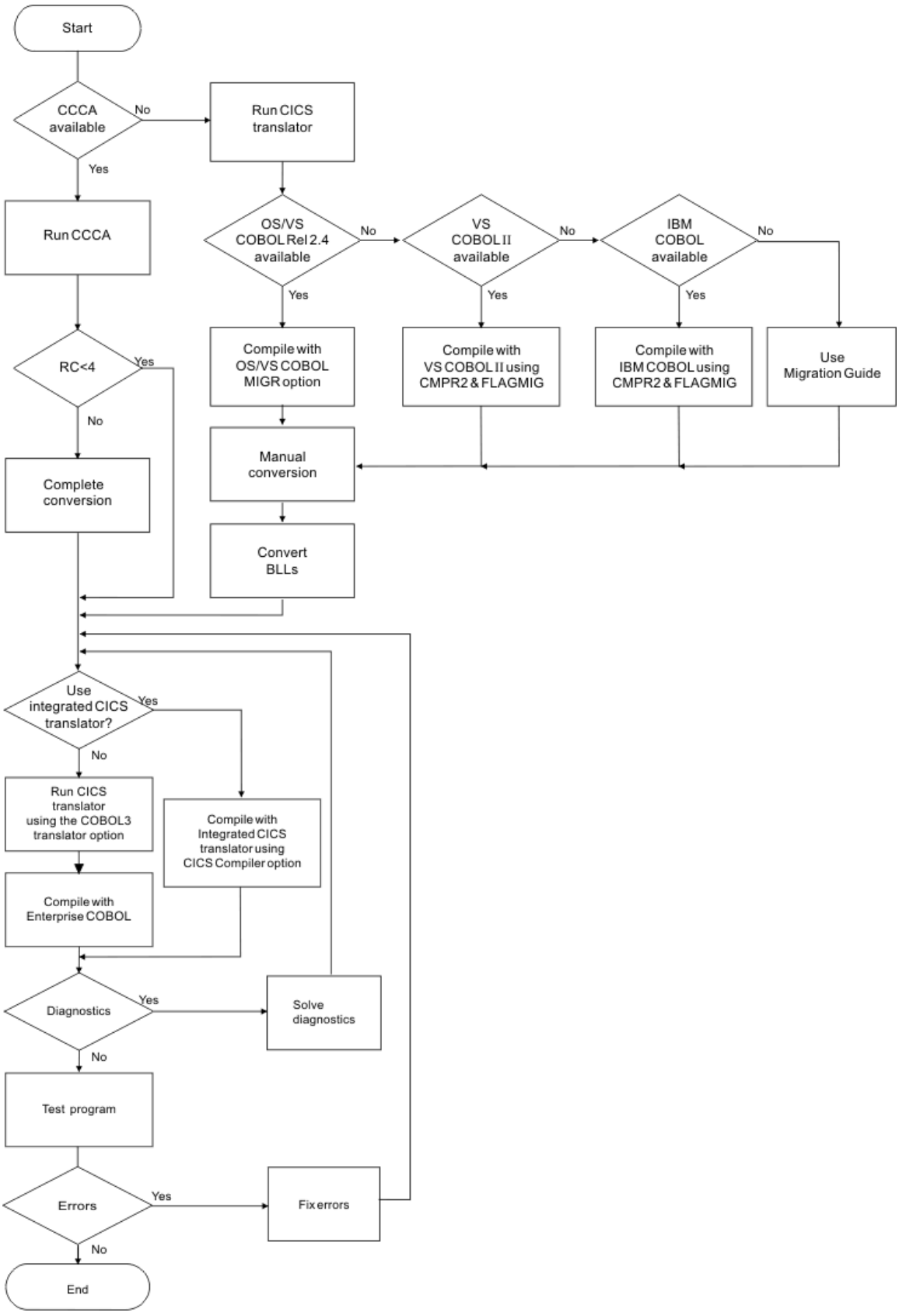

Figure 2. Steps for converting an OS/VS COBOL program containing CICS commands

Programs with Report Writer statements to be discarded

To convert an OS/VS COBOL program with Report Writer statements to Enterprise COBOL, and remove Report Writer statements, perform the steps shown in the flowchart below.

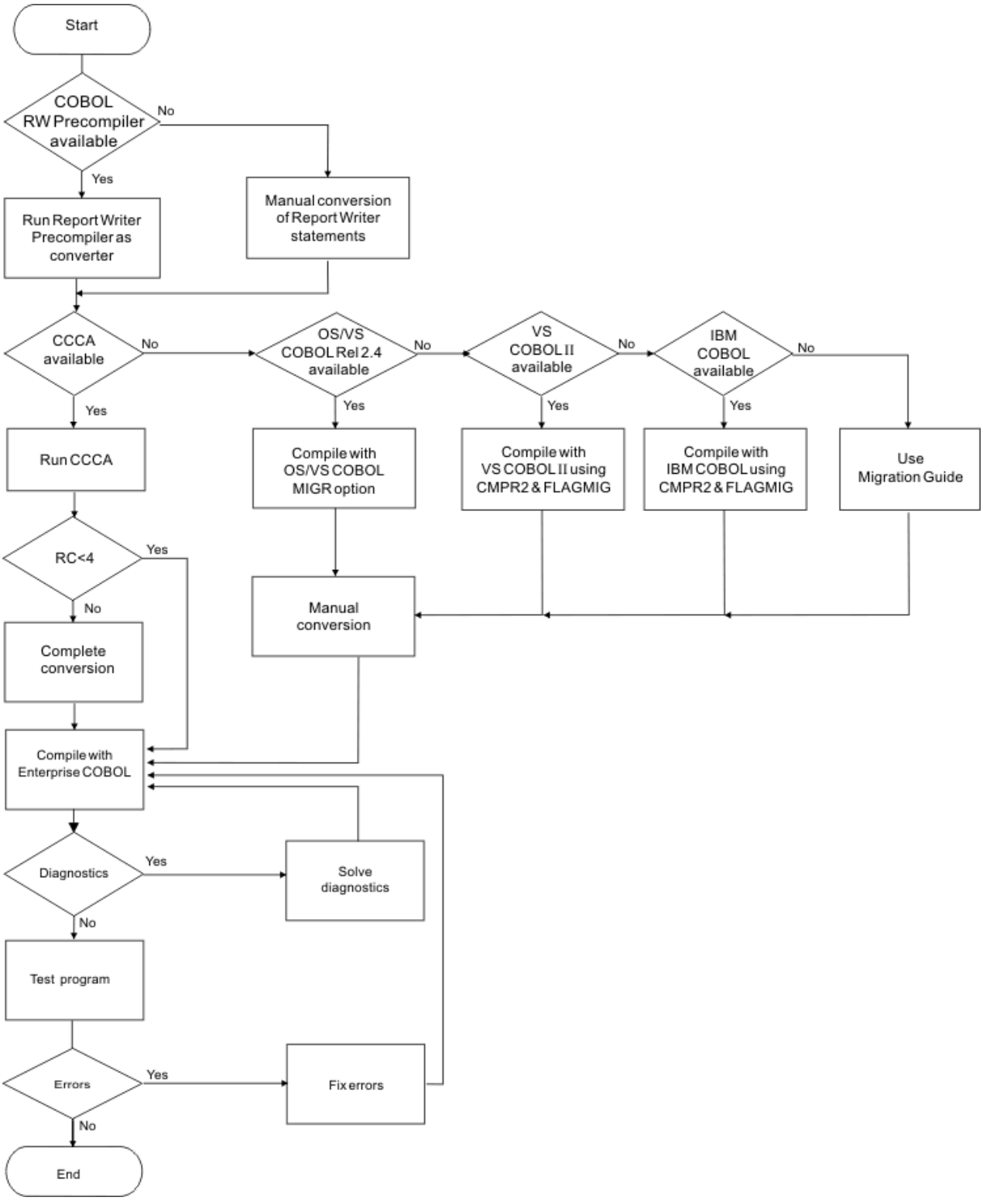

Figure 3. Steps for converting an OS/VS COBOL program and discarding Report Writer statements

Programs with Report Writer statements to be retained

To convert an OS/VS COBOL program that contains Report Writer statements to an Enterprise COBOL program, and retain the Report Writer statements in the source code, do the steps shown in the flowchart below.

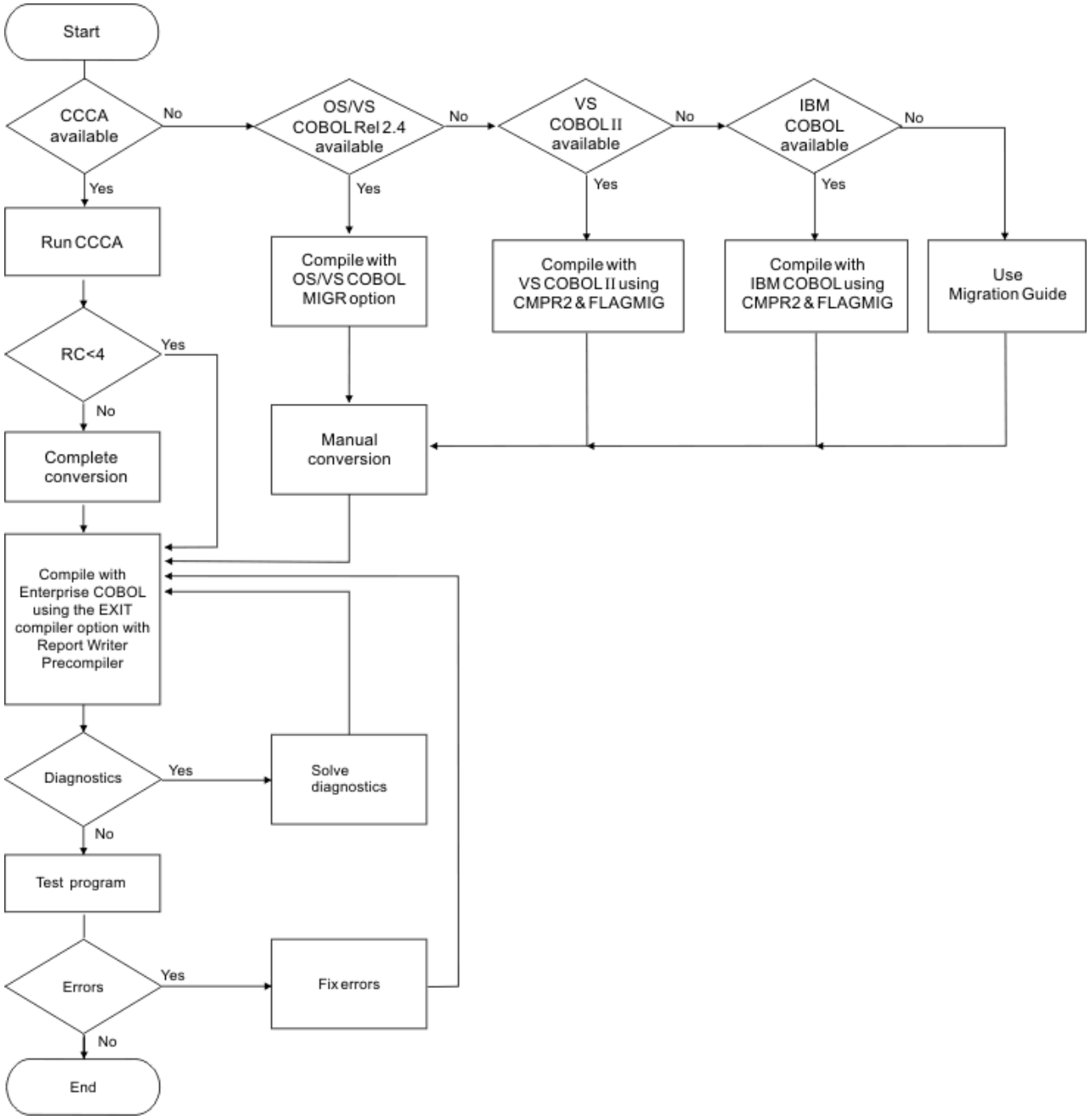

Figure 4. Steps for converting an OS/VS COBOL program and retaining Report Writer statements

Making application program updates

The following application programming tasks are necessary when upgrading your source. They should be performed in roughly the following order:

Save the existing source as a backup (a benchmark to compare to and a version to which to recover if the converted modules have problems).

1. Update the job and module documentation.

   It is extremely important that all updates be properly documented. COBOL itself is reasonably self-documenting. However, keep a log of the compiler options you specify and the reasons for specifying them. Also document any special system considerations. This is an iterative process and should be performed throughout the conversion programming task.

2. Update the available source code.

   Whenever possible, use the conversion tools described in Appendix C, "Conversion tools for source programs," on page 263. Otherwise, update the source code manually.

3. Compile, bind (link-edit), and run.

   It is recommended that you compile and test two times. The first time, compile with SSRANGE, NUMCHECK, and INITCHECK; and then after a successful test, recompile with NOSSRANGE, NONUMCHECK, and NOINITCHECK for production.

   It is also recommended that you recompile all programs in an application as you upgrade. This way you will shake out all possible problems and also get the maximum performance benefit of Enterprise COBOL V5 or V6.

   After the source has been updated, you can process the program as you would a newly written Enterprise COBOL program.

4. Debug.

   Analyze program output and, if the results are not correct, use Debug Tool or Language Environment dump output to uncover any errors.

5. Test the converted programs.

   Compare results of the newly recompiled version of the application with the existing version of the application to make sure that the results are the same. Some customers have used the code coverage feature of Debug Tool to make sure that their programs have the same behavior with COBOL V5 or V6 as they did with previous COBOL compilers, as well as comparing output of the programs.

   After upgrading your source to Enterprise COBOL, set up a procedure for regression testing. Regression testing will help to identify:

   - Fixed file attribute mismatches (file status 39 problems). Verify that your COBOL record descriptions, JCL DD statements, and physical file attributes match. For more information, see Appendix G, "Preventing file status 39 for QSAM files," on page 305.
   - Performance differences.
   - Sign handling problems—S0C7 abends. The data's sign must match the signs allowed by the NUMPROC compiler option suboption that you specify.
   - DATA(24) issues. Do not mix AMODE 24 programs with 31-bit data.

   After you have established a regression testing procedure, and after your programs run correctly, test them against a variety of data:

   - Locally: Each program separately
   - Globally: Programs in a run unit in interaction with each other

   In this way, you can exercise all the program processing features to help ensure that there are no unexpected execution differences.

6. Repeat when necessary.

   Make any further corrections that you need, and then recompile, relink, rerun, and, if necessary, continue to debug.

7. Cut over to production mode.

   When your testing shows that the entire application receives the expected results, you can move the entire unit over to production mode. (This assumes you have completed your migration to Language Environment.)

In case of unexpected errors, be prepared for instant recovery:

- Under z/OS, run the old version as a substitute from the latest productivity checkpoint.
- Under DB2 and IMS return to the last commit point and then continue processing from that point using the unmigrated COBOL program. (For DB2, use an SQL ROLLBACK WORK statement.)
- For non-CICS applications, use your shop's backup and restore facilities to recover.

8. Run in production mode.

   After cut over, monitor the application for a short time to ensure that you are getting the results expected. After that, your source conversion task is completed.

Part 3. Upgrading programs

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Chapter 6. Upgrading OS/VS COBOL source programs

There are differences between OS/VS COBOL language and Enterprise COBOL language that might require that you upgrade your programs.

This information will help you upgrade your OS/VS COBOL programs to Enterprise COBOL.

Besides the specific topics listed in this section, there has also been a change in tape user Label support. Support for the format 2 declarative syntax: USE...AFTER...LABEL PROCEDURE..., and optionally the syntax: GO TO MORE-LABELS was removed in Enterprise COBOL V5.

Also consider changes in reserved words as described in Appendix B, “COBOL reserved word comparison,” on page 241.

Enterprise COBOL provides 85 COBOL Standard support. When upgrading your OS/VS COBOL programs to Enterprise COBOL, you must convert them to 85 COBOL Standard programs in order to compile them with Enterprise COBOL.

This section is not intended to be a syntax guide. You can find complete descriptions and coding rules for the relevant COBOL language elements in:

- *VS COBOL for OS/VS Reference, GC26-3857-04*
- *Enterprise COBOL Language Reference, SC27-8713*

Tips:

1. *VS COBOL for OS/VS Reference* is no longer available from IBM.
2. There are special considerations related to CICS. OS/VS COBOL programs no longer run under CICS. Any OS/VS programs to be run under CICS must be upgraded to Enterprise COBOL.
3. In the following sections, any reference to 68 COBOL Standard is a reference to the COBOL language supported by IBM Full American National Standard COBOL Version 4 (Program 5734-CB2), or to LANGLVL(1) of OS/VS COBOL (Program 5740-CB1).
4. Information throughout this *Migration Guide* about OS/VS COBOL applies to OS/VS COBOL Release 2.4, with the latest service updates applied.

Comparing OS/VS COBOL to Enterprise COBOL

OS/VS COBOL supported the 68 COBOL Standard (LANGLVL(1)) and the 74 COBOL Standard (LANGLVL(2)). Enterprise COBOL supports the 85 COBOL Standard. In addition to the language differences between the 74 COBOL Standard and Enterprise COBOL, your OS/VS COBOL programs might contain undocumented OS/VS COBOL extensions.

Language elements that require change (quick reference)

Table 8 on page 46 lists the language elements different in OS/VS COBOL and Enterprise COBOL. This table also lists conversion tools, if any, available to automate the conversion.

The language items listed below are described in detail throughout this section, and are classified and ordered according to the following categories:

- OS/VS COBOL language elements requiring other products
- OS/VS COBOL language elements not supported
- OS/VS COBOL language elements implemented differently
- Undocumented OS/VS COBOL extensions not supported

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Table 8. Language element differences between OS/VS COBOL and Enterprise COBOL

Language element	Conversion tool	Page
Abbreviated combined relation conditions		"Abbreviated combined relation conditions and use of parentheses" on page 61
ACCEPT statement		"ACCEPT statement" on page 62
ALPHABETIC class changes	CCCA	"ALPHABETIC class changes" on page 69
ALPHABET clause changes—ALPHABET key word	CCCA	"ALPHABET-NAME clause changes: ALPHABET keyword " on page 69
Area A, periods in	CCCA	"Periods in Area A " on page 65
Arithmetic statement changes		"Arithmetic statement changes " on page 69
ASSIGN . . . OR	CCCA	"ASSIGN . . . OR" on page 56
ASSIGN TO *integer system-name*	CCCA	"ASSIGN . . . OR" on page 56
ASSIGN . . . FOR MULTIPLE REEL /UNIT	CCCA	"ASSIGN . . . FOR MULTIPLE REEL/ UNIT " on page 56
ASSIGN clause changes—*assignment-name* forms	CCCA	"ASSIGN clause changes" on page 69
B symbol in PICTURE clause—changes in evaluation		"B symbol in PICTURE clause: changes in evaluation " on page 69
BDAM file handling	CCCA*	"#unique_163/ unique_163_Connect_42_BDAMfile" on page 55
BLANK WHEN ZERO clause and asterisk (*) override		"BLANK WHEN ZERO clause and asterisk (*) override" on page 62
CALL identifier statement—B symbol in PICTURE clause		"B symbol in PICTURE clause: changes in evaluation " on page 69
CALL statement changes—procedure names and file names in USING phrase		"CALL statement changes " on page 70
CANCEL statement—B symbol in PICTURE clause		"B symbol in PICTURE clause: changes in evaluation " on page 69
CLOSE . . . FOR REMOVAL statement		"CLOSE . . . FOR REMOVAL statement" on page 62

Table 8. Language element differences between OS/VS COBOL and Enterprise COBOL (continued)

Language element	Conversion tool	Page
CLOSE statement—WITH POSITIONING, DISP phrases	CCCA	"CLOSE statement: WITH POSITIONING, DISP phrases " on page 56
Combined abbreviated relation condition changes	CCCA	"Combined abbreviated relation condition changes" on page 70
Comparing group to numeric packed-decimal item		"Comparing group to numeric packed-decimal item" on page 62
COPY statement with associated names	CCCA	"COPY statement with associated names " on page 72
Communication feature		"#unique_164/unique_164_Connect_42_comfeature" on page 55
CURRENCY-SIGN clause changes—'/', '=', and 'L' characters		"CURRENCY-SIGN clause changes: '/', '=', and 'L' characters" on page 72
CURRENT-DATE special register	CCCA	"CURRENT-DATE special register " on page 56
DIVIDE . . . ON SIZE ERROR—change in intermediate results		"ON SIZE ERROR phrase: changes in intermediate results " on page 77
Dynamic CALL statements to programs with alternate entry points without an intervening CANCEL		"Dynamic CALL statements to ENTRY points " on page 72
EXAMINE statement	CCCA	"EXAMINE statement " on page 57
EXHIBIT statement	CCCA	"Corrective action for EXHIBIT NAMED" on page 57
EXIT PROGRAM/GOBACK statement changes		"EXIT PROGRAM/GOBACK statement changes " on page 72
FILE STATUS clause changes	CCCA	"FILE STATUS clause changes " on page 72
FILE-LIMIT clause of the FILE-CONTROL paragraph	CCCA	"FILE-LIMIT clause of the FILE-CONTROL paragraph " on page 58
Flow of control, no terminating statement		"Flow of control, no terminating statement" on page 62
FOR MULTIPLE REEL/UNIT	CCCA	"ASSIGN . . . FOR MULTIPLE REEL/UNIT " on page 56

Table 8. Language element differences between OS/VS COBOL and Enterprise COBOL (continued)

Language element	Conversion tool	Page
GIVING phrase of USE AFTER STANDARD ERROR declarative	CCCA	“GIVING phrase of USE AFTER STANDARD ERROR declarative ” on page 58
IF . . . OTHERWISE statement changes	CCCA	“IF . . . OTHERWISE statement changes ” on page 75
Index names—nonunique		“Index names” on page 63
INSPECT statement—PROGRAM COLLATING SEQUENCE clause		“PROGRAM COLLATING SEQUENCE clause changes ” on page 78
IS as an optional word		“Optional word IS ” on page 77
ISAM file handling	CCCA	“#unique_165/unique_165_Connect_42_isam” on page 55
JUSTIFIED clause changes	CCCA	“JUSTIFIED clause changes ” on page 75
LABEL declaratives		“LABEL declaratives” on page 58
LABEL RECORDS clause with TOTALING/TOTALED AREA	CCCA	“LABEL RECORDS clause with TOTALING/TOTALED AREA phrases ” on page 58
LABEL RECORD IS statement		“LABEL RECORD IS statement” on page 63
MOVE statement—binary value and DISPLAY value		“MOVE statement - binary value and DISPLAY value” on page 63
MOVE statements and comparisons—scaling changes		“MOVE statements and comparisons: scaling changes ” on page 75
MOVE CORRESPONDING statement	CCCA	“MOVE CORRESPONDING statement” on page 63
MOVE statement—multiple TO specification		“MOVE statement - multiple TO specification” on page 64
MOVE ALL—TO PIC 99		“MOVE ALL - TO PIC 99” on page 64
MOVE statement—warning message for numeric truncation		“MOVE statement - warning message for numeric truncation” on page 64
MULTIPLY ... ON SIZE ERROR—change in intermediate results		“ON SIZE ERROR phrase: changes in intermediate results ” on page 77

Table 8. Language element differences between OS/VS COBOL and Enterprise COBOL (continued)

Language element	Conversion tool	Page
Nonunique program-ID names	CCCA	"PROGRAM-ID names, nonunique " on page 66
NOTE statement	CCCA	"NOTE statement " on page 58
Numeric class test on group items		"Numeric class test on group items" on page 76
Numeric data changes		"Numeric data changes" on page 76
Numeric-editing changes (PICTURE clause)		"PICTURE string " on page 65
OCCURS clause (order of phrases)		"OCCURS clause" on page 64
OCCURS DEPENDING ON— ASCENDING and DESCENDING KEY phrases		"OCCURS DEPENDING ON clause: ASCENDING and DESCENDING KEY phrase" on page 76
OCCURS DEPENDING ON—value for receiving items changed	CCCA	"OCCURS DEPENDING ON clause: value for receiving items changed " on page 76
ON statement	CCCA	"ON statement " on page 58
ON SIZE ERROR phrase—changes in intermediate results		"ON SIZE ERROR phrase: changes in intermediate results " on page 77
OPEN statement failing for QSAM files (file status 39)		"OPEN statement failing for VSAM files (file status 39)" on page 59
OPEN statement failing for VSAM files (file status 39)		"OPEN statement failing for QSAM files (file status 39)" on page 59
OPEN statement with LEAVE, REREAD, and DISP phrases	CCCA	"OPEN statement with the LEAVE, REREAD, and DISP phrases " on page 59
OPEN REVERSED statement		"OPEN REVERSED statement" on page 65
OTHERWISE clause changes		"IF . . . OTHERWISE statement changes " on page 75
Paragraph names not allowed as parameters		"CALL statement changes " on page 70
PERFORM statement—changes in the VARYING and AFTER phrases		"PERFORM statement: changes in the VARYING/ AFTER phrases " on page 77

Table 8. Language element differences between OS/VS COBOL and Enterprise COBOL (continued)

Language element	Conversion tool	Page
PERFORM statement—second UNTIL		“PERFORM statement - second UNTIL” on page 65
Periods, consecutive in any division		“Periods, consecutive in any division ” on page 65
Periods in Area A	CCCA	“Periods in Area A ” on page 65
Periods missing on paragraphs	CCCA	“Periods missing on paragraphs ” on page 65
Periods missing at the end of SD, FD, or RD		“Periods missing at the end of SD, FD, or RD ” on page 65
PICTURE clause (numeric-editing changes)		“PICTURE string ” on page 65
PROGRAM COLLATING SEQUENCE clause changes		“PROGRAM COLLATING SEQUENCE clause changes ” on page 78
Program-ID names, nonunique	CCCA	“PROGRAM-ID names, nonunique ” on page 66
Qualification - using the same phrase repeatedly		“Qualification - using the same phrase repeatedly ” on page 66
READ statement - redefined record keys in the KEY phrase		“READ statement - redefined record keys in the KEY phrase” on page 66
READ and RETURN statement changes—INTO phrase		“READ and RETURN statement changes: INTO phrase ” on page 78
READY TRACE and RESET TRACE statements	CCCA	“READY TRACE and RESET TRACE statements ” on page 59
RECORD CONTAINS n CHARACTERS clause		“RECORD CONTAINS n CHARACTERS clause ” on page 66
RECORD KEY phrase and ALTERNATE RECORD KEY phrase		“RECORD KEY phrase and ALTERNATE RECORD KEY phrase” on page 66
REDEFINES clause in SD or FD entries	CCCA	“REDEFINES clause in SD or FD entries” on page 66
REDEFINES clause with tables		“REDEFINES clause with tables” on page 67
Relation conditions	CCCA	“Relation conditions” on page 67

Table 8. Language element differences between OS/VS COBOL and Enterprise COBOL (continued)

Language element	Conversion tool	Page
REMARKS paragraph	CCCA	"REMARKS paragraph " on page 60
RENAMES clause—nonunique, nonqualified data names		"RENAMES clause - nonunique, nonqualified data names " on page 67
Report Writer statements	Report Writer Precompiler	"#unique_166/unique_166_Connect_42_reportwr" on page 53
RERUN clause changes		"RERUN clause changes " on page 78
RESERVE clause changes	CCCA	"RESERVE clause changes " on page 78
Reserved word list changes	CCCA	"Reserved word list changes" on page 79
SEARCH statement changes	CCCA	"SEARCH statement changes " on page 79
Segmentation changes—PERFORM statement in independent segments		"Segmentation changes: PERFORM statement in independent segments " on page 79
SELECT statement without a corresponding FD		"SELECT statement without a corresponding FD" on page 67
SELECT OPTIONAL clause changes	CCCA	"SELECT OPTIONAL clause changes " on page 79
SORT special registers		"SORT special registers " on page 80
SORT statement		"SORT statement" on page 67
SORT or MERGE		"SORT or MERGE" on page 68
Source language debugging changes		"Source language debugging changes " on page 80
START . . . USING KEY statement	CCCA	"START . . . USING KEY statement " on page 60
STRING statement—PROGRAM COLLATING SEQUENCE clause		"PROGRAM COLLATING SEQUENCE clause changes " on page 78
STRING statement—sending field identifier		"STRING statement - sending field identifier " on page 68
Subscripts out of range—flagged at compile-time		"Subscripts out of range flagged at compile time " on page 80

Table 8. Language element differences between OS/VS COBOL and Enterprise COBOL (continued)

Language element	Conversion tool	Page
THEN as a statement connector	CCCA	"THEN as a statement connector " on page 60
TIME-OF-DAY special register	CCCA	"TIME-OF-DAY special register " on page 60
TOTALING/TOTALED AREA phrases in LABEL RECORDS clause	CCCA	"LABEL RECORDS clause with TOTALING/TOTALED AREA phrases " on page 58
TRANSFORM statement	CCCA	"TRANSFORM statement " on page 61
UNSTRING statement—PROGRAM COLLATING SEQUENCE clause		"PROGRAM COLLATING SEQUENCE clause changes " on page 78
UNSTRING statement—coding with 'OR', 'IS', or a numeric edited item	CCCA	"UNSTRING statement - coding with 'OR', 'IS', or a numeric edited item " on page 68
UNSTRING statement—multiple INTO phrases		"UNSTRING statement - multiple INTO phrases " on page 68
UNSTRING statements—subscript evaluation changes		"UNSTRING statements: subscript evaluation changes " on page 80
UPSI switches	CCCA	"UPSI switches " on page 81
USE AFTER STANDARD ERROR—GIVING phrase	CCCA	"GIVING phrase of USE AFTER STANDARD ERROR declarative " on page 58
USE BEFORE STANDARD LABEL statement	CCCA	"USE BEFORE STANDARD LABEL " on page 61
VALUE clause—signed value in relation to the PICTURE clause	CCCA	"VALUE clause - signed value in relation to the PICTURE clause " on page 68
VALUE clause—condition names	CCCA	"VALUE clause condition names " on page 82
WHEN-COMPILED special register	CCCA	"WHEN-COMPILED special register " on page 82
WRITE AFTER POSITIONING statement	CCCA	"WRITE AFTER POSITIONING statement" on page 82

* This is a partial conversion for handling BDAM files.

Converting to 85 COBOL Standard

To help you make the needed changes when upgrading to Enterprise COBOL, you can use any of several means, including the information provided elsewhere in this *Migration Guide*.

A brief description of two of the helpful mechanisms (CCCA and the MIGR option) follows. For additional information, see Appendix C, “Conversion tools for source programs,” on page 263.

Tip: Non-IBM tools are also available to help automate the conversion to the 85 COBOL Standard.

COBOL Conversion Tool (CCCA)

The COBOL and CICS/VS Command Level Conversion Aid (CCCA) is *not* for CICS only; it converts any old COBOL to Enterprise COBOL. The CCCA provides you with either a report of the statements that need to be changed or the actual converted program itself.

For details, see “COBOL and CICS/VS Command Level Conversion Aid (CCCA)” on page 267 and the *COBOL and CICS/VS Command Level Conversion Aid Program Description and Operations Manual*.

OS/VS COBOL MIGR compiler option

The OS/VS COBOL MIGR compiler option flags most statements in an OS/VS COBOL program that are not supported or are changed in Enterprise COBOL. The MIGR compiler option allows you to analyze the conversion effort, and helps you identify required changes, without purchasing any conversion tools. Thus, for each of your programs, even before conversion, you can get a good idea of how much conversion effort will be required.

“MIGR compiler option” on page 263 lists the items flagged by MIGR. A complete description of MIGR-flagged items is included in Appendix H of *IBM VS COBOL for OS/VS*.

Language elements that require other products for support

Although some OS/VS COBOL language elements are not supported in Enterprise COBOL, you can get equivalent function by using other products.

Report Writer

The Report Writer feature is supported through use of the Report Writer Precompiler. In order for existing Report Writer code to work with Enterprise COBOL, you have the following considerations:

- “Keep existing Report Writer code and use the Report Writer Precompiler” on page 53
- “Convert existing Report Writer code using the Report Writer Precompiler” on page 54
- “Run existing OS/VS COBOL-compiled Report Writer programs under Language Environment” on page 54
- “Report Writer language items affected” on page 54

Note: Starting with Enterprise COBOL V5.1, COBOL Report Writer Precompiler V1.6.01 or later is required due to changes to the compiler architecture. Updates to the COBOL Report Writer must be obtained from SPC Systems subject to an SPC Systems support contract. For program services and technical support (including Q&A), contact SPC Systems at https://www.spc-systems.com.

For more information about the COBOL Report Writer Precompiler product, see “COBOL Report Writer Precompiler” on page 269.

Keep existing Report Writer code and use the Report Writer Precompiler

When you recompile existing Report Writer applications (or newly written applications) with the Report Writer Precompiler, and use the output as input to the Enterprise COBOL compiler, your Report Writer applications can run above the 16-MB line. Through Enterprise COBOL, you can also extend their processing capabilities.

This method requires the use of both the Report Writer Precompiler and the Enterprise COBOL compiler.

You can run Report Writer Precompiler as a separate precompiler, or incorporate it into the COBOL compilation by using the EXIT compiler option.

Convert existing Report Writer code using the Report Writer Precompiler

If you permanently convert Report Writer code to non-Report Writer code, you can stop using the Report Writer Precompiler and just use the Enterprise COBOL compiler. However, this might produce hard-to-maintain COBOL code.

When converting Report Writer code to non-Report Writer code, the Precompiler generates variable names and paragraph names. These names might not be meaningful, and thus hard to identify when attempting to make changes to the program after the conversion. You can change the names to be meaningful, but this might be difficult and time consuming.

Run existing OS/VS COBOL-compiled Report Writer programs under Language Environment

You can run existing OS/VS COBOL Report Writer applications using Language Environment without compiling with Enterprise COBOL but they cannot be mixed with Enterprise COBOL V5 or V6. If you want to mix Enterprise COBOL V5 or V6 programs with OS/VS COBOL Report Writer programs, you must convert all of the programs to use Enterprise COBOL V5 or V6, and use the Report Writer Precompiler.

OS/VS COBOL Report Writer programs will not run above the 16-MB line.

Report Writer language items affected

The following Report Writer language items are accepted by Enterprise COBOL only when the Report Writer precompiler is installed:

GENERATE statement
INITIATE statement
LINE-COUNTER special register
Nonnumeric literal IS mnemonic-name
PAGE-COUNTER special register
PRINT-SWITCH special register
REPORT clause of FD entry
REPORT SECTION
TERMINATE statement
USE BEFORE REPORTING declarative

The Report Writer Precompiler is described in Appendix C, “Conversion tools for source programs,” on page 263

Language elements that are not implemented

The following OS/VS COBOL language elements are not supported by Enterprise COBOL:

- ISAM file handling
- BDAM file handling
- Communication feature

With Enterprise COBOL, support for most of the 68 COBOL Standard language elements has been removed. There are also miscellaneous OS/VS COBOL language items that are not implemented in Enterprise COBOL.

The language elements affected and the conversion actions that you can perform are documented in the following sections. There is a brief description of each item, plus conversion suggestions and, where helpful, coding examples.

ISAM file handling

Enterprise COBOL does not support the processing of ISAM files, nor does z/OS V1.7 and later releases. You must convert ISAM files to VSAM/KSDS files before you move to z/OS V1.7 or later.

ISAM file handling language items affected

The following ISAM language items are not accepted by Enterprise COBOL:

APPLY CORE-INDEX
APPLY REORG-CRITERIA
File declarations for ISAM files
NOMINAL KEY clause
Organization parameter I
TRACK-AREA clause
USING KEY clause of START statement

Conversion options

Two conversion tools can help you convert ISAM files to VSAM/KSDS files. You can use either IDCAMS REPRO or CCCA. The IDCAMS REPRO facility will perform the conversion unless the file has a hardware dependency. IDCAMS repro will only work for ISAM files on z/OS V1.6 or earlier. You must migrate ISAM to VSAM/KSDS before moving to z/OS V1.7 or later.

The COBOL conversion tool (CCCA) can automatically convert the file definition and I/O statements from your ISAM COBOL language to VSAM/KSDS COBOL language. The CCCA conversion tool is described in Appendix C, “Conversion tools for source programs,” on page 263.

BDAM file handling

Enterprise COBOL does not support the processing of BDAM files. Convert any BDAM files to virtual storage access method/relative record data set (VSAM/RRDS) files.

BDAM file handling language items affected

The following BDAM language items are not accepted by Enterprise COBOL:

ACTUAL KEY clause
APPLY RECORD-OVERFLOW
File declarations for BDAM files
Organization parameters D, R, W
SEEK statement
TRACK-LIMIT clause

Automated conversion options

The COBOL conversion tool (CCCA) can automatically convert your BDAM COBOL language to VSAM/RRDS COBOL language, however, you must provide the key algorithm. The CCCA conversion tool is described in Appendix C, “Conversion tools for source programs,” on page 263.

Communication feature

The Communication feature is not supported by Enterprise COBOL.

Communication language items affected

The following communication language items are not accepted by Enterprise COBOL:

ACCEPT MESSAGE COUNT statement
COMMUNICATION SECTION

DISABLE statement
ENABLE statement
RECEIVE statement
SEND statement

Communication conversion actions

Existing TCAM applications that use the OS/VS COBOL SEND and RECEIVE statements run under Language Environment with one exception: the QUEUE runtime option of OS/VS COBOL is not supported. (The QUEUE runtime option is used only in an OS/VS COBOL program with a RECEIVE statement in a CD . . . FOR INITIAL INPUT.)

For more information, see the *IBM VS COBOL for OS/VS*, and the *IBM OS/VS COBOL Compiler and Library Programmer's Guide*.

Language elements that are not supported

Enterprise COBOL does not support the following OS/VS COBOL language elements. When upgrading to Enterprise COBOL, you must either remove or alter these items as indicated in the following descriptions:

ASSIGN . . . OR
OS/VS COBOL accepted the ASSIGN ... OR clause. To use this clause under Enterprise COBOL, you must remove the OR.

ASSIGN TO *integer system-name*
OS/VS COBOL accepted the ASSIGN TO *integer system-name* clause. To use this clause under Enterprise COBOL, you must remove the integer.

ASSIGN . . . FOR MULTIPLE REEL/UNIT
OS/VS COBOL accepted the ASSIGN ... FOR MULTIPLE REEL/UNIT phrase, and treated it as documentation. Enterprise COBOL does not support this phrase.

CLOSE statement: WITH POSITIONING, DISP phrases
OS/VS COBOL accepted the WITH POSITIONING and DISP phrases of the CLOSE statement provided as IBM extensions in OS/VS COBOL. In Enterprise COBOL, these phrases are not accepted.

CURRENT-DATE special register
OS/VS COBOL accepted the CURRENT-DATE special register. It is valid only as the sending field in a MOVE statement. CURRENT-DATE has the 8-byte alphanumeric format:

```
MM/DD/YY  (month, day, year)
```

Enterprise COBOL supports the DATE special register. It is valid only as the sending field in an ACCEPT statement. DATE has the 6-byte alphanumeric format:

```
YYMMDD  (year, month, day)
```

Therefore, you must change an OS/VS COBOL program with statements similar to the following one:

```
77  DATE-IN-PROGRAM  PICTURE X(8).
    . . .
    MOVE CURRENT-DATE TO DATE-IN-PROGRAM.
```

An example of one way to change it, keeping the two-digit year format, is as follows:

```
01  DATE-IN-PROGRAM.
    02 MONTH-OF-YEAR     PIC X(02).
    02 FILLER            PIC X(01)  VALUE "/".
    02 DAY-OF-MONTH      PIC X(02).
    02 FILLER            PIC X(01)  VALUE "/".
    02 YEAR              PIC X(02).

01  ACCEPT-DATE.
    02 YEAR              PIC X(02).
    02 MONTH-OF-YEAR     PIC X(02).
    02 DAY-OF-MONTH      PIC X(02).
```

```
    . . .
    ACCEPT ACCEPT-DATE FROM DATE.
    MOVE  CORRESPONDING ACCEPT-DATE TO DATE-IN-PROGRAM.
```

An example of how to change it and specify a four-digit year is as follows:

```
01  DATE-IN-PROGRAM.
    02 MONTH-OF-YEAR     PIC X(02).
    02 FILLER            PIC X(01)  VALUE "/".
    02 DAY-OF-MONTH      PIC X(02).
    02 FILLER            PIC X(01)  VALUE "/".
    02 YEAR              PIC X(04).

01  CURRENT-DATE.
    02 YEAR              PIC X(04).
    02 MONTH-OF-YEAR     PIC X(02).
    02 DAY-OF-MONTH      PIC X(02).
    . . .
    MOVE FUNCTION CURRENT-DATE(1:8) TO CURRENT-DATE.
    MOVE CORRESPONDING CURRENT-DATE TO DATE-IN-PROGRAM.
```

EXAMINE statement

OS/VS COBOL accepted the EXAMINE statement; Enterprise COBOL does not.

Therefore, if your OS/VS COBOL program contains coding similar to the following one:

```
EXAMINE DATA-LENGTH TALLYING UNTIL FIRST " "
```

Replace it in Enterprise COBOL with:

```
MOVE 0 TO TALLY
INSPECT DATA-LENGTH TALLYING TALLY FOR CHARACTERS BEFORE " "
```

You can continue to use the TALLY special register wherever you can specify a WORKING-STORAGE elementary data item of integer value.

EXHIBIT statement

OS/VS COBOL accepted the EXHIBIT statement; Enterprise COBOL does not.

With Enterprise COBOL, you can use DISPLAY statements to replace EXHIBIT statements. However, the DISPLAY statement does not perform all the functions of the EXHIBIT statement.

Corrective action for EXHIBIT NAMED

You can replace the EXHIBIT NAMED statement directly with a DISPLAY statement:

```
    OS/VS COBOL                          Enterprise COBOL

WORKING-STORAGE SECTION.          WORKING-STORAGE SECTION.
77  DAT-1 PIC X(8).              77  DAT-1 PIC X(8).
77  DAT-2 PIC X(8).              77  DAT-2 PIC X(8).
        . . .                             . . .
    EXHIBIT NAMED DAT-1 DAT-2         DISPLAY "DAT-1 = " DAT-1
                                          "DAT-2 = " DAT-2
```

Corrective action for EXHIBIT CHANGED

You can replace the EXHIBIT CHANGED statement with IF and DISPLAY statements, as follows:

1. Specify an IF statement to discover if the new value of the data item is different from the old.
2. Specify a DISPLAY statement as the *statement-1* of the IF statement.

This change displays the value of the specified data item only if the new value is different from the old:

```
    OS/VS COBOL                          Enterprise COBOL

WORKING-STORAGE SECTION.          WORKING-STORAGE SECTION.
77  DAT-1 PIC X(8).              77  DAT-1 PIC X(8).
77  DAT-2 PIC X(8).              77  DAT-2 PIC X(8).
                                  77  DAT1-CMP PIC X(8).
                                  77  DAT2-CMP PIC X(8).
        . . .                             . . .
 EXHIBIT CHANGED DAT-1 DAT-2      IF DAT-1 NOT EQUAL TO DAT1-CMP
                                    DISPLAY DAT-1
```

```
                                    END-IF
                                    IF DAT-2 NOT EQUAL TO DAT2-CMP
                                      DISPLAY DAT-2
                                    END-IF
                                    MOVE DAT-1 TO DAT1-CMP
                                    MOVE DAT-2 TO DAT2-CMP
```

Corrective action for EXHIBIT CHANGED NAMED

You can replace the EXHIBIT CHANGED NAMED statement with IF and DISPLAY statements, as follows:

1. Specify an IF statement to discover if the new value of the data item is different from the old.
2. Specify a DISPLAY statement as the *statement-1* of the IF statement.

This change displays the value of the specified data item only if the new value is different from the old:

```
    OS/VS COBOL                          Enterprise COBOL

WORKING-STORAGE SECTION.          WORKING-STORAGE SECTION.
77  DAT-1 PIC X(8).              77  DAT-1    PIC X(8).
77  DAT-2 PIC X(8).              77  DAT-2    PIC X(8).
                                  77  DAT1-CMP PIC X(8).
                                  77  DAT2-CMP PIC X(8).
          . . .                             . . .
  EXHIBIT CHANGED NAMED            IF DAT-1 NOT EQUAL TO DAT1-CMP
      DAT-1 DAT-2                     DISPLAY "DAT-1 = " DAT-1
                                   END-IF
                                   IF DAT-2 NOT EQUAL TO DAT2-CMP
                                       DISPLAY "DAT-2 = " DAT-2
                                   END-IF
                                   MOVE DAT-1 TO DAT1-CMP
                                   MOVE DAT-2 TO DAT2-CMP
```

FILE-LIMIT clause of the FILE-CONTROL paragraph

OS/VS COBOL accepted the FILE-LIMIT clause and treats it as a comment; Enterprise COBOL does not. Therefore, you must remove any occurrences of the FILE-LIMIT clause.

GIVING phrase of USE AFTER STANDARD ERROR declarative

In OS/VS COBOL, you could specify the GIVING phrase of the USE AFTER STANDARD ERROR declarative. Enterprise COBOL does not support this phrase. Therefore, you must remove any occurrences of the GIVING phrase of the USE AFTER STANDARD ERROR declarative.

Use the FILE-CONTROL FILE STATUS clause to replace the GIVING phrase. The FILE STATUS clause gives you information after each I/O request, rather than only after an error occurs.

LABEL declaratives

Beginning with Enterprise COBOL V5, LABEL declaratives are no longer supported:

- Format 2 declarative syntax: USE...AFTER...LABEL PROCEDURE... is no longer supported.
- The syntax: GO TO MORE-LABELS is no longer supported.

If your programs have any of these language elements, they must be removed before you can compile and run these programs with Enterprise COBOL V5 and V6.

LABEL RECORDS clause with TOTALING/TOTALED AREA phrases

OS/VS COBOL allowed the TOTALING and TOTALED phrases of the LABEL RECORDS clause.

Enterprise COBOL does not support these phrases. Therefore, you must remove any occurrences of the TOTALING/TOTALED phrases from the LABEL RECORDS clause. Also check the variables associated with these phrases.

NOTE statement

OS/VS COBOL accepted the NOTE statement. Enterprise COBOL does not accept the NOTE statement. Therefore, for Enterprise COBOL delete all NOTE statements and use comment lines instead for the entire NOTE paragraph.

ON statement

OS/VS COBOL accepted the ON statement. Enterprise COBOL does not accept the ON statement.

The ON statement allows selective execution of statements it contains. Similar functions are provided in Enterprise COBOL by the EVALUATE statement and the IF statement.

OPEN statement failing for QSAM files (file status 39)

In OS/VS COBOL, the fixed file attributes for QSAM files did not need to match your COBOL program or JCL for a successful OPEN. In Enterprise COBOL, if the following conditions do not match, an OPEN statement in your program might not run successfully:

- The fixed file attributes specified in the DD statement or the data set label for a file
- The attributes specified for that file in the SELECT and FD statements of your COBOL program

Mismatches in the attributes for file organization, record format (fixed or variable), the code set, or record length result in a file status code 39, and the OPEN statement fails.

To prevent common file status 39 problems, see Appendix G, "Preventing file status 39 for QSAM files," on page 305.

OPEN statement failing for VSAM files (file status 39)

In OS/VS COBOL, the RECORDSIZE defined in your VSAM files associated with IDCAMS was not required to match your COBOL program for a successful OPEN. In Enterprise COBOL they must match. The following rules apply to VSAM ESDS, KSDS, and RRDS file definitions:

Table 9. Rules for VSAM file definitions

File type	Rules
ESDS and KSDS VSAM	RECORDSIZE(*avg*,*m*) is specified where *avg* is the average size of the COBOL records, and is strictly less than *m*; *m* is greater than or equal to the maximum size of a COBOL record.
RRDS VSAM	RECORDSIZE(*n*,*n*) is specified where *n* is greater than or equal to the maximum size of a COBOL record.

OPEN statement with the LEAVE, REREAD, and DISP phrases

OS/VS COBOL allowed the OPEN statement with the LEAVE, REREAD and DISP phrases. Enterprise COBOL does not allow these phrases.

To replace the REREAD function, define a copy of your input records in the WORKING-STORAGE SECTION and move each record into WORKING-STORAGE after it is read or use READ INTO.

READY TRACE and RESET TRACE statements

OS/VS COBOL allowed the READY TRACE and RESET TRACE statements. Enterprise COBOL does not support these statements.

To get function similar to the READY TRACE statement, you can use either Debug Tool, or the COBOL language available in the Enterprise COBOL compiler.

If you use Debug Tool, compile your program with the TEST option and use the following Debug Tool command:

```
"AT GLOBAL LABEL PERFORM;
 LIST LINES %LINE; GO; END-PERFORM;"
```

If you use the COBOL language, the Enterprise COBOL USE FOR DEBUGGING ON ALL PROCEDURES declarative can perform functions similar to READY TRACE and RESET TRACE.

For example:

```
ENVIRONMENT DIVISION.
  CONFIGURATION SECTION.
  SOURCE-COMPUTER. IBM-370 WITH DEBUGGING MODE.
  . . .
DATA DIVISION.
  . . .
  WORKING-STORAGE SECTION.
  01 TRACE-SWITCH        PIC 9 VALUE 0.
```

```
     88  READY-TRACE           VALUE 1.
     88  RESET-TRACE           VALUE 0.
  . . .
PROCEDURE DIVISION.
  DECLARATIVES.
  COBOL-II-DEBUG SECTION.
    USE FOR DEBUGGING ON ALL PROCEDURES.
  COBOL-II-DEBUG-PARA.
    IF READY-TRACE THEN
        DISPLAY DEBUG-NAME
    END-IF.
  END DECLARATIVES.
  MAIN-PROCESSING SECTION.
  . . .
  PARAGRAPH-3.
  . . .
    SET READY-TRACE TO TRUE.
  PARAGRAPH-4.
  . . .
  PARAGRAPH-6.
  . . .
    SET RESET-TRACE TO TRUE.
  PARAGRAPH-7.
```

where DEBUG-NAME is a field of the DEBUG-ITEM special register that displays the procedure-name causing execution of the debugging procedure. (In this example, the object program displays the names of procedures PARAGRAPH-4 through PARAGRAPH-6 as control reaches each procedure within the range.)

At run time, you must specify PARM=/DEBUG in your EXEC statement to activate this debugging procedure. In this way, you have no need to recompile the program to activate or deactivate the debugging declarative.

REMARKS paragraph

OS/VS COBOL accepted the REMARKS paragraph.

Enterprise COBOL does not accept the REMARKS paragraph. As a replacement, use comment lines beginning with an * in column 7 or use the floating comment indicator *>.

START . . . USING KEY statement

OS/VS COBOL allowed the START statement with the USING KEY phrase; Enterprise COBOL does not. In Enterprise COBOL, you can specify the START statement with the KEY IS phrase.

THEN as a statement connector

OS/VS COBOL accepted the use of THEN as a statement connector.

The following example shows the OS/VS COBOL usage:

```
MOVE A TO B THEN ADD C TO D
```

Enterprise COBOL does not support the use of THEN as a statement connector. Therefore, in Enterprise COBOL change it to:

```
MOVE A TO B
ADD C TO D
```

TIME-OF-DAY special register

OS/VS COBOL supported the TIME-OF-DAY special register. It was valid only as the sending field in a MOVE statement. TIME-OF-DAY had the following 6-byte EXTERNAL decimal format:

```
HHMMSS (hour, minute, second)
```

Enterprise COBOL does not support the TIME-OF-DAY special register.

Therefore, you must change an OS/VS COBOL program with statements similar to the following one:

```
77  TIME-IN-PROGRAM   PICTURE  X(6).
. . .
    MOVE TIME-OF-DAY TO TIME-IN-PROGRAM.
```

An example of one way to change it is as follows:

```
MOVE FUNCTION CURRENT-DATE (9:6) TO TIME-IN-PROGRAM
```

TRANSFORM statement

OS/VS COBOL supported the TRANSFORM statement. Enterprise COBOL does not support the TRANSFORM statement, but it does support the INSPECT statement. Therefore, any TRANSFORM statements in your OS/VS COBOL program must be replaced by INSPECT CONVERTING statements.

For example, in the following OS/VS COBOL TRANSFORM statement:

```
77  DATA-T     PICTURE X(9) VALUE "ABCXYZCCC"
  . . .
    TRANSFORM DATA-T FROM "ABC" TO "CAT"
```

TRANSFORM evaluates each character, changing each A to C, each B to A, and each C to T.

After the TRANSFORM statement is executed. DATA-T contains "CATXYZTTT".

For example, in the following INSPECT CONVERTING statement (valid only in Enterprise COBOL):

```
77  DATA-T     PICTURE X(9) VALUE "ABCXYZCCC"
  . . .
    INSPECT DATA-T
        CONVERTING "ABC" TO "CAT"
```

INSPECT CONVERTING evaluates each character just as TRANSFORM does, changing each A to C, each B to A, and each C to T.

After the INSPECT CONVERTING statement is executed. DATA-T contains "CATXYZTTT:.

USE BEFORE STANDARD LABEL

OS/VS COBOL accepted the USE BEFORE STANDARD LABEL statement; Enterprise COBOL does not.

Therefore, you must remove any occurrences of the USE BEFORE STANDARD LABEL statement. Enterprise COBOL does not support nonstandard labels, so you cannot process nonstandard labeled files with Enterprise COBOL.

SEARCH ALL statements

If you have programs that contain SEARCH ALL statements and that were compiled with OS/VS COBOL, you may need to make some changes due to changes in the behavior of the SEARCH ALL statement

The new behavior for the SEARCH ALL statement is described in “Upgrading programs that have SEARCH ALL statements” on page 99.

Undocumented OS/VS COBOL extensions that are not supported

This section consists primarily of COBOL statements that are not flagged by the MIGR option. These statements were accepted by the OS/VS COBOL compiler; some are not accepted by Enterprise COBOL.

Because these language elements are undocumented extensions to OS/VS COBOL, they are not considered to be valid OS/VS COBOL code. This list might not contain all undocumented extensions; it includes all of the undocumented extensions of which we are aware.

Abbreviated combined relation conditions and use of parentheses

OS/VS COBOL accepted the use of parentheses within an abbreviated combined relation condition.

Enterprise COBOL supports most parenthesis usage as IBM extensions. However, there are two differences:

- Within the scope of an abbreviated combined relation condition, Enterprise COBOL does not support relational operators inside parentheses. For example:

```
A = B  AND ( < C OR D)
```

- Some incorrect usages of parentheses in relation conditions were accepted by OS/VS COBOL, but are not by Enterprise COBOL. For example:

```
(A = 0 AND B) = 0
```

ACCEPT statement

OS/VS COBOL accepted the ACCEPT statement without the keyword FROM between the identifier and the mnemonic or function name.

Enterprise COBOL does not accept such an ACCEPT statement.

BLANK WHEN ZERO clause and asterisk (*) override

In OS/VS COBOL, if you specified the BLANK WHEN ZERO clause and the asterisk (*) as a zero suppression symbol for the same entry, zero suppression would override BLANK WHEN ZERO.

Enterprise COBOL does not accept these two language elements when they are specified for the same data description entry. Thus Enterprise COBOL must not contain instances of both the clause and the symbol in one data description entry.

If you have specified both the BLANK WHEN ZERO clause and the asterisk as a zero suppression symbol in your OS/VS COBOL programs, to get the same behavior in Enterprise COBOL, remove the BLANK WHEN ZERO clause.

CLOSE . . . FOR REMOVAL statement

OS/VS COBOL allowed the FOR REMOVAL clause for sequential files, and it had an effect on the execution of the program. Enterprise COBOL syntax-checks the statement but it has no effect on the execution of the program.

Comparing group to numeric packed-decimal item

OS/VS COBOL allowed a comparison between a group and a numeric packed-decimal item, but generated code that produced an incorrect result.

For example, the result of the comparison below is the message

```
"1 IS NOT > 0"
```

and is not the numerically correct

```
"1 > 0"

    05  COMP-TABLE.
        10 COMP-PAY              PIC 9(4).
        10  COMP-HRS             PIC 9(3).
    05  COMP-ITEM                PIC S9(7) COMP-3.

PROCEDURE DIVISION.
    MOVE 0 TO COMP-PAY COMP-HRS.
    MOVE 1 TO COMP-ITEM.
    IF COMP-ITEM > COMP-TABLE
       DISPLAY '1 > 0'
    ELSE
       DISPLAY '1 IS NOT > 0'.
```

Enterprise COBOL does not allow such a comparison.

Flow of control, no terminating statement

In OS/VS COBOL, it would be possible to link-edit an assembler program to the end of an OS/VS COBOL program and have the flow of control go from the end of the COBOL program to the assembler program.

In Enterprise COBOL, if you do not code a terminating statement at the end of your program (STOP RUN or GOBACK), the program will terminate with an implicit GOBACK. The flow of control cannot go beyond the end of the COBOL program.

If you have programs that rely on 'falling through the end' into another program, change the code to a CALL interface to the other program.

Index names

OS/VS COBOL allowed the use of qualified index names.

Enterprise COBOL does not allow qualified index names; index names must be unique if referenced.

LABEL RECORD IS statement

OS/VS COBOL accepted a LABEL RECORD clause without the word RECORD. You could have LABEL IS OMITTED instead of LABEL RECORD IS OMITTED.

Enterprise COBOL does not accept such a LABEL RECORD clause.

MOVE statement - binary value and DISPLAY value

Although the Enterprise COBOL TRUNC(OPT) compiler option is recommended for compatibility with the OS/VS COBOL NOTRUNC compiler option, you might receive different results involving moves of fullword binary items (USAGE COMP with Picture 9(5) through Picture 9(9)).

For example:

```
WORKING-STORAGE SECTION.
  01 WK1 USAGE COMP-4 PIC S9(9).

PROCEDURE DIVISION.

  MOVE 1234567890 to WK1
  DISPLAY WK1.
  GOBACK.
```

This example actually shows COBOL coding that is not valid, since 10 digits are being moved into a 9-digit item.

For example, the results are as follows when compiled with the following compiler options:

	OS/VS COBOL NOTRUNC	Enterprise COBOL TRUNC(OPT)
Binary value	x'499602D2'	x'0DFB38D2'
DISPLAY value	234567890	234567890

For OS/VS COBOL, the binary value contained in the binary data item is not the same as the DISPLAY value. The DISPLAY value is based on the number of digits in the PICTURE clause and the binary value is based on the size of the binary data item, in this case, 4 bytes. The actual value of the binary data item in decimal digits is 1234567890.

For Enterprise COBOL, the binary value and the DISPLAY value are equal because the truncation that occurred was based on the number of digits in the PICTURE clause.

This situation is flagged by MIGR in OS/VS COBOL and by Enterprise COBOL when compiled with TRUNC(OPT).

MOVE CORRESPONDING statement

- OS/VS COBOL allowed more than one receiver with MOVE CORRESPONDING; Enterprise COBOL does not. Therefore, you must change the following OS/VS COBOL statement:

  ```
  MOVE CORRESPONDING GROUP-ITEM-A TO GROUP-ITEM-B GROUP-ITEM-C
  ```

  to two Enterprise COBOL MOVE CORRESPONDING statements:

  ```
  MOVE CORRESPONDING GROUP-ITEM-A TO GROUP-ITEM-B
  MOVE CORRESPONDING GROUP-ITEM-A TO GROUP-ITEM-C
  ```

- Releases prior to Release 2.4 of OS/VS COBOL accepted nonunique subordinate data items in the receiver of a MOVE CORRESPONDING statement; Enterprise COBOL does not. For example:

  ```
  01  KANCFUNC.
      03  CL  PIC XX.
      03  KX9 PIC XX.
      03  CC  PIC XX.
  ```

```
01  HEAD1-AREA.
    03  CL  PIC XX.
    03  KX9 PIC XX.
    03  CC  PIC XX.
    03  KX9 PIC XX.
.
.
.
    MOVE CORR KANCFUNC to HEAD1-AREA.
```

For Enterprise COBOL, change the data items in the receiver to have unique names.

MOVE statement - multiple TO specification

OS/VS COBOL allowed the reserved word TO to precede each receiver in a MOVE statement. For example:

```
MOVE aa TO bb TO cc
```

In Enterprise COBOL, the above statement must be changed to:

```
MOVE aa TO bb cc
```

MOVE ALL - TO PIC 99

OS/VS COBOL allowed group moves into a fixed numeric receiving field. For example:

```
MOVE ALL ' ' TO num1
```

where, num1 is PIC 99.

Enterprise COBOL does not allow the above case. In Enterprise COBOL, you can change the example to the following statement and it would be accepted:

```
MOVE ALL ' ' TO num1(1:)
```

MOVE statement - warning message for numeric truncation

OS/VS COBOL issued a warning message for a MOVE statement with a numeric receiver that would result in a loss of digits. For example:

```
77 A PIC 999.
77 B PIC 99.
.
.
.
    MOVE A TO B.
```

You can get the same behavior with Enterprise COBOL if the compiler option DIAGTRUNC is in effect.

OCCURS clause

OS/VS COBOL allowed a nonstandard order for phrases following the OCCURS clause; Enterprise COBOL does not.

For example, the following code sequence would be allowed in OS/VS COBOL:

```
01  D   PIC 999.
01  A.
    02  B OCCURS 1 TO 200 TIMES
          ASCENDING KEY C
          DEPENDING ON D
          INDEXED BY H.
    02  C PIC 99.
```

In Enterprise COBOL, the above example must be changed to the following code sequence:

```
01  D   PIC 999.
01  A.
    02  B OCCURS 1 TO 200 TIMES
          DEPENDING ON D
          ASCENDING KEY C
```

```
          INDEXED BY H.
    02  C PIC 99.
```

OPEN REVERSED statement

OS/VS COBOL accepted the REVERSED phrase for multireel files; Enterprise COBOL does not.

PERFORM statement - second UNTIL

OS/VS COBOL allowed a second UNTIL in a PERFORM statement, as in the following example:

```
PERFORM CHECK-FOR-MATCH THRU CHECK-FOR-MATCH-EXIT
    UNTIL PARM-COUNT = 7
    OR UNTIL SSREJADV-EOF.
```

Enterprise COBOL does not allow a second UNTIL statement. It must be removed as shown in the following example:

```
PERFORM CHECK-FOR-MATCH THRU CHECK-FOR-MATCH-EXIT
    UNTIL PARM-COUNT = 7
    OR SSREJADV-EOF.
```

Periods in Area A

OS/VS COBOL allowed you to code a period in Area A following an Area-A item (or no item) that was not valid. With Enterprise COBOL, a period in Area A must be preceded by a valid Area-A item.

Periods, consecutive in any division

OS/VS COBOL allowed you to code two consecutive periods in any division.

Enterprise COBOL issues a warning message (RC = 4) if two periods in a row are found in the PROCEDURE DIVISION, and a severe message (RC = 12) if two periods in a row are found in either the ENVIRONMENT DIVISION or the DATA DIVISION.

The following code would be accepted by OS/VS COBOL, but would receive a severe (RC = 12) error and a warning (RC = 4) under Enterprise COBOL:

```
WORKING-STORAGE SECTION.
01 A PIC 9..
.
.
.
    MOVE 1 TO A..
.
.
    GOBACK.
```

Periods missing at the end of SD, FD, or RD

A period is required at the end of a sort, file, or report description, preceding the 01-level indicator.

OS/VS COBOL diagnosed the missing period with a warning message (RC = 4).

Enterprise COBOL issues an error message (RC = 8).

Periods missing on paragraphs

Releases prior to Release 2.4 of OS/VS COBOL accepted paragraph names not followed by a period. Release 2.4 of OS/VS COBOL issued a warning message (RC = 4) whereas Enterprise COBOL issues an error message (RC = 8) .

PICTURE string

OS/VS COBOL accepted a PICTURE string with all Z's to the left of the implied decimal point, a Z immediately to the right of the implied decimal point, but ending with a 9 or 9-. For example:

```
05 WEIRD-NUMERIC-EDITED PIC Z(11)VZ9.
```

Enterprise COBOL does not accept statements such as the statements in the example above. You must change the Z9 to either ZZ or 99.

PROGRAM-ID names, nonunique
OS/VS COBOL allowed a data-name or paragraph-name to be the same as the PROGRAM-ID name. Enterprise COBOL requires the PROGRAM-ID name to be unique.

Qualification - using the same phrase repeatedly

```
A of B of B
```

OS/VS COBOL allowed repeating of phrases; Enterprise COBOL does not.

READ statement - redefined record keys in the KEY phrase
OS/VS COBOL accepted implicitly or explicitly redefined record keys in the KEY phrase of the READ statement.

Enterprise COBOL accepts only the names of the data items that are specified as record keys in the SELECT clause for the file being read.

RECORD CONTAINS *n* CHARACTERS clause
In variation with the 74 COBOL Standard, the RECORD CONTAINS *n* CHARACTERS clause of an OS/VS COBOL program was overridden if an OCCURS DEPENDING ON clause was specified in the FD, and produced a file containing variable-length records instead of fixed-length records.

Under Enterprise COBOL, the RECORD CONTAINS *n* CHARACTERS clause produces a file containing fixed-length records.

RECORD KEY phrase and ALTERNATE RECORD KEY phrase
OS/VS COBOL allowed the leftmost character position of the ALTERNATE RECORD KEY *data-name-4* to be the same as the leftmost character position of the RECORD KEY or of any other ALTERNATE RECORD KEY phrases.

Enterprise COBOL does not allow this.

Record length, obtaining from QSAM RDW
In OS/VS COBOL, you can obtain the record length for files that have variable-length records from the RDW by using invalid negative subscripts.

In Enterprise COBOL, the RDW for variable files in the area preceding the record content is not available. To migrate from previous COBOL products, use the Format 3 RECORD clause in FD entries to set or obtain the length of variable records when the information is not in the record itself. The syntax contains RECORD IS VARYING DEPENDING ON *data-name-1*. *data-name-1* is defined in WORKING-STORAGE. After the compiler reads a variable record, the length of the data read is automatically stored at *data-name-1*. For example:

```
FILE  SECTION.
 FD  THE-FILE RECORD IS VARYING DEPENDING ON REC-LENGTH.
 01  THE-RECORD  PICTURE X(5000) .
 WORKING-STORAGE  SECTION.
 01  REC-LENGTH  PICTURE 9(5)  COMPUTATIONAL.
 01  SAVED-RECORD PICTURE X(5000).
 PROCEDURE DIVISION.
* Read a record of unknown length.
     READ THE-FILE.
     DISPLAY REC-LENGTH.
* or use REC-LENGTH to access the right amount of data:
     MOVE THE-RECORD (1:REC-LENGTH) TO SAVED-RECORD.
```

For more information about the RECORD clause, see the *Enterprise COBOL Language Reference*.

REDEFINES clause in SD or FD entries
Releases prior to OS/VS COBOL Release 2.4 accepted a REDEFINES clause in a level-01 SD or FD; Enterprise COBOL and OS/VS COBOL Release 2.4 do not.

For example, the following code sequence is not valid:

```
SD ...
01  SORT-REC-HEADER.
    05  SORT-KEY          PIC X(20).
    05  SORT-HEADER-INFO  PIC X(40).
```

```
    05  FILLER            PIC X(20).
01  SORT-REC-DETAIL REDEFINES SORT-REC-HEADER.
    05  FILLER            PIC X(20).
    05  SORT-DETAIL-INFO  PIC X(60).
```

To get similar function in Enterprise COBOL, delete the REDEFINES clause.

REDEFINES clause with tables

OS/VS COBOL allowed you to specify tables within the REDEFINES clause. For example, OS/VS COBOL would issue a warning message (RC = 4) for the following example:

```
01 E.
    03 F OCCURS 10.
        05  G PIC X.
    03 I REDEFINES F PIC X.
```

Enterprise COBOL does not allow tables to be redefined, and issues a severe (RC = 12) message for the example above.

Relation conditions

Releases prior to OS/VS COBOL Release 2.4 accepted operators in relation conditions that are not valid. The following table lists the operators accepted by OS/VS COBOL Release 2.3 that are not accepted by Enterprise COBOL. It also shows the valid coding for Enterprise COBOL programs.

OS/VS COBOL R2.3	Enterprise COBOL
= TO	= or EQUAL TO
> THAN	> or GREATER THAN
< THAN	< or LESS THAN

RENAMES clause - nonunique, nonqualified data names

No MIGR message is issued if the RENAMES clause in your OS/VS COBOL program references a nonunique, nonqualified data name. However, Enterprise COBOL does not support the use of nonunique, nonqualified data names.

SELECT statement without a corresponding FD

OS/VS COBOL accepted a SELECT statement that does not have a corresponding FD entry; Enterprise COBOL does not.

SORT statement

At early maintenance levels, the OS/VS COBOL compiler accepted the UNTIL and TIMES phrases in the SORT statement, for example:

```
SORT FILE-1
 ON ASCENDING KEY AKEY-1
  INPUT PROCEDURE IPROC-1
   OUTPUT PROCEDURE OPROC-1
    UNTIL AKEY-1 = 99.


SORT FILE-2
 ON ASCENDING KEY AKEY-2
  INPUT PROCEDURE IPROC-2
   OUTPUT PROCEDURE OPROC-2
    10 TIMES.
```

Enterprise COBOL does not accept statements such as the statements in the example above.

In a SORT statement, the correct syntax allows ASCENDING KEY or DESCENDING KEY followed by a data-name which is the sort key. The word KEY is optional.

OS/VS COBOL accepted IS if used following ASCENDING KEY. Enterprise COBOL does not accept IS in this context. For example:

```
SORT SORT-FILE
     ASCENDING KEY IS SD-NAME-FIELD
```

```
     USING INPUT-FILE
     GIVING SORTED-FILE.
```

SORT or MERGE

With OS/VS COBOL, a MOVE to the SD buffer before the first RETURN in a SORT or MERGE output PROCEDURE did not overlay the data of the first record.

In Enterprise COBOL such a MOVE would overlay the data of the first record. During a SORT or MERGE operation, the SD data item is used. You must not use it in the OUTPUT PROCEDURE before the first RETURN statement executes. If data is moved into this record area before the first RETURN statement, the first record to be returned will be overwritten.

STRING statement - sending field identifier

OS/VS COBOL allowed a numeric sending field identifier that is not an integer. Under Enterprise COBOL, a numeric sending field identifier must be an integer.

UNSTRING statement - coding with 'OR', 'IS', or a numeric edited item

OS/VS COBOL would not issue a diagnostic error message for UNSTRING statements containing any of the following instances of coding that is not valid:

1. Lack of the required word "OR" between literal-1 and literal-2, as in:

```
UNSTRING A-FIELD DELIMITED BY '-'  ','
    INTO RECV-FIELD-1
    POINTER PTR-FIELD.
```

2. Presence of the extraneous word "IS" in specifying a pointer, as in:

```
UNSTRING A-FIELD DELIMITED BY '-' OR ','
    INTO RECV-FIELD-2
    POINTER IS PTR-FIELD.
```

3. Use of a numeric edited item as the source of an UNSTRING statement, as in:

```
01 NUM-ED-ITEM    PIC $$9.99+
.
.
.
    UNSTRING NUM-ED-ITEM DELIMITED BY '$'
         INTO RECV-FIELD-1
         POINTER PTR-FIELD
```

   Enterprise COBOL allows only nonnumeric data items as senders in the UNSTRING statement.

Enterprise COBOL issues a message if an UNSTRING statement containing any of these errors is encountered.

UNSTRING statement - multiple INTO phrases

OS/VS COBOL issued a warning (RC = 4) message when multiple INTO phrases were coded. For example:

```
UNSTRING ID-SEND DELIMITED BY ALL "*"
   INTO ID-R1 DELIMITER IN ID-D1 COUNT IN ID-C1
   INTO ID-R2 DELIMITER IN ID-D2 COUNT IN ID-C2
   INTO ID-R2 DELIMITER IN ID-D3 COUNT IN ID-C3
```

Enterprise COBOL does not allow multiple INTO phrases in an UNSTRING statement.

VALUE clause - signed value in relation to the PICTURE clause

In OS/VS COBOL, the VALUE clause literal could be signed if the PICTURE clause was unsigned.

In Enterprise COBOL, the VALUE clause literal must match the PICTURE clause and the sign must be removed.

Language elements that changed from OS/VS COBOL

Several OS/VS COBOL language elements are changed in Enterprise COBOL in order to conform to 85 COBOL Standard.

For some elements, the syntax of the language is different. For others, the language syntax is unchanged, but the execution results can be different because semantics changed.

For each element listed, there is a brief description pointing out the differences in results and what actions to take. Clarifying coding examples are also given as needed.

ALPHABETIC class changes

In OS/VS COBOL, only uppercase letters and the space character were considered to be ALPHABETIC.

In Enterprise COBOL, uppercase letters, lowercase letters, and the space character are considered to be ALPHABETIC.

If your OS/VS COBOL program uses the ALPHABETIC class test, and the data tested consists of mixed uppercase and lowercase letters, there can be differences in execution results. In such cases, you can ensure identical results by substituting the Enterprise COBOL ALPHABETIC-UPPER class test for the OS/VS COBOL ALPHABETIC test.

ALPHABET-NAME clause changes: ALPHABET keyword

In OS/VS COBOL, the keyword ALPHABET was not allowed in the ALPHABET-NAMES clause.

In Enterprise COBOL, there is a keyword ALPHABET and it is required.

Arithmetic statement changes

Enterprise COBOL supports the following arithmetic items with enhanced accuracy:

- Use of floating-point data items
- Use of floating-point literals
- Use of fractional exponentiation

Therefore, for arithmetic statements that contain these items, Enterprise COBOL might provide more accurate results than OS/VS COBOL. You will need to test your applications to verify that these changes do not have a negative impact on them.

ASSIGN clause changes

Enterprise COBOL supports only the following format of the ASSIGN clause:

```
ASSIGN TO assignment-name
```

Where *assignment-name* can have the following forms:

QSAM files
[comments-][S-]name

VSAM sequential files
[comments-][AS-]name

VSAM indexed or relative files
[comments-]name

LINE SEQUENTIAL files
[comments-]name

If your OS/VS COBOL program uses other formats of the ASSIGN clause, or other forms of the *assignment-name*, you must change it to conform to the format supported by Enterprise COBOL.

B symbol in PICTURE clause: changes in evaluation

OS/VS COBOL accepted the PICTURE symbols A and B in definitions for alphabetic items.

Enterprise COBOL accepts only the PICTURE symbol A. (A PICTURE that contains both symbols A and B defines an alphanumeric edited item.)

This change can cause execution differences between OS/VS COBOL and Enterprise COBOL for evaluations of the:

- CANCEL statement
- CALL statement
- Class test
- STRING statement

CALL statement changes

OS/VS COBOL accepted paragraph names, section names, and file names in the USING phrase of the CALL statement.

Enterprise COBOL CALL statements do not accept procedure names and accept only QSAM file names in the USING phrase. Therefore, you must remove the procedure names and make sure that file names used in the USING phrase of the CALL statement name QSAM physical sequential files.

To convert OS/VS COBOL programs that call assembler programs and pass procedure names, you need to rewrite the assembler routines. In OS/VS COBOL programs, assembler routines can be written to receive an address or a list of addresses from the paragraph name that was passed as a parameter. The assembler routines can then use this address to return to an alternative place in the main program, if an error occurs.

In Enterprise COBOL, code your assembler routines so that they return to the point of origin with an assigned number. If an error occurs in the assembler program, this number can then be used to go to alternative places in the calling routine.

For example, this assembler routine in OS/VS COBOL is not valid in Enterprise COBOL :

```
CALL "ASMMOD" USING PARAMETER-1,
                    PARAGRAPH-1,
                    PARAGRAPH-2,
NEXT STATEMENT.
 . . .
PARAGRAPH-1.
 . . .
PARAGRAPH-2.
```

The sample code above should be rewritten as shown in the following example in order to compile with Enterprise COBOL:

```
CALL "ASMMOD" USING PARAMETER-1,
                    PARAMETER-2.
IF PARAMETER-2 NOT = 0
   GOTO PARAGRAPH-1,
        PARAGRAPH-2,
        DEPENDING ON PARAMETER-2.
```

In this example, you would modify the assembler program (ASMMOD) so that it does not branch to an alternative location. Instead, it will pass back the number zero to the calling routine if there are no errors, and a nonzero return value if an error occurred. The nonzero value would be used to determine which paragraph in the COBOL program would handle the error condition.

Many COBOL programmers code assembler programs that use the 390 SPIE mechanism to get control when there is an error or condition. These routines can pass control to a COBOL program at a paragraph whose name was passed to the SPIE routine. Applications that use these user-written SPIE routines should be converted to use Language Environment condition handling.

Combined abbreviated relation condition changes

Three considerations affect combined abbreviated relation conditions:

- NOT and logical operator/relational operator evaluation
- Parenthesis evaluation
- Optional word IS

All are described in the following sections.

NOT and logical operator/relational operator evaluation: OS/VS COBOL with LANGLVL(1) accepted the use of NOT in combined abbreviated relation conditions as follows:

- When only the subject of the relation condition is implied, NOT is considered a logical operator. For example:

  ```
  A = B AND NOT LESS THAN C OR D
  ```

  is equivalent to:

  ```
  ((A = B) AND NOT (A < C) OR (A < D))
  ```

- When both the subject and the relational operator are implied, NOT is considered to be part of the relational operator.

  For example:

  ```
  A > B AND NOT C
  ```

  is equivalent to:

  ```
  A > B AND A NOT > C
  ```

OS/VS COBOL with LANGLVL(2) and Enterprise COBOL in combined abbreviated relation conditions consider NOT to be:

- Part of the relational operator in the forms NOT GREATER THAN, NOT >, NOT LESS THAN, NOT <, NOT EQUAL TO, and NOT =. For example:

  ```
  A = B AND NOT LESS THAN C OR D
  ```

  is equivalent to:

  ```
  ((A = B) AND (A NOT < C) OR (A NOT < D))
  ```

- NOT in any other position is considered to be a logical operator (and thus results in a negated relation condition). For example:

  ```
  A > B AND NOT C
  ```

  is equivalent to:

  ```
  A > B AND NOT A > C
  ```

To ensure that you get the execution results that you want when moving from OS/VS COBOL with LANGLVL(1), you should expand all abbreviated combined conditions to their full unabbreviated forms.

Parenthesis evaluation: OS/VS COBOL accepted the use of parentheses within an abbreviated combined relational condition.

Enterprise COBOL supports most parentheses usage as IBM extensions. However, there are some differences:

- Within the scope of an abbreviated combined relation condition, Enterprise COBOL does not support relational operators inside parentheses. For example:

  ```
  A = B AND  ( < C OR D)
  ```

- Some incorrect usages of parentheses in relation conditions were accepted by OS/VS COBOL, but are not accepted by Enterprise COBOL. For example:

  ```
  (A = 0 AND B) = 0
  ```

Optional word IS: OS/VS COBOL accepted the optional word IS immediately preceding objects within an abbreviated combined relation condition. For example:

```
A = B OR IS C AND IS D
```

Enterprise COBOL does not accept this use of the optional word IS. In Enterprise COBOL, delete the word IS when used in this manner.

Enterprise COBOL does permit the use of the optional word IS as part of the relational operator in abbreviated combined relational conditions. For example:

```
A = B OR IS = C AND IS = D
```

COPY statement with associated names

OS/VS COBOL with LANGLVL(1) allowed COPY statements to be preceded by an 01-level indicator, which would result in the 01-level name replacing the 01-level name in the COPY member. For example, with the following contents of COPY member MBR-A:

```
01 RECORD-A.
   05 FIELD-A...
   05 FIELD-B...
```

and a COPY statement like this:

```
01  RECORD1 COPY MBR-A.
```

the resultant source would look like this:

```
01  RECORD1.
    05 FIELD-A...
    05 FIELD-B...
```

Enterprise COBOL does not accept this COPY statement. To compile with Enterprise COBOL, use the following statement:

```
01  RECORD1.
    COPY MBR-A REPLACING ==01 RECORD-A.== BY == ==.
```

CURRENCY-SIGN clause changes: '/', '=', and 'L' characters

OS/VS COBOL with LANGLVL(1), accepted the '/' (slash) character, the 'L' character, and the '=' (equal) sign in the CURRENCY-SIGN clause.

Enterprise COBOL does not accept these characters as valid.

If these characters are present, you must remove them from the CURRENCY SIGN clause.

Dynamic CALL statements to ENTRY points

OS/VS COBOL allowed dynamic CALL statements to alternate entry points of subprograms without an intervening CANCEL, in some cases.

Enterprise COBOL always requires an intervening CANCEL. When converting these programs, add an intervening CANCEL between dynamic CALL statements referencing alternate ENTRY points of subprograms.

EXIT PROGRAM/GOBACK statement changes

In OS/VS COBOL, when an EXIT PROGRAM or GOBACK statement was executed, if the end of range of a PERFORM statement within it had not been reached, the PERFORM statement remained in its uncompleted state.

In Enterprise COBOL, when an EXIT PROGRAM or GOBACK statement is executed, the end of range of every PERFORM statement within it is considered to have been reached.

FILE STATUS clause changes

In Enterprise COBOL, status key values have been changed from those received from OS/VS COBOL:

- For QSAM files, see Table 10 on page 73.

- For VSAM files, see Table 11 on page 73.

If your OS/VS COBOL program uses status key values to determine the course of execution, you must modify the program to use the new status key values. For complete information about Enterprise COBOL file status codes, see the *Enterprise COBOL Language Reference*.

Table 10. Status key values: QSAM files

OS/VS	Enterprise COBOL	Meaning
(undefined)	04	Wrong length record; successful completion
(undefined)	05	Optional file not available; successful completion
(undefined)	07	NO REWIND/REEL/UNIT/FOR REMOVAL specified for OPEN or CLOSE, but file not on a reel/unit medium; successful completion
00	00	Successful completion
10	10	At END (no next logical record); successful completion
30	30	Permanent error
34	34	Permanent error file boundary violation
90	90	Other errors with no further information
90	35	Nonoptional file not available
90	37	Device type conflict
90	39	Conflict of fixed file attributes; OPEN fails
90	96	No file identification (no DD statement for the file)
92	38	OPEN attempted for file closed WITH LOCK
92	41	OPEN attempted for a file in OPEN mode
92	42	CLOSE attempted for a file not in OPEN mode
92	43	REWRITE attempted when last I/O statement was not READ
92	44	Attempt to rewrite a sequential file record with a record of a different size
92	46	Sequential READ attempted with no valid next record
92	47	READ attempted when file not in OPEN INPUT or I-O mode
92	48	WRITE attempted when file not in OPEN OUTPUT, I-O, or EXTEND mode
00	48	WRITE attempted when file in OPEN I-O mode
92	49	DELETE or REWRITE attempted when file not in OPEN I-O mode
92	92	Logic error

Table 11. Status key values: VSAM files

OS/VS	Enterprise COBOL	Meaning
(undefined)	14	On sequential READ for relative file, size of relative record number too large for relative key

Table 11. Status key values: VSAM files (continued)

OS/VS	Enterprise COBOL	Meaning
00	00	Successful completion
00	04	Wrong length record; successful completion
00	05	Optional file not available; successful completion
00	35	Nonoptional file not available. Can occur when the file is empty.
02	02	Duplicate key, and DUPLICATES specified; successful completion
10	10	At END (no next logical record); successful completion
21	21	Key not valid for a VSAM indexed or relative file; sequence error
22	22	Key not valid for a VSAM indexed or relative file; duplicate key and duplicates not allowed
23	23	Key not valid for a VSAM indexed or relative file; no record found
24	24	Key not valid for a VSAM indexed or relative file; attempt to write beyond file boundaries Enterprise COBOL: for a WRITE to a relative file, size of relative record number too large for relative key
30	30	Permanent error
90	37	Attempt to open a file not on a mass storage device
90	90	Other errors with no further information
91	91	VSAM password failure
92	41	OPEN attempted for a file in OPEN mode
92	42	CLOSE attempted for a file not in OPEN mode
92	43	REWRITE attempted when last I/O statement was not READ or DELETE
92	47	READ attempted when file not in OPEN INPUT or I-O mode
92	48	WRITE attempted when file not in OPEN OUTPUT, I-O, or EXTEND mode
92	49	DELETE or REWRITE attempted when file not in OPEN I-O mode
93	93	VSAM resource not available
93 96	35	Nonoptional file not available
94	46	Sequential READ attempted with no valid next record
95	39	Conflict of fixed file attributes; OPEN fails
95	95	Not valid or incomplete VSAM file information
96	96	No file identification (no DD statement for this VSAM file)

Table 11. Status key values: VSAM files (continued)

OS/VS	Enterprise COBOL	Meaning
97	97 (when VSAMOPENFS(COMPAT), the default, is in effect)	OPEN statement execution successful; file integrity verified
	00 (when VSAMOPENFS(SUCC) is in effect)	OPEN statement execution successful; file integrity verified

IF . . . OTHERWISE statement changes

OS/VS COBOL allowed IF statements of the nonstandard format:

```
IF condition THEN statement-1 OTHERWISE statement-2
```

Enterprise COBOL allows only IF statements having the standard format:

```
IF condition THEN statement-1 ELSE statement-2
```

Therefore, OS/VS COBOL programs containing nonstandard IF . . . OTHERWISE statements must be changed to standard IF . . . ELSE statements.

JUSTIFIED clause changes

Under OS/VS COBOL with LANGLVL(1), if a JUSTIFIED clause is specified together with a VALUE clause for a data description entry, the initial data is right-justified. For example:

```
77  DATA-1 PIC X(9) JUSTIFIED VALUE "FIRST".
```

results in "FIRST" occupying the five rightmost character positions of DATA-1:

```
bbbbFIRST
```

In Enterprise COBOL, the JUSTIFIED clause does not affect the initial placement of the data within the data item. If a VALUE and JUSTIFIED clause are both specified for an alphabetic or alphanumeric item, the initial value is left-justified within the data item. For example:

```
77  DATA-1 PIC X(9) JUSTIFIED VALUE "FIRST".
```

results in "FIRST" occupying the five leftmost character positions of DATA-1:

```
FIRSTbbbb
```

To achieve unchanged results in Enterprise COBOL, you can specify the literal value as occupying all nine character positions of DATA-1. For example:

```
77  DATA-1 PIC X(9) JUSTIFIED VALUE "    FIRST".
```

which right-justifies the value in DATA-1:

```
bbbbFIRST
```

MOVE statements and comparisons: scaling changes

In OS/VS COBOL with LANGLVL(1), if either the sending field in a MOVE statement or a field in a comparison is a scaled integer (that is, if the rightmost PICTURE symbols are the letter P) and the receiving field (or the field to be compared) is alphanumeric or numeric-edited, the trailing zeros (0) are truncated.

For example, after the following MOVE statement is executed:

```
05  SEND-FIELD     PICTURE 999PPP VALUE 123000.
05  RECEIVE-FIELD  PICTURE XXXXXX.
```

```
    . . .
    MOVE SEND-FIELD TO RECEIVE-FIELD.
```

RECEIVE-FIELD contains the value 123*bbb* (left-justified), where '*b*' represents a blank.

With Enterprise COBOL, a MOVE statement transfers the trailing zeros, and a comparison includes them.

For example, after the following MOVE statement is executed:

```
05  SEND-FIELD     PICTURE 999PPP VALUE 123000.
05  RECEIVE-FIELD  PICTURE XXXXXX.
    . . .
    MOVE SEND-FIELD TO RECEIVE-FIELD.
```

RECEIVE-FIELD contains the value 123000.

Numeric class test on group items

OS/VS COBOL allowed the IF NUMERIC class test to be used with group items that contained one or more signed elementary items.

For example, `IF grp1 IS NUMERIC`, when `grp1` is a group item:

```
01 grp1.
   03 yy PIC S99.
   03 mm PIC S99.
   03 dd PIC S99.
```

Enterprise COBOL issues an S-level message when the IF NUMERIC class test is used for GROUP items whose subordinates are signed.

Numeric data changes

Enterprise COBOL uses the NUMPROC compiler option to alter the code generated for decimal data. While NUMPROC(NOPFD) will cause processing more similar to OS/VS COBOL than NUMPROC(PFD), results are not the same in all cases. The results of MOVE statements, comparisons, and arithmetic statements might differ from OS/VS COBOL, particularly when the fields have not been initialized.

Programs that rely on data exceptions to either identify contents of decimal data items that are not valid or to terminate abnormally might need to be changed to use the class test to validate data in decimal data items.

Since Enterprise COBOL V5.2, you can use the ZONEDATA(MIG) compiler option to ease your migration to COBOL V5 or V6. When the ZONEDATA(MIG) option is in effect, the compiler generates instructions to do numeric comparisons that ignore the zone bits of each digit in zoned decimal data items. The compiler will also avoid performing known optimizations that might produce a different result than COBOL V4 when a zoned decimal data item has invalid zone bits. For more information, see ZONEDATA.

OCCURS DEPENDING ON clause: ASCENDING and DESCENDING KEY phrase

OS/VS COBOL accepted a variable-length key in the ASCENDING and DESCENDING KEY phrases of the OCCURS DEPENDING ON clauses as an IBM extension.

In Enterprise COBOL, you cannot specify a variable-length key in the ASCENDING or DESCENDING KEY phrase.

OCCURS DEPENDING ON clause: value for receiving items changed

In OS/VS COBOL, the current value of the OCCURS DEPENDING ON (ODO) object is always used for both sending and receiving items.

In Enterprise COBOL, for sending items, the current value of the ODO object is used. For receiving items:

- If a group item contains both the subject and object of an ODO, and is not followed in the same record by a nonsubordinate data item, the maximum length of the item is used.
- If a group item contains both the subject and object of an ODO and is followed in the same record by a nonsubordinate data item, the actual length of the receiving item is used.

- If a group item contains the subject, but not the object of an ODO, the actual length of the item is used.

When the maximum length is used, it is not necessary to initialize the ODO object before the table receives data. For items whose location depends on the value of the ODO object, you need to set the object of the OCCURS DEPENDING ON clause before using them in the using phrase of a CALL statement. Under Enterprise COBOL, for any variable-length group that is not variably located, you do not need to set the object for the item when it is used in the USING BY REFERENCE phrase of the CALL statement. This is true even if the group is described by the second bullet above.

For example:

```
01  TABLE-GROUP-1
    05  ODO-KEY-1 PIC 99.
    05  TABLE-1 PIC X(9)
        OCCURS 1 TO 50 TIMES DEPENDING ON ODO-KEY-1.
01  ANOTHER-GROUP.
    05  TABLE-GROUP-2.
        10  ODO-KEY-2 PIC 99.
        10  TABLE-2 PIC X(9)
            OCCURS 1 to 50 TIMES DEPENDING ON ODO-KEY-2.
    05  VARIABLY-LOCATED-ITEM PIC X(200).
    . . .
PROCEDURE DIVISION.
    . . .
   MOVE SEND-ITEM-1 TO TABLE-GROUP-1
    . . .
   MOVE ODO-KEY-X TO ODO-KEY-2
   MOVE SEND-ITEM-2 TO TABLE-GROUP-2.
```

When TABLE-GROUP-1 is a receiving item, Enterprise COBOL moves the maximum number of character positions for it (450 bytes for TABLE-1 plus two bytes for ODO-KEY-1). Therefore, you need not initialize the length of TABLE-1 before moving the SEND-ITEM-1 data into the table.

However, a nonsubordinate VARIABLY-LOCATED-ITEM follows TABLE-GROUP-2 in the record description. In this case, Enterprise COBOL uses the actual value in ODO-KEY-2 to calculate the length of TABLE-GROUP-2, and you must set ODO-KEY-2 to its valid current length before moving the SEND-ITEM-2 data into the group receiving item.

ON SIZE ERROR phrase: changes in intermediate results

For OS/VS COBOL, the SIZE ERROR phrase for the DIVIDE and MULTIPLY statements applied to both intermediate and final results.

For Enterprise COBOL, the SIZE ERROR phrase for the DIVIDE and MULTIPLY statements applies only to final results. This is a change between the 74 COBOL Standard and the 85 COBOL Standard. This change might or might not affect your programs.

Therefore, if your OS/VS COBOL program depends upon SIZE ERROR detection for intermediate results, you might need to change it.

Optional word IS

For OS/VS COBOL programs, no MIGR message would be issued if the optional word IS immediately preceded objects within an abbreviated combined relation condition. For example:

```
A = B OR IS C AND IS D
```

Enterprise COBOL does not accept this use of the optional word IS. In Enterprise COBOL, delete the word IS when used in this manner.

Enterprise COBOL does permit the use of the optional word IS as part of the relational operator in abbreviated combined relational conditions. For example:

```
A = B OR IS = C AND IS = D
```

PERFORM statement: changes in the VARYING/AFTER phrases

In OS/VS COBOL, in a PERFORM statement with the VARYING/AFTER phrases, two actions take place when an inner condition tests as TRUE:

1. The identifier/index associated with the inner condition is set to its current FROM value.
2. The identifier/index associated with the outer condition is augmented by its current BY value.

In Enterprise COBOL in such a PERFORM statement, the following results take place when an inner condition tests as TRUE:

1. The identifier/index associated with the outer condition is augmented by its current BY value.
2. The identifier/index associated with the inner condition is set to its current FROM value.

The following example illustrates the differences in results:

```
PERFORM ABC VARYING X FROM 1 BY 1 UNTIL X > 3
            AFTER Y FROM X BY 1 UNTIL Y > 3
```

In OS/VS COBOL, ABC is executed 8 times with the following values:

```
X:  1  1  1  2  2  2  3  3
Y:  1  2  3  1  2  3  2  3
```

In Enterprise COBOL, ABC is executed 6 times with the following values:

```
X:  1  1  1  2  2  3
Y:  1  2  3  2  3  3
```

By using nested PERFORM statements, you could achieve the same processing results as in OS/VS COBOL, as follows:

```
MOVE 1 TO X, Y, Z
PERFORM EX-1 VARYING X FROM 1 BY 1 UNTIL X > 3
. . .
EX-1.
    PERFORM ABC VARYING Y FROM Z BY 1 UNTIL Y > 3.
    MOVE X TO Z.
ABC.
```

PROGRAM COLLATING SEQUENCE clause changes

In OS/VS COBOL, the collating sequence specified in the *alphabet-name* of the PROGRAM COLLATING SEQUENCE clause is applied to comparisons implicitly performed during execution of INSPECT, STRING, and UNSTRING statements.

In Enterprise COBOL, the collating sequence specified in *alphabet-name* is not used for these implicit comparisons.

READ and RETURN statement changes: INTO phrase

When the sending field is chosen for the move associated with a READ or RETURN . . . INTO identifier statement, OS/VS COBOL and Enterprise COBOL can select different records from under the FD or SD to use as the sending field. This only affects implicit elementary MOVE statements, when the record description has a PICTURE clause.

RERUN clause changes

When the RERUN clause is specified, OS/VS COBOL takes a checkpoint on the first record; Enterprise COBOL does not.

RESERVE clause changes

OS/VS COBOL supported the following formats of the FILE CONTROL paragraph RESERVE clause:

```
RESERVE NO ALTERNATE AREA
RESERVE NO ALTERNATE AREAS
RESERVE integer ALTERNATE AREA
RESERVE integer ALTERNATE AREAS
RESERVE integer AREA
RESERVE integer AREAS
```

Enterprise COBOL supports only the following forms of the RESERVE clause:

```
RESERVE integer AREA
RESERVE integer AREAS
```

If your OS/VS COBOL program uses either the RESERVE integer ALTERNATE AREA or the RESERVE integer ALTERNATE AREAS format, you must specify the RESERVE clause with *integer + 1* areas to get equivalent processing under Enterprise COBOL. That is, the OS/VS COBOL phrase RESERVE 2 ALTERNATE AREAS is equivalent to RESERVE 3 AREASA in Enterprise COBOL.

Under OS/VS COBOL with LANGLVL(1), the interpretation of the RESERVE integer AREAS format differed from the interpretation of this format using Enterprise COBOL.

With LANGLVL(1), using the RESERVE integer AREA or RESERVE integer AREAS format, you must specify the RESERVE clause with *integer + 1* areas to get equivalent processing under Enterprise COBOL.

Reserved word list changes

Differences exist between the reserved word list for Enterprise COBOL and OS/VS COBOL. Appendix B, “COBOL reserved word comparison,” on page 241 contains a complete listing of reserved words.

SEARCH statement changes

In OS/VS COBOL, the ASCENDING and DESCENDING KEY data items could be specified either as the subject or as the object of the WHEN relation-condition of the SEARCH statement.

In Enterprise COBOL, the WHEN phrase data-name (the subject of the WHEN relation-condition) must be an ASCENDING or a DESCENDING KEY data item in this table element, and identifier-2 (the object of the WHEN relation-condition) must not be an ASCENDING or DESCENDING key data item for this table element.

OS/VS COBOL accepted the following statement; Enterprise COBOL does not:

```
WHEN VAL = KEY-1 ( INDEX-NAME-1 )
  DISPLAY "TABLE RECORDS OK".
```

The following SEARCH example will execute under both Enterprise COBOL andOS/VS COBOL:

```
01  VAL  PIC X.
01  TABLE-01.
    05  TABLE-ENTRY
           OCCURS 100 TIMES
           ASCENDING KEY IS KEY-1
           INDEXED BY INDEX-NAME-1.
        10  FILLER PIC X.
        10  KEY-1 PIC X.
    SEARCH ALL TABLE-ENTRY
        AT END DISPLAY "ERROR"
      WHEN KEY-1 ( INDEX-NAME-1 ) = VAL
        DISPLAY "TABLE RECORDS OK".
```

Segmentation changes: PERFORM statement in independent segments

In OS/VS COBOL with LANGLVL(1), if a PERFORM statement in an independent segment refers to a permanent segment, the independent segment is initialized upon each exit from the performed procedures.

In OS/VS COBOL with LANGLVL(2), for a PERFORM statement in an independent segment that refers to a permanent segment, control is passed to the performed procedures only once for each execution of the PERFORM statement.

In Enterprise COBOL, the compiler does not perform overlay; therefore, the rules given above do not apply.

If your program logic depends upon either of the OS/VS COBOL implementations of these segmentation rules, you must rewrite the program.

SELECT OPTIONAL clause changes

In OS/VS COBOL with LANGLVL(1), if the SELECT OPTIONAL clause is specified in the file control entry, the program will fail if the file is not available. In Enterprise COBOL, if the SELECT OPTIONAL clause is specified in the file control entry, the program will *not* fail if the file is not available and a file status code of 05 is returned. A USERMOD can influence this behavior for VSAM. For details, see: *Language Environment Installation and Customization*.

SORT special registers

The SORT-CORE-SIZE, SORT-FILE-SIZE, SORT-MESSAGE, and SORT-MODE-SIZE special registers are supported under Enterprise COBOL, and they will be used in the SORT interface when they have nondefault values. However, at run time, individual SORT special registers will be overridden by the corresponding parameters on control statements that are included in the SORT-CONTROL file, and a message will be issued. In addition, a compiler warning message (W-level) will be issued for each SORT special register that was set in the program.

In OS/VS COBOL, the SORT-RETURN special register can contain codes for successful SORT completion (RC=0), OPEN or I/O errors concerning the USING or GIVING files (RC=2 through RC=12), and unsuccessful SORT completion (RC=16). In Enterprise COBOL, the SORT-RETURN register only contains codes for successful (RC=0) and unsuccessful (RC=16) SORT completion.

Source language debugging changes

With Enterprise COBOL and OS/VS COBOL, you can debug source language with the USE FOR DEBUGGING declarative. Valid operands are shown in Table 12 on page 80. Operands that are not valid in Enterprise COBOL must be removed from the OS/VS COBOL program. Use Debug Tool to achieve the same debugging results.

Table 12. USE FOR DEBUGGING declarative: valid operands

Debugging operands		Procedures are executed immediately:
OS/VS COBOL	**Enterprise COBOL**	
procedure-name-1	procedure-name-1	Before each execution of the named procedure. After execution of an ALTER statement referring to the named procedure.
ALL PROCEDURES	ALL PROCEDURES	Before execution of every nondebugging procedure in the outermost program After execution of every ALTER statement in the outermost program (except ALTER statements in declarative procedures).
file-name-n	(none)	See the *IBM VS COBOL for OS/VS* for a description.
ALL REFERENCES OF identifier-n	(none)	See the *IBM VS COBOL for OS/VS* for a description.
cd-name-1	(none)	See the *IBM VS COBOL for OS/VS* for a description.

Subscripts out of range flagged at compile time

Enterprise COBOL issues an error (RC = 8) message if a literal subscript or index value is coded that is greater than the allowed maximum, or less than one. This message is generated whether or not the SSRANGE option is specified.

OS/VS COBOL did not issue an equivalent error message.

UNSTRING statements: subscript evaluation changes

In the UNSTRING statements for OS/VS COBOL, any associated subscripting, indexing, or length calculation would be evaluated immediately before the transfer of data into the receiving item for the DELIMITED BY, INTO, DELIMITER IN, and COUNT IN fields.

For these fields, in the Enterprise COBOL UNSTRING statement, any associated subscripting, indexing, or length calculation is evaluated once: immediately before the examination of the delimiter sending fields. For example:

```
01  ABC     PIC  X(30).
01  IND.
    02 IND-1 PIC 9.
01  TAB.
    02 TAB-1 PIC X OCCURS 10 TIMES.
01  ZZ      PIC  X(30).
 . . .
    UNSTRING ABC DELIMITED BY TAB-1 (IND-1) INTO IND ZZ.
```

In OS/VS COBOL, subscript IND-1 would be reevaluated before the second receiver ZZ was filled.

In Enterprise COBOL, the subscript IND-1 is evaluated only once at the beginning of the execution of the UNSTRING statement.

In OS/VS COBOL with LANGLVL(1), when the DELIMITED BY ALL phrase of UNSTRING is specified, two or more contiguous occurrences of any delimiter are treated as if they were only one occurrence. As much of the first occurrence as will fit is moved into the current delimiter receiving field (if specified). Each additional occurrence is moved only if the complete occurrence will fit. For more information about the behavior of this phrase in OS/VS COBOL, see the *IBM VS COBOL for OS/VS*.

In Enterprise COBOL, one or more contiguous occurrences of any delimiters are treated as if they are only one occurrence, and this one occurrence is moved to the delimiter receiving field (if specified).

For example, if ID-SEND contains 123**45678**90AB:

```
UNSTRING ID-SEND DELIMITED BY ALL "*"
    INTO ID-R1 DELIMITER IN ID-D1 COUNT IN ID-C1
         ID-R2 DELIMITER IN ID-D2 COUNT IN ID-C2
         ID-R3 DELIMITER IN ID-D3 COUNT IN ID-C3
```

OS/VS COBOL with LANGLVL(1), will produce this result:

```
ID-R1  123       1D-D1  **        ID-C1  3
ID-R2  45678     1D-D2  **        ID-C2  5
ID-R3  90AB      1D-D3             ID-C3  4
```

OS/VS COBOL with LANGLVL(2) and Enterprise COBOL will produce this result:

```
ID-R1  123       1D-D1  *         ID-C1  3
ID-R2  45678     1D-D2  *         ID-C2  5
ID-R3  90AB      1D-D3             ID-C3  4
```

UPSI switches

OS/VS COBOL allowed references to UPSI switches and mnemonic names associated with UPSI. Enterprise COBOL allows condition-names only.

For example, if a condition-name is defined in the SPECIAL-NAMES paragraph, the following code examples have the same effect:

```
OS/VS COBOL                    Enterprise COBOL

SPECIAL-NAMES.                 SPECIAL-NAMES.
    UPSI-0 IS MNUPO                UPSI-0 IS MNUPO
                                    ON STATUS IS UPSI-0-ON
                                    OFF STATUS IS UPSI-0-OFF
       . . .                         . .  .
PROCEDURE DIVISION             PROCEDURE DIVISION
      . . .                          . .  .
    IF UPSI-0 = 1 ...              IF UPSI-0-ON ...
    IF MNUPO = 0 ...               IF UPSI-0-OFF ...
```

VALUE clause condition names

For VALUE clause condition names, releases prior to Release 2.4 of OS/VS COBOL allowed the initialization of an alphanumeric field with a numeric value. For example:

```
01 FIELD-A.
    02   LAST-YEAR  PIC XX VALUE 87.
    02   THIS-YEAR  PIC XX VALUE 88.
    02   NEXT-YEAR  PIC XX VALUE 89.
```

Enterprise COBOL does not accept this language extension. Therefore, to correct the above example, you should code alphanumeric values in the VALUE clauses, as in the following example:

```
01 FIELD-A.
    02   LAST-YEAR  PIC XX VALUE "87".
    02   THIS-YEAR  PIC XX VALUE "88".
    02   NEXT-YEAR  PIC XX VALUE "89".
```

WHEN-COMPILED special register

Enterprise COBOL and OS/VS COBOL support the use of the WHEN-COMPILED special register. The rules for use of the special register are the same for both compilers. However, the format of the data differs.

In OS/VS COBOL the format is:

```
hh.mm.ssMMM DD, YYYY  (hour.minute.secondMONTH DAY, YEAR)
```

In Enterprise COBOL the format is:

```
MM/DD/YYhh.mm.ss  (MONTH/DAY/YEARhour.minute.second)
```

WRITE AFTER POSITIONING statement

OS/VS COBOL supported the WRITE statement with the AFTER POSITIONING phrase; Enterprise COBOL does not.

In Enterprise COBOL, you can use the WRITE . . . AFTER ADVANCING statement to obtain behavior similar to WRITE . . . AFTER POSITIONING. The following two examples show OS/VS COBOL POSITIONING phrases and the equivalent Enterprise COBOL phrases.

When using WRITE . . . AFTER ADVANCING with literals:

```
   OS/VS COBOL                              Enterprise COBOL

AFTER POSITIONING 0                    AFTER ADVANCING PAGE
AFTER POSITIONING 1                    AFTER ADVANCING 1 LINE
AFTER POSITIONING 2                    AFTER ADVANCING 2 LINES
AFTER POSITIONING 3                    AFTER ADVANCING 3 LINES
```

When using WRITE...AFTER ADVANCING with nonliterals:

```
WRITE OUTPUT-REC AFTER POSITIONING SKIP-CC.

   OS/VS COBOL                              Enterprise COBOL
                           SKIP-CC


AFTER POSITIONING SKIP-CC      1         AFTER ADVANCING PAGE
AFTER POSITIONING SKIP-CC     ' '        AFTER ADVANCING 1 LINE
AFTER POSITIONING SKIP-CC      0         AFTER ADVANCING 2 LINES
AFTER POSITIONING SKIP-CC      -         AFTER ADVANCING 3 LINES
```

Restriction: With Enterprise COBOL, channel skipping is only supported with references to SPECIAL-NAMES.

CCCA can automatically convert WRITE . . . AFTER POSITIONING statements. For example, given the following statement:

```
WRITE OUTPUT-REC AFTER POSITIONING n.
```

If n is a literal, CCCA would change the above example to `WRITE...AFTER ADVANCING n LINES`. If n is an identifier, SPECIAL-NAMES are generated and a section is added at the end of the program.

Chapter 7. Compiling converted OS/VS COBOL programs

This section contains information about the following topics:

- Compiler options for converted programs
- Unsupported OS/VS COBOL compiler options
- Prolog format changes

Information specific to OS/VS COBOL or Enterprise COBOL is noted.

Compiler options for converted programs

Table 13 on page 85 lists the compiler options that have special relevance to converted programs.

Table 13. Compiler options for converted OS/VS COBOL programs

Compiler option	Comments
BUFSIZE	In OS/VS COBOL, the BUF option value specifies the total number of bytes reserved for buffers. In Enterprise COBOL, BUFSIZE specifies the amount of buffer storage reserved for each compiler work data set. The default is 4096. If your OS/VS COBOL program uses the BUF option, you must adjust the amount requested in your Enterprise COBOL BUFSIZE option.
DATA(24)	Use DATA(24) for Enterprise COBOL programs that are compiled with RENT and mixed with AMODE 24 assembler programs.
DIAGTRUNC	Use DIAGTRUNC to get numeric truncation flagging for MOVE statements. This is similar to the flagging in OS/VS COBOL.
NOSTGOPT	Use NOSTGOPT if you have unreferenced data items as eye-catchers or time/version stamps in WORKING-STORAGE. Use STGOPT only if you do not need unused data items, or the unused data items are defined with the VOLATILE clause.
NUMPROC	Use NUMPROC(NOPFD) plus the installation option NUMCLS(ALT) if you were using the USERMOD shipped with OS/VS COBOL. With the USERMOD, characters A, B, and E (as well as C, D, and F) are considered valid numeric signs in the COBOL numeric class test. For other alternatives for sign representation, see the *Enterprise COBOL Programming Guide*.
OUTDD(ddname)	Use this option to override the default ddname (SYSOUT) for SYSOUT output that goes to the system logic output unit. If the ddname is the same as the Language Environment MSGFILE ddname, the output is routed to the ddname designated for MSGFILE. If the ddname is *not* the same as the Language Environment MSGFILE ddname, the output from the DISPLAY statement is directed to the OUTDD ddname destination. If the ddname is not present at first reference, dynamic allocation will take place with the default name and attributes that are specified by Language Environment.
PGMNAME(COMPAT)	Use PGMNAME(COMPAT) to ensure that program names are processed in a manner compatible with OS/VS COBOL.

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Table 13. Compiler options for converted OS/VS COBOL programs (continued)

Compiler option	Comments
TRUNC	TRUNC controls the way arithmetic fields are truncated into binary receiving fields during MOVE and arithmetic operations. Use TRUNC(STD) if your shop used TRUNC as the default with OS/VS COBOL. Use TRUNC(OPT) if your shop uses NOTRUNC as the default with OS/VS COBOL (except for select programs that require guaranteed nontruncation of binary data). For programs that require nontruncation of binary data, use TRUNC(BIN), especially if there is a possibility that data being moved into binary data items can have a value larger than that defined by the PICTURE clause for the binary data item. For individual data items you can specify USAGE COMP-5 to get guaranteed nontruncation of binary data. **High-order digits:** Enterprise COBOL programs compiled with TRUNC(OPT) can give different results than OS/VS COBOL programs compiled with NOTRUNC. The main difference is that programs can lose nonzero high-order digits. For statements for which a loss of high-order digits might take place, Enterprise COBOL issues a diagnostic message indicating that you should ensure that at least one of the following conditions is met: • The sending items will not contain large numbers. • The receiving items are defined with enough digits in the PICTURE clause to handle the largest sending data items.

Unsupported OS/VS COBOL compiler options

Table 14 on page 86 shows the OS/VS COBOL compiler options that are not supported by Enterprise COBOL.

For a complete list of Enterprise COBOL compiler options, see Appendix E, “Option comparison,” on page 277.

Table 14. OS/VS COBOL compiler options not supported by Enterprise COBOL

OS/VS COBOL option	Enterprise COBOL equivalent
BATCH/NOBATCH	Batch environment is always available (sequence of programs). CBL statements are always processed with Enterprise COBOL. Enterprise COBOL considerations for sequence of programs are described in the *Enterprise COBOL Programming Guide*.
COUNT/NOCOUNT	Similar function is available in Debug Tool.
ENDJOB/NOENDJOB	ENDJOB behavior is always in effect.
LANGLVL(1/2)	The LANGLVL option is not available. Enterprise COBOL supports only 85 COBOL Standard.
LVL=A|B|C|D/ NOLVL	FLAGSTD is used for FIPS flagging. ANSI COBOL 74 FIPS is not supported.
RES/NORES	The RES or NORES option is not available. With Enterprise COBOL, the object module is always treated such that library subroutines are located dynamically at run time, instead of being link-edited with the COBOL program. This is equivalent to RES behavior in OS/VS COBOL.
STATE/NOSTATE	Function is available with the TEST option.
SUPMAP/NOSUPMAP	Equivalent to the NOCOMPILE/COMPILE compiler option.

Table 14. OS/VS COBOL compiler options not supported by Enterprise COBOL (continued)

OS/VS COBOL option	Enterprise COBOL equivalent
SYMDMP/ NOSYMDMP	ABEND dumps and dynamic dumps are available through Language Environment services. Symbolic dumps are available through using the TEST compiler option.
SXREF/NOSXREF	The XREF option provides sorted SXREF output.
VBSUM/NOVBSUM	Function is available with the VBREF compiler option.
CDECK/NOCDECK	The LISTER feature is not supported.
FDECK/NOFDECK	The LISTER feature is not supported.
LCOL1/LCOL2	The LISTER feature is not supported.
LSTONLY/LSTCOMP NOLST	The LISTER feature is not supported.
L120/L132	The LISTER feature is not supported.
OSDECK	With Enterprise COBOL, the object deck runs only in the z/OS environment, not z/VM®. The OSDECK function is not supported.

Prolog format changes

The prolog of an object program is the code that the compiler generates at the entry point of the program. It also contains data that identifies the program.

Object modules generated by Enterprise COBOL are Language Environment conforming, and thus have a different prolog format than with OS/VS COBOL. You will need to update existing assembler programs that scan for date and time to the new format.

You can compile your programs with the Enterprise COBOL LIST compiler option to generate a listing that you can use to compare the OS/VS COBOL prolog format with the Enterprise COBOL prolog format.

Chapter 8. Upgrading VS COBOL II source programs

There are differences between the VS COBOL II language and the Enterprise COBOL language that might require that you modify your programs.

Your VS COBOL II programs will compile without change using the Enterprise COBOL compiler unless the programs meet one or more of the following conditions:

- Programs were compiled with the CMPR2 compiler option. Enterprise COBOL does not support the CMPR2/NOCMPR2 compiler option.
- Programs were compiled with VS COBOL II Release 3.x, and that contain one or more of three minor 85 COBOL Standard features that were subject to 85 COBOL Standard interpretation changes
- Programs were compiled with VS COBOL II Release 3.0 and that use ACCEPT . . . FROM CONSOLE
- Programs use words which are now reserved in Enterprise COBOL
- Programs with undocumented VS COBOL II extensions
- Programs with SEARCH ALL statements
- Programs use the SIMVRD support
- Programs contain the format 2 declarative syntax: `USE...AFTER...LABEL PROCEDURE...`, and optionally the syntax: `GO TO MORE-LABELS`. The support for these were removed in Enterprise COBOL Version 5

Upgrading VS COBOL II programs compiled with the CMPR2 compiler option

If your VS COBOL II source programs were compiled with the CMPR2 compiler option, you must convert them to NOCMPR2 programs in order to compile them with Enterprise COBOL. The CMPR2/NOCMPR2 compiler option is not supported in Enterprise COBOL. Enterprise COBOL programs behave as if NOCMPR2 was always in effect. For information about language differences between CMPR2 and NOCMPR2 (85 COBOL Standard), see "Upgrading programs compiled with the CMPR2 compiler option" on page 104.

For information about tools that will help with the CMPR2 to NOCMPR2 conversion, see Appendix C, "Conversion tools for source programs," on page 263.

85 COBOL Standard interpretation changes

Some language differences exist between programs compiled with NOCMPR2 on VS COBOL II Release 3 (including 3.0, 3.1, and 3.2) and programs compiled with NOCMPR2 on subsequent releases (including VS COBOL II Release 4, IBM COBOL, and Enterprise COBOL). These changes are the result of responses from COBOL Standard Interpretation Requests that required an implementation different from that used in VS COBOL II Release 3. Most likely you do not have these very minor differences in your programs because of their rarity. However, the following language elements are affected:

- REPLACE and comment lines
- Precedence of USE procedures for nested programs
- Reference modification of a variable-length group receiver with no length specified

REPLACE and comment lines

This item affects the treatment of blank lines and comment lines that are displayed in text that matches pseudo-text-1 of REPLACE statements.

Blank lines, which are interspersed in the matched text, will not be displayed in the output of the REPLACE statement. This change could affect the semantics of the resulting program since the line

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numbers could be different. (For example, if a program uses the USE FOR DEBUGGING declarative, the contents of DEBUG-ITEM might be different). If an Enterprise COBOL generated program differs from the equivalent VS COBOL II program, the following message will be issued:

IGYLI0193-I
Matched pseudo-text-1 contained blank or comment lines. Execution results may differ from VS COBOL II Release 3.x.

Precedence of USE procedures

This difference affects the precedence of USE procedures relating to contained programs.

In VS COBOL II Release 3.x, a file-specific USE procedure always takes precedence over a mode-specific USE procedure. This precedence occurs if an applicable mode-specific USE procedure exists in the current program, or if a mode-specific USE procedure with the GLOBAL attribute in an outer program is "nearer" than the file-specific procedure.

In VS COBOL II Release 4 and Enterprise COBOL, USE procedure precedence is based on a program by program level; from the current program to the containing program for that program, and so on to the outermost program.

The following message will be issued if an Enterprise COBOL generated program selects a different USE procedure than would have been used by the VS COBOL II Release 3.x program:

IGYSC2300-I
A mode-specific declarative may be selected for file "file-name" in program "program-name." Execution results may differ from VS COBOL II Release 3.x.

Reference modification of a variable-length group receiver

Programs that MOVE data to reference-modified, variable-length groups might produce different results depending on whether the length used for the variable-length group is evaluated by using the actual length or the maximum length.

You might see a difference if the variable-length group meets all of the following criteria:

- If it is a receiver
- If it contains its own OCCURS DEPENDING ON object
- If it is not followed by a nonsubordinate item (also referred to as a variably located data item)
- If it is reference-modified and a length is not specified

For example, Group *VAR-LEN-GROUP-A* contains an ODO object and an OCCURS subject and is followed by a variably located data item.

```
01 VAR-LEN-PARENT-A.
   02 VAR-LEN-GROUP-A.
      03 ODO-OBJECT PIC 99 VALUE 5.
      03 OCCURS-SUBJECT OCCURS 10 TIMES DEPENDING ON ODO-OBJECT.
         04 TAB-ELEM  PIC X(4).
   02 VAR-LOC-ITEM  PIC XX.
01 NEXT-GROUP.

MOVE ALL SPACES TO VAR-LEN-GROUP-A(1:).
```

Group *VAR-LEN-GROUP-B* contains an ODO object and an OCCURS subject and is *not* followed by a variably located data item. VAR-LOC-ITEM follows the OCCURS subject, but does *not* follow VAR-LEN-GROUP-B.

```
01 VAR-LEN-PARENT-B.
   02 VAR-LEN-GROUP-B.
      03 ODO-OBJECT PIC 99 VALUE 5.
      03 OCCURS-SUBJECT OCCURS 10 TIMES DEPENDING ON ODO-OBJECT.
         04 TAB-ELEM PIC X(4).
      03 VAR-LOC-ITEM PIC XX.
01 NEXT-GROUP.
```

```
MOVE ALL SPACES TO VAR-LEN-GROUP-B(1:).
```

In the above examples, `MOVE ALL SPACES TO VAR-LEN-GROUP-A (1:)` would give the same results with any NOCMPR2 program (VS COBOL II Release 3.x, VS COBOL II Release 4, or Enterprise COBOL). They all use the actual length in this case.

`MOVE ALL SPACES TO VAR-LEN-GROUP-B (1:)` would give different results for the following programs compiled with NOCMPR2:

- VS COBOL II Release 3.x uses the actual length of the group as defined by the current value of the ODO object (the actual length of the group is set to spaces using the ODO object value).
- VS COBOL II Release 4 and Enterprise COBOL use the maximum length of the group (the entire data item is set to spaces using the ODO object value).

If a program contains a reference-modified, variable-length group receiver that contains its own ODO object and is not followed by variably located data and whose reference modifier does not have a length specified, the following message is issued:

IGYPS2298-I
The reference to variable-length group "data name" will be evaluated using the maximum length of the group. Execution results might differ from VS COBOL II Release 3.x.

ACCEPT statement

One additional difference between later releases and VS COBOL II Release 3.0 involves the system input devices for the mnemonic-name suboption of the ACCEPT statement.

For VS COBOL II Release 3.0 only, an input record of 80 characters is assumed even if a logical record length of other than 80 characters is specified. For VS COBOL II Release 3.1 through Release 4.0, an input record of 256 characters is assumed even if a logical record length of other than 80 characters is specified.

In Enterprise COBOL, the maximum logical record length allowed is 32,760 characters.

New reserved words

Enterprise COBOL has quite a few more reserved words than VS COBOL II. If your VS COBOL II programs use these reserved words as user-defined words, then they must be changed before you can compile your programs with Enterprise COBOL.

New reserved words

If your programs use any of the new reserved words as user-defined words (such as data item names or paragraph names), then those words must be changed. You can do something similar to what CCCA does and just add a suffix such as `-85` to all instances of the word. For example:

```
77 VOLATILE PIC S9(9) BINARY.
Move 0 TO VOLATILE.
```

To compile with Enterprise COBOL V5 or V6, change it to:

```
77 VOLATILE-85 PIC S9(9) BINARY.
Move 0 TO VOLATILE-85.
```

The new reserved words in Enterprise COBOL V6 are ALLOCATE, DEFAULT, END-JSON, FREE, JSON, and JSON-CODE.

You can use CCCA to convert the reserved words automatically. For more information about the CCCA tool, see Appendix C, “Conversion tools for source programs,” on page 263.

CCCA is updated for reserved word conversions for Enterprise COBOL V5.1 by the PTF for APAR PM86253. For V5.2, CCCA is updated for reserved word conversions by the PTF for APAR PI32750. For V6.1, CCCA is updated for reserved word conversions by the PTF for APAR PI55980.

The following table shows the reserved words added to each subsequent release of COBOL. For a complete list of reserved words, see Appendix B, "COBOL reserved word comparison," on page 241.

Table 15. New reserved words by compilers

Compiler	Reserved word
COBOL/370 V1R1	FUNCTION, PROCEDURE-POINTER
COBOL for MVS & VM V1R2	CLASS-ID, METACLASS, RECURSIVE, END-INVOKE, METHOD, REPOSITORY, INHERITS, METHOD-ID, RETURNING, INVOKE, OBJECT, SELF, SUPER, LOCAL-STORAGE, OVERRIDE
COBOL for OS/390 & VM V2R1	Same as COBOL for MVS & VM
COBOL for OS/390 & VM V2R2	COMP-5, COMPUTATIONAL-5, EXEC, END-EXEC, SQL, TYPE, FACTORY
COBOL for OS/390 & VM V2R2 with PQ49375	EXECUTE
Enterprise COBOL V3R1	JNIENVPTR, NATIONAL, XML, END-XML, XML-EVENT, XML-CODE, XML-TEXT, XML-NTEXT, FUNCTION-POINTER
Enterprise COBOL V3R4	NATIONAL-EDITED, GROUP-USAGE
Enterprise COBOL V4R1	XML-NAMESPACE, XML-NAMESPACE-PREFIX, XML-NNAMESPACE, XML-NNAMESPACE-PREFIX
Enterprise COBOL V4R2	XML-SCHEMA **Note:** XML-INFORMATION is added as a reserved word with APAR PM85035.
Enterprise COBOL V5R1	XML-INFORMATION
Enterprise COBOL V5R2	VOLATILE
Enterprise COBOL V6R1	ALLOCATE, DEFAULT, END-JSON, FREE, JSON, JSON-CODE

Undocumented VS COBOL II extensions

The VS COBOL II compiler did not diagnose a period in Area A following an Area A item (or no item) that is not valid. In Enterprise COBOL, periods in Area A must be preceded by a valid Area A item.

SEARCH ALL statements

If you have programs that contain SEARCH ALL statements and that were compiled with VS COBOL II, you may need to make some changes due to changes in the behavior of the SEARCH ALL statement

The new behavior for the SEARCH ALL statement is described in "Upgrading programs that have SEARCH ALL statements" on page 99.

Upgrading programs that use SIMVRD support

This section describes the actions to upgrade programs that use SIMVRD support. Support for *COBOL simulated variable-length relative-record data sets (RRDS)* is removed for programs compiled with Enterprise COBOL Version 4 or later. These files must be changed to VSAM RRDS files.

In COBOL compilers that supported the NOCMPR2 compiler option before Enterprise COBOL Version 4, it was possible to use *COBOL simulated variable-length RRDS* using a VSAM KSDS when you used the SIMVRD runtime option support.

The coding that you use in a COBOL program to identify and describe VSAM variable-length RRDS and COBOL simulated variable-length RRDS is similar. With Enterprise COBOL Version 4 you must use VSAM variable-length RRDS support. In general, the only action to migrate from COBOL simulated variable-length RRDS to VSAM variable-length RRDS support is to change the IDCAMS definition of the file.

Table 16. Steps for using variable-length RRDS

Step	VSAM variable-length RRDS	COBOL simulated variable-length RRDS
1	Define the file with the ORGANIZATION IS RELATIVE clause.	Same
2	Use FD entries to describe the records with variable-length sizes.	Same, but you must also code RECORD IS VARYING in the FD entry of every COBOL program that accesses the data set.
3	Use the NOSIMVRD runtime option.	Use the SIMVRD runtime option.

4	Define the VSAM file through access-method services as an RRDS.	Define the VSAM file through access-method services as follows:
		`DEFINE CLUSTER INDEXED`
		`KEYS(4,0)`
		`RECORDSIZE(`*`avg`*`,`*`m`*`)`
		avg
		Is the average size of the COBOL records; strictly less than *m*.
		m
		Is greater than or equal to the maximum size COBOL record + 4.

In step 2 for simulated variable-length RRDS, coding other language elements that implied a variable-length record format did not give you COBOL simulated variable-length RRDS. For example, the following elements alone did not cause the use of simulated variable-length RRDS access, and therefore did not require the SIMVRD runtime option:

- Multiple FD records of different lengths
- OCCURS . . . DEPENDING ON in the record definitions
- RECORD CONTAINS *integer-1* TO *integer-2* CHARACTERS

Use the REUSE IDCAMS parameter for files that contain records and that you will open for output.

- Define the file with the ORGANIZATION IS RELATIVE clause.
- Use FD entries to describe the records with variable-length sizes.
- Use the NOSIMVRD runtime option.
- Define the VSAM file through access-method services as an RRDS.

Errors: When you work with simulated variable-length relative data sets and true VSAM RRDS data sets, an OPEN file status 39 occurs if the COBOL file definition and the VSAM data-set attributes do not match.

For more reference information about the commands for using variable-length RRDS, see *z/OS DFSMS: Access Method Services for Catalogs*.

Chapter 9. Compiling VS COBOL II programs

This section contains information about the following topics:

- Compiler options for VS COBOL II programs
- Prolog format changes

Information specific to VS COBOL II or Enterprise COBOL is noted.

Compiler options for VS COBOL II programs

The Enterprise COBOL and VS COBOL II compilers are similar. If you will be using the same compiler options that are specified in your current VS COBOL II applications, some internal changes might take effect, but basically the behavior is unchanged.

If you do change compiler option settings from the ones you used with VS COBOL II, make sure you understand the possible effects on your applications. For information about converting your source programs from CMPR2 to NOCMPR2 see "Upgrading programs compiled with the CMPR2 compiler option" on page 104. For information about other compiler options, see the *Enterprise COBOL Programming Guide*.

Compiling with Enterprise COBOL

Table 17 on page 95 lists the Enterprise COBOL compiler options that have special relevance to converted programs.

Table 17. Key Enterprise COBOL compiler options for VS COBOL II programs

Enterprise COBOL compiler options	Comments
PGMNAME	If compiling with Enterprise COBOL, use the PGMNAME(COMPAT) option to ensure that program names are processed in a manner compatible with VS COBOL II (and COBOL/370).
TEST	The syntax of the TEST option is different in Enterprise COBOL than in VS COBOL II. The TEST option now has two suboptions. You can specify whether or not source file information is stored in the object and whether or not JUMPTO and GOTO commands are enabled for use with Debug Tool. TEST without any suboptions gives you TEST(NOEJPD,SOURCE). For more information about the TEST option, see the *Enterprise COBOL Programming Guide*.

Compiler options not supported in Enterprise COBOL

Table 18 on page 95 lists the VS COBOL II compiler options that are not supported in Enterprise COBOL. In some cases, the function of the VS COBOL II compiler option is mapped to an Enterprise COBOL compiler option, as described in the comments section.

Table 18. Compiler options not supported in Enterprise COBOL

VS COBOL II compiler options	Comments
CMPR2	The CMPR2 option is not supported. You must convert programs compiled with CMPR2 to 85 COBOL Standard in order to compile them with Enterprise COBOL.

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Table 18. Compiler options not supported in Enterprise COBOL (continued)

VS COBOL II compiler options	Comments
FDUMP/NOFDUMP	Enterprise COBOL does not provide the FDUMP compiler option. For existing applications, FDUMP is mapped to the Enterprise COBOL TEST compiler option, which can provide equivalent function and more. Language Environment generates a better formatted dump than VS COBOL II, regardless of the FDUMP option. The use of TEST enables Language Environment to include the symbolic dump of information about data items in the formatted dump. For information about how to obtain the Language Environment formatted dump at abnormal termination, see the *Language Environment Debugging Guide and Run-Time Messages*. If NOFDUMP is encountered, Enterprise COBOL issues a warning message because NOFDUMP is not supported.
FLAGMIG	The FLAGMIG option is not supported in Enterprise COBOL. FLAGMIG requires CMPR2, which is not supported in Enterprise COBOL. To get similar migration flagging use CCCA, this *Migration Guide*, or a compiler released prior to Enterprise COBOL to compile programs that use FLAGMIG.
FLAGSAA	Enterprise COBOL does not support the FLAGSAA option. If FLAGSAA is specified, Enterprise COBOL issues a warning message.
NUMPROC(MIG)	Enterprise COBOL V5 and V6 does not support the NUMPROC(MIG) option. If NUMPROC(MIG) is specified, Enterprise COBOL V5 or V6 issues a warning message and the compilation will get the default setting for NUMPROC. This is either the user-customized default or the IBM default, which is NUMPROC(NOPFD). To migrate your programs compiled with NUMPROC(MIG) to Enterprise COBOL V6, consider using the NUMCHECK compiler option to help you migrate to NUMPROC(PFD): 1. Compile your programs with NUMCHECK(ZON,PAC) and NUMPROC(PFD). 2. Run a thorough regression test with a good breadth of input data. If your applications get no NUMCHECK messages or NUMCHECK abends, you can safely compile with NUMPROC(PFD) and NONUMCHECK for production. This will not only solve the invalid data problem, but NUMPROC(PFD) is the most efficient setting for the NUMPROC compiler option. NUMCHECK is introduced in Enterprise COBOL V6.1 with the service PTFs. For details, see *NUMCHECK* in the *Enterprise COBOL Programming Guide*.
RES/NORES	Enterprise COBOL does not provide the RES/NORES compiler option. If RES or NORES are encountered, Enterprise COBOL issues an error message.

Prolog format changes

The prolog of an object program is the code that the compiler generates at the entry point of the program. It also contains data that identifies the program.

Object modules generated by Enterprise COBOL are Language Environment conforming, and thus have a different prolog format than in VS COBOL II. Existing applications that scan for date and time and user-level information need to be updated to the new format.

You can compile your programs with the Enterprise COBOL LIST compiler option to generate a listing that you can use to compare the VS COBOL II format with the Enterprise COBOL format.

Chapter 10. Upgrading IBM COBOL source programs

There are differences in COBOL language support between IBM COBOL and Enterprise COBOL.

This information will help you determine which IBM COBOL programs need source modifications in order to compile with Enterprise COBOL. For example, IBM COBOL programs compiled with the CMPR2 option require source modification because Enterprise COBOL does not support the CMPR2/NOCMPR2 compiler option.

This section contains information about the following items that you will need to consider when upgrading IBM COBOL source programs to Enterprise COBOL:

- Determining which programs require upgrade before you compile with Enterprise COBOL
- Upgrading SOM-based object-oriented (OO) COBOL programs
- SOM-based OO COBOL language elements that are not supported
- SOM-based OO COBOL language elements that are changed
- New reserved words in Enterprise COBOL
- Language Environment runtime considerations

For information about upgrading programs compiled with the CMPR2 compiler option, see “Migrating from the CMPR2 compiler option to NOCMPR2” on page 104.

For more information about migrating from the separate CICS translator to the integrated CICS translator, see “Migrating from the separate CICS translator to the integrated translator” on page 216

Determining which programs require upgrade before you compile with Enterprise COBOL

Many IBM COBOL programs will compile without change under Enterprise COBOL.

These programs, however, will need to be upgraded before compiling with Enterprise COBOL:

- Programs that have SEARCH ALL statements
- Programs that use the SIMVRD support
- Programs that use words which are now reserved in Enterprise COBOL
- Programs that have undocumented IBM COBOL extensions
- Programs that contain the format 2 declarative syntax: `USE...AFTER...LABEL PROCEDURE...`, and optionally the syntax: `GO TO MORE-LABELS`. The support for these were removed in Enterprise COBOL Version 5
- Programs that use DATE FORMAT data types and/or DATEVAL, UNDATE or YEARWINDOW functions for Y2K
- Programs that have SOM-based object-oriented COBOL syntax
- Programs compiled with the CMPR2 compiler option

Upgrading programs that have SEARCH ALL statements

Enterprise COBOL has corrected errors in the implementation of the SEARCH ALL statement. SEARCH ALL statements in earlier releases of COBOL contained errors in the key comparison logic, which caused different results than might have been intended. In particular, the comparison did not produce the same result as an IF statement or a sequential SEARCH statement.

Length mismatch problem: a search argument is longer than the table key

The SEARCH ALL statement comparisons should pad an alphanumeric key with blanks or extend a numeric key with leading zeros if the key is shorter than the SEARCH argument. However, in V3R3 and

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earlier releases, SEARCH ALL ignored the excess characters in the argument in some cases. For example, an alphanumeric search argument of `01 ARG PIC X(6)` containing "ABCDEF" would incorrectly match a table or array key of `05 MY-KEY PIC X(4)` with value "ABCD". A search argument containing "ABCD??" (where ? is a blank) would match, as expected.

Similar problems occurred with a numeric search argument and keys. For example, a search argument of `01 ARG PIC 9(6)` containing 123456 would incorrectly match a table or array key of `05 MY-KEY PIC 9(4)` with value 3456. A search argument containing 003456 would match, as expected.

Sign mismatch problem: signed numeric argument and unsigned numeric key

A second problem occurs when the search argument is a signed numeric item and the table key is an unsigned numeric item. If the runtime value of the search argument is negative, such as -1234, programs compiled with V3R3 and earlier would match a table key of 1234. These comparisons should be done using the rules for a normal COBOL relation condition, and a negative argument such as -1234 should never match a table key that is unsigned.

The correction:

Enterprise COBOL corrected these problems. However, some applications compiled with earlier releases might depend on the incorrect behavior. You must identify and modify these applications before you move them to Enterprise COBOL Version 4 or later.

To assist you in identifying the programs and SEARCH ALL statements that are impacted by these corrections, the following compiler and runtime warning diagnostics are issued.

- Compiler messages: Enterprise COBOL compiler generates the following compiler diagnostics. Whether there is an actual impact depends on the contents of the argument at run time.
  - IGYPG3189-W for all SEARCH ALL statements that have a search argument that is longer than the table key, and hence might be impacted by the first problem
  - IGYPG3188-W when the search argument is a signed numeric item and the table key is an unsigned numeric item, and hence the program might be impacted by the second problem
- Runtime messages: The following runtime messages are generated. Programs that generate either of these runtime messages might be affected by the change.
  - IGZ0194W for all SEARCH ALL statements that have search arguments with excess bytes that are not blank or zero.
  - IGZ0193W when the search argument is a signed numeric item with a negative value and the table key is an unsigned numeric item.

To migrate

To move an application to Enterprise COBOL Version 4 or later, do one of the following sets of steps:

- Act on the compiler messages:
  1. Compile your programs with Enterprise COBOL
  2. Review any SEARCH ALL statements that are flagged with compiler messages IGYPG3188-W or IGYPG3189-W; such statements are potentially impacted.

     Tip: To minimize the possibility of incompatible results, you can force programmers at your site to correct these SEARCH ALL statements by changing the severity of these messages to E or S. To change the severity of these messages, you can use the MSGEXIT suboption of the EXIT compiler option. By doing this, the programs that get these messages cannot be run until the code is corrected. The sample user exit IGYMSGXT has sample code in it to change the severity of IGYPG3188-W and IGYPG3189-W, to IGYPG3188-S and IGYPG3189-S, respectively.
- Act on the runtime messages:
  1. Run the application in a test environment.
  2. Review any SEARCH ALL statements that generate runtime message IGZ0193W or IGZ0194W.

After you have identified which of the SEARCH ALL statements are affected, adjust the application logic appropriately by doing the following steps:

- For SEARCH ALL statements in which the search argument is longer than the table key, do one of the following actions:
  - Ensure that any bytes in the argument in excess of the key length are spaces or zeroes as appropriate.

    Tip: When you have completed this investigation and if you decided not to change your programs, you can change the severity of IGYPG3188-W and IGYPG3189-W, to IGYPG3188-I and IGYPG3189-I, respectively, or suppress these messages entirely, by using the MSGEXIT suboption of the EXIT compiler options. This allows your programs to then compile with RC=0. The sample user exit IGYMSGXT has sample code in it to change the severity of IGYPG3188-W and IGYPG3189-W.
  - Move the argument to a temporary data item of the same size as the key and use the temporary item as the search argument.
  - Limit the range of the comparison with reference-modification. For example:
    - in the alphanumeric case of search argument `01 ARG PIC X(6)` and key of `05 MY-KEY PIC X(4)` use this:

      ```
      WHEN MY-KEY (MY-INDEX) = ARG(1:4)
      ```
    - in the numeric case of search argument `01 ARG PIC 9(6)` and array key of `05 MY-KEY PIC 9(4)` use this:

      ```
      WHEN MY-KEY (MY-INDEX) = ARG(3:4)
      ```

  The second and third actions above will prevent the warning message in the future.
- For SEARCH ALL statements in which the search argument is signed and the table key is unsigned, ensure that the search argument is correctly initialized to a positive value before the SEARCH statement is run. Depending on the specific application logic in the COBOL program, it might be possible to make one of the following changes:
  - Change the data description of the argument to be unsigned.
  - Move the search argument to a temporary variable with no sign and use the temporary variable in the SEARCH ALL statement.

  Either action will prevent the warning message in the future.

Upgrading programs that use SIMVRD support

This section describes the actions to upgrade programs that use SIMVRD support. Support for *COBOL simulated variable-length relative-record data sets (RRDS)* is removed for programs compiled with Enterprise COBOL Version 4 or later. These files must be changed to VSAM RRDS files.

In COBOL compilers that supported the NOCMPR2 compiler option before Enterprise COBOL Version 4, it was possible to use *COBOL simulated variable-length RRDS* using a VSAM KSDS when you used the SIMVRD runtime option support.

The coding that you use in a COBOL program to identify and describe VSAM variable-length RRDS and COBOL simulated variable-length RRDS is similar. With Enterprise COBOL Version 4 you must use VSAM variable-length RRDS support. In general, the only action to migrate from COBOL simulated variable-length RRDS to VSAM variable-length RRDS support is to change the IDCAMS definition of the file.

Table 19. Steps for using variable-length RRDS

Step	VSAM variable-length RRDS	COBOL simulated variable-length RRDS
1	Define the file with the ORGANIZATION IS RELATIVE clause.	Same

Table 19. Steps for using variable-length RRDS (continued)		
Step	**VSAM variable-length RRDS**	**COBOL simulated variable-length RRDS**
2	Use FD entries to describe the records with variable-length sizes.	Same, but you must also code RECORD IS VARYING in the FD entry of every COBOL program that accesses the data set.
3	Use the NOSIMVRD runtime option.	Use the SIMVRD runtime option.

4	Define the VSAM file through access-method services as an RRDS.	Define the VSAM file through access-method services as follows:
		`DEFINE CLUSTER INDEXED`
		`KEYS(4,0)`
		`RECORDSIZE(`*`avg`*`,`*`m`*`)`
		avg
		Is the average size of the COBOL records; strictly less than *m*.
		m
		Is greater than or equal to the maximum size COBOL record + 4.

In step 2 for simulated variable-length RRDS, coding other language elements that implied a variable-length record format did not give you COBOL simulated variable-length RRDS. For example, the following elements alone did not cause the use of simulated variable-length RRDS access, and therefore did not require the SIMVRD runtime option:

- Multiple FD records of different lengths
- OCCURS . . . DEPENDING ON in the record definitions
- RECORD CONTAINS *integer-1* TO *integer-2* CHARACTERS

Use the REUSE IDCAMS parameter for files that contain records and that you will open for output.

- Define the file with the ORGANIZATION IS RELATIVE clause.
- Use FD entries to describe the records with variable-length sizes.
- Use the NOSIMVRD runtime option.
- Define the VSAM file through access-method services as an RRDS.

Errors: When you work with simulated variable-length relative data sets and true VSAM RRDS data sets, an OPEN file status 39 occurs if the COBOL file definition and the VSAM data-set attributes do not match.

For more reference information about the commands for using variable-length RRDS, see *z/OS DFSMS: Access Method Services for Catalogs*.

Language Environment runtime considerations

Enterprise COBOL programs use the Language Environment STACK storage in several cases where IBM COBOL used HEAP storage. These cases include intrinsic functions UPPER-CASE and LOWER-CASE. Recompiling with Enterprise COBOL may result in a significant STACK storage usage difference. If the STACK is allocated below the 16-MB line and a large DSA (Dynamic Save Area) is needed, an insufficient storage error might occur.

To see the amount of storage that is required, compile your program with the compiler options MAP and LIST. Look for `FuncResultTemp` under the listing line: `***** AUTOMATIC MAP******`

You may need to reduce the amount of storage required or change to STACK=(...ANYWHERE..) to use storage above the line.

New reserved words in Enterprise COBOL

Enterprise COBOL has a few more reserved words than IBM COBOL. If your IBM COBOL programs use these reserved words as user-defined words, then they must be changed before you can compile your programs with Enterprise COBOL.

New reserved words

If your programs use any of the new reserved words as user-defined words (such as data item names or paragraph names), then those words must be changed. You can do something similar to what CCCA does and just add a suffix such as -85 to all instances of the word. For example:

```
77 VOLATILE PIC S9(9) BINARY.
Move 0 TO VOLATILE.
```

To compile with Enterprise COBOL V5 or V6, change it to:

```
77 VOLATILE-85 PIC S9(9) BINARY.
Move 0 TO VOLATILE-85.
```

The new reserved words in Enterprise COBOL V6 are ALLOCATE, DEFAULT, END-JSON, FREE, JSON, and JSON-CODE.

You can use CCCA to convert the reserved words automatically. For more information about the CCCA tool, see Appendix C, “Conversion tools for source programs,” on page 263.

CCCA is updated for reserved word conversions for Enterprise COBOL V5.1 by the PTF for APAR PM86253. For V5.2, CCCA is updated for reserved word conversions by the PTF for APAR PI32750. For V6.1, CCCA is updated for reserved word conversions by the PTF for APAR PI55980.

The following table shows the reserved words added to each subsequent release of COBOL. For a complete list of reserved words, see Appendix B, “COBOL reserved word comparison,” on page 241.

Table 20. New reserved words by compilers

Compiler	Reserved word
COBOL/370 V1R1	FUNCTION, PROCEDURE-POINTER
COBOL for MVS & VM V1R2	CLASS-ID, METACLASS, RECURSIVE, END-INVOKE, METHOD, REPOSITORY, INHERITS, METHOD-ID, RETURNING, INVOKE, OBJECT, SELF, SUPER, LOCAL-STORAGE, OVERRIDE
COBOL for OS/390 & VM V2R1	Same as COBOL for MVS & VM
COBOL for OS/390 & VM V2R2	COMP-5, COMPUTATIONAL-5, EXEC, END-EXEC, SQL, TYPE, FACTORY
COBOL for OS/390 & VM V2R2 with PQ49375	EXECUTE
Enterprise COBOL V3R1	JNIENVPTR, NATIONAL, XML, END-XML, XML-EVENT, XML-CODE, XML-TEXT, XML-NTEXT, FUNCTION-POINTER
Enterprise COBOL V3R4	NATIONAL-EDITED, GROUP-USAGE
Enterprise COBOL V4R1	XML-NAMESPACE, XML-NAMESPACE-PREFIX, XML-NNAMESPACE, XML-NNAMESPACE-PREFIX
Enterprise COBOL V4R2	XML-SCHEMA **Note:** XML-INFORMATION is added as a reserved word with APAR PM85035.

Table 20. New reserved words by compilers (continued)

Compiler	Reserved word
Enterprise COBOL V5R1	XML-INFORMATION
Enterprise COBOL V5R2	VOLATILE
Enterprise COBOL V6R1	ALLOCATE, DEFAULT, END-JSON, FREE, JSON, JSON-CODE

SEARCH ALL statements

If you have programs that contain SEARCH ALL statements and that were compiled with IBM COBOL, you may need to make some changes due to changes in the behavior of the SEARCH ALL statement

You need to take some actions for certain programs that have SEARCH ALL statements and that were compiled with one of the following compilers:

- COBOL for OS/390 & VM
- COBOL for MVS & VM
- COBOL/370

The new behavior for the SEARCH ALL statement is described in "Upgrading programs that have SEARCH ALL statements" on page 99.

Migrating from the CMPR2 compiler option to NOCMPR2

If your COBOL programs were compiled with the CMPR2 option, you must convert them to NOCMPR2 programs to compile them with Enterprise COBOL. The CMPR2/NOCMPR2 option is not supported in Enterprise COBOL.

Enterprise COBOL programs behave as if NOCMPR2 is always in effect.

Upgrading programs compiled with the CMPR2 compiler option

Beginning with VS COBOL II Release 3.0, you could choose the 85 COBOL Standard behavior (without the Intrinsic Function module) by using NOCMPR2, or the 74 COBOL Standard behavior by using the CMPR2 compiler option. But with Enterprise COBOL, programs must be at the 85 COBOL Standard level.

The CMPR2 option provided the Standard COBOL 74 behavior as implemented by VS COBOL II Release 2, as well as *nonstandard* Release 2 extensions now implemented in 85 COBOL Standard. The NOCMPR2 option provided 85 COBOL Standard-conforming behavior and IBM extensions. This same mechanism was provided by IBM COBOL as an aid to allow delaying the upgrade from VS COBOL II Release 2 level code to 85 COBOL Standard level code. In Enterprise COBOL, this delay is not available.

Enterprise COBOL provides 85 COBOL Standard support whereas VS COBOL II Release 2, provided the 74 COBOL Standard support (with some 85 COBOL Standard features added in). The implementation of 85 COBOL Standard caused some language elements to behave in a manner that differs from the implementation of 74 COBOL Standard.

When referring to VS COBOL II Release 3 or later and IBM COBOL, the following terms have been defined:

CMPR2

We use CMPR2 to refer to the language and behavior of programs compiled and run with:

- VS COBOL II Release 2
- VS COBOL II, Release 3 or 4 with the CMPR2 compiler option
- IBM COBOL with the CMPR2 compiler option.

NOCMPR2
We use NOCMPR2 to refer to the language and behavior of programs compiled and run with:

- VS COBOL II, Release 3 or 4, with the NOCMPR2 compiler option
- IBM COBOL with the NOCMPR2 compiler option
- Enterprise COBOL

FLAGMIG
We use FLAGMIG to refer to the use of a pre-Enterprise COBOL compiler (VS COBOL II or IBM COBOL) that supports the CMPR2 and FLAGMIG options.

Tip: To aid you with migration to Enterprise COBOL, use a previous COBOL compiler that supports FLAGMIG and CMPR2 to flag the statements that need to be converted.

The language elements listed below are affected by the CMPR2/NOCMPR2 compiler option. The differences are explained in the sections that follow.

Table 21. Language elements different between CMPR2 and NOCMPR2

Language element	Page
ALPHABET clause of the SPECIAL-NAMES paragraph	“ALPHABET clause of the SPECIAL-NAMES paragraph” on page 106
ALPHABETIC class	“ALPHABETIC class” on page 107
CALL ... ON OVERFLOW	“CALL . . . ON OVERFLOW” on page 107
Comparisons between scaled integers and nonnumerics	“Comparisons between scaled integers and nonnumerics” on page 108
COPY...REPLACING statements using non-COBOL characters	“COPY ... REPLACING statements using non-COBOL characters” on page 109
COPY statement using national extension characters	“COPY statement using national extension characters” on page 111
File status codes	“File status codes” on page 112
Fixed filed attributes and DCB= parameters of JCL	“Fixed-file attributes and DCB= parameters of JCL” on page 114
Implicit EXIT PROGRAM	“Implicit EXIT PROGRAM” on page 115
OPEN statement failing for QSAM file (FILE STATUS 39)	“OPEN statement failing for QSAM files (FILE STATUS 39)” on page 116
OPEN statement failing for VSAM files (FILE STATUS 39)	“OPEN statement failing for VSAM files (FILE STATUS 39)” on page 117
PERFORM return mechanism	“PERFORM return mechanism” on page 117
PERFORM...VARYING...AFTER	“PERFORM ... VARYING ... AFTER” on page 119
PICTURE clause with "A"s and "B"s	“PICTURE clause with "A"s and "B"s” on page 121
PROGRAM COLLATING SEQUENCE	“PROGRAM COLLATING SEQUENCE” on page 123

Table 21. Language elements different between CMPR2 and NOCMPR2 (continued)

Language element	Page
READ INTO and RETURN INTO	“READ INTO and RETURN INTO” on page 124
RECORD CONTAINS n CHARACTERS	“RECORD CONTAINS n CHARACTERS” on page 125
SET...TO TRUE	“SET . . . TO TRUE” on page 126
SIZE ERROR on MULTIPLY and DIVIDE	“SIZE ERROR on MULTIPLY and DIVIDE” on page 128
UNSTRING operand evaluation	“UNSTRING operand evaluation” on page 129
UPSI switches	“UPSI switches” on page 134
Variable-length group moves	“Variable-length group moves” on page 135

ALPHABET clause of the SPECIAL-NAMES paragraph

Whether ALPHABET is a reserved word that must be specified in the ALPHABET clause depends on the setting of the CMPR2/NOCMPR2 option.

CMPR2

The ALPHABET clause does not include the keyword ALPHABET. In fact, ALPHABET is not a reserved word.

For example:

```
SPECIAL-NAMES.
   ALPHA-NAME IS STANDARD-1.
```

NOCMPR2

The ALPHABET clause requires the use of the keyword ALPHABET. ALPHABET is now a reserved keyword.

For example:

```
SPECIAL-NAMES.
   ALPHABET ALPHA-NAME IS STANDARD-1.
```

Messages

Compiling the program with the CMPR2 and FLAGMIG compiler options generates the following message for each ALPHABET clause of the SPECIAL-NAMES paragraph:

IGYDS1190-W
MIGR Alphabet-name must be preceded by the keyword "ALPHABET" under the "NOCMPR2" compiler option.

Corrective action for ALPHABET clause of the SPECIAL-NAMES paragraph:

Add the keyword ALPHABET to the ALPHABET clause.

ALPHABETIC class

Whether the ALPHABETIC class includes the 26 lowercase letters depends on the setting of the CMPR2/NOCMPR2 option.

CMPR2

The ALPHABETIC class of characters defined by the ALPHABETIC class test consists of the 26 uppercase letters and the space. The 26 lowercase letters are not considered alphabetic.

For example:

```
MOVE "AbC dE" TO PIC-X6.
IF PIC-X6 IS NOT ALPHABETIC THEN DISPLAY "CMPR2".
```

NOCMPR2

The ALPHABETIC class of characters defined by the ALPHABETIC class test consists of the 26 uppercase letters, the 26 lowercase letters, and the space.

For example:

```
MOVE "AbC dE" TO PIC-X6.
IF PIC-X6 IS ALPHABETIC THEN DISPLAY "NOCMPR2".
```

Messages

Compiling the program with the CMPR2 and FLAGMIG compiler options generates the following message for each ALPHABETIC class test:

IGYPS2221-W
: **MIGR** The alphabetic class has been expanded to include lowercase letters under the "NOCMPR2" compiler option.

Corrective action for the ALPHABETIC class:

Use the ALPHABETIC-UPPER class test under NOCMPR2 to get the same function as the ALPHABETIC class test under CMPR2. The ALPHABETIC-UPPER class under NOCMPR2 consists of the 26 uppercase letters and the space.

CALL . . . ON OVERFLOW

Whether the ON OVERFLOW condition is raised for errors other than "out of storage" errors depends on the setting of the CMPR2/NOCMPR2 option.

CMPR2

Under CMPR2, the ON OVERFLOW condition exists if the available portion of object time memory cannot accommodate the program specified in the CALL statement. CMPR2 interpreted that definition to cover only the condition "not enough storage available to load the program."

Only errors that occur on the actual LOAD of the called program raise the ON OVERFLOW condition. Errors occurring after the program has been loaded and has started execution do not raise the condition.

NOCMPR2

Under NOCMPR2, the ON OVERFLOW condition exists if the program specified by the CALL statement cannot be made available for execution at that time.

NOCMPR2 implements 85 COBOL Standard rules and defines the ON OVERFLOW condition to handle any "recoverable" condition that may prevent the called program from being made available.

Only errors that occur on the actual LOAD of the called program raise the ON OVERFLOW condition. Errors occurring after the program has been loaded and started execution do not raise the condition.

Messages

Compiling the program with the CMPR2 and FLAGMIG options will cause the compiler to issue messages for all CALL statements that specify the ON OVERFLOW phrase. The following message will be issued:

IGYPS2012-W
MIGR The "ON OVERFLOW" phrase of the "CALL" statement will execute under more conditions under the "NOCMPR2" compiler option.

The following program fragment illustrates one situation that will be affected by this change:

```
PERFORM UNTIL ALL-ACCOUNTS-SETTLED
⋮
  CALL "SUBPROGA" USING CURRENT-ACCOUNT
    ON OVERFLOW
       CANCEL "SUBPROGB"
       CALL "SUBPROGA" USING CURRENT-ACCOUNT
       END-CALL
  END-CALL
⋮
  CALL "SUBPROGB" USING CURRENT-ACCOUNT
    ON OVERFLOW
       CANCEL "SUBPROGA"
       CALL "SUBPROGB" USING CURRENT-ACCOUNT
       END-CALL
  END-CALL
⋮
END-PERFORM
```

The assumption is that for some executions of this program, SUBPROGA and SUBPROGB might not fit into available storage at the same time. The ON OVERFLOW phrase is used to react to this situation, and to release the storage occupied by the other subprogram.

Running under CMPR2, the ON OVERFLOW condition will be raised only for the "out of storage" errors, and the approach above is reasonable.

Running under NOCMPR2, the ON OVERFLOW condition might be raised for errors other than the "out of storage" errors, and therefore, the second call (inside the ON OVERFLOW phrase) might fail as well.

Corrective action for CALL . . . ON OVERFLOW:

No correction that is generally applicable exists for programs using this or similar techniques. If the ON OVERFLOW condition is indeed raised because of the "out of storage" error, the program will exhibit the same behavior as before; if the condition is raised for some other error, the recovery statements that you coded (in the ON OVERFLOW phrase) might not correct the error, and the subsequent CALL will fail as well.

In general, it is not possible for an Enterprise COBOL program to determine the actual cause of the error that raised the ON OVERFLOW condition.

Comparisons between scaled integers and nonnumerics

Comparisons between nonnumeric items and scaled numeric items are handled differently depending on the setting of the CMPR2/NOCMPR2 option.

CMPR2

Under CMPR2, the numeric or algebraic value of a scaled numeric item is used in comparison operations with nonnumeric items. In determining the algebraic value, all symbols P in the PICTURE character-string are included in the total number of digits, and zeros are used in their place.

NOCMPR2

Under NOCMPR2, the actual character representation or character value of the scaled numeric item is used in comparison operations with nonnumeric items. The character value for scaled numeric items does not include any digit positions specified with the symbol P. These digit positions are ignored and not counted in the size of the operand.

For example:

```
01  NUM    PIC 99PP  VALUE 2300.
01  ALPHA1 PIC XX    VALUE "23".
01  ALPHA2 PIC XXX   VALUE "23".
01  ALPHA3 PIC XXXX  VALUE "2300".

    IF NUM EQUAL ALPHA1 DISPLAY "ALPHA1".
    IF NUM EQUAL ALPHA2 DISPLAY "ALPHA2".
    IF NUM EQUAL ALPHA3 DISPLAY "ALPHA3".

                    CMPR2              NOCMPR2

Results             ALPHA3             ALPHA1
displayed                              ALPHA2
```

In this example, under NOCMPR2, the character value of NUM has only two digit positions. When it is compared to a nonnumeric item of unequal length as in ALPHA2, the shorter operand (NUM) is padded with enough blanks to equal the length of the other operand.

Messages

Compiling a program with the CMPR2 and FLAGMIG options will cause the compiler to issue the following message for all comparisons between scaled integers and nonnumeric items.

IGYPG3138-W

MIGR The comparison between the scaled integer item " " and the nonnumeric item " " will be performed differently under the "NOCMPR2" compiler option.

Corrective action for comparisons between scaled integers and nonnumerics:

To preserve CMPR2 behavior, you can define the scaled integer within a structure. FILLER serves as the placeholders for the integer scaling positions and must be initialized to zero. There must be as many alphanumeric positions defined in FILLER as there are scaling positions in NUM. Wherever NUM is used in a comparison with a nonnumeric item, CHARVAL should be substituted instead.

```
01  CHARVAL.
  05  NUM     PIC 99PP  VALUE 2300.
  05  FILLER  PIC XX    VALUE "00".

      IF CHARVAL EQUAL ALPHA1 DISPLAY "ALPHA1".
      IF CHARVAL EQUAL ALPHA2 DISPLAY "ALPHA2".
      IF CHARVAL EQUAL ALPHA3 DISPLAY "ALPHA3".
```

COPY ... REPLACING statements using non-COBOL characters

Some non-COBOL characters in library text or COPY ... REPLACING statements are treated differently depending on the setting of the CMPR2/NOCMPR2 option.

Non-COBOL characters are the EBCDIC characters outside the legal set of COBOL characters, excluding nonnumeric literals. Nonnumeric literals can contain any character within the character set of the computer.

CMPR2

Under CMPR2, library text and COPY ... REPLACING statements can contain operands consisting of non-COBOL characters.

NOCMPR2

85 COBOL Standard disallows all non-COBOL characters and adds lowercase and the colon to the character set.

Lowercase alphabetic characters

"Lowercase" alphabetic characters, which were non-COBOL with CMPR2, are now in the set of legal COBOL characters with Enterprise COBOL. With CMPR2, COPY allowed replacement of lowercase characters:

```
COPY  A  REPLACING == abc ==  BY  == XYZ ==.
```

The previous example would locate all instances of "abc" and replace it with "XYZ". In contrast, Enterprise COBOL will treat lowercase and uppercase characters as equivalent in data-names and replace all instances of "abc" as well as "ABC" with "XYZ". If member A contains:

```
1  abc PIC X.
1  ABC PIC XX.
```

then the results are as follows:

```
   CMPR2                          NOCMPR2

After COPY & REPLACING     After COPY & REPLACING
 1  XYZ PIC X.                   1  XYZ  PIC X.
 1  ABC PIC XX.                  1  XYZ  PIC XX.
```

Message

The difference in behavior is flagged by the FLAGMIG compiler option.

IGYLI0161-W
MIGR Lowercase character " " found in column " " will be treated the same as its uppercase equivalent under the "NOCMPR2" compiler option. Results may be different.

Corrective action for lowercase alphabetic characters:

To obtain the same results when compiling CMPR2 programs under Enterprise COBOL, you must verify that all your REPLACING arguments are unique (even after folding to uppercase).

The colon (:) character

With CMPR2, the colon character was a non-COBOL character that COPY ... REPLACING allowed as part of its operands. This character is a legal COBOL separator under Enterprise COBOL.

```
COPY  A  REPLACING  == A ==    BY  == X ==
                    == B ==    BY  == Y ==
                    == A:B ==  BY  == Z ==.
```

If member A contains:

```
MOVE  A:B  TO  ID2.
```

These are the differences between CMPR2 and Enterprise COBOL after COPY ... REPLACING has been performed.

```
      CMPR2                          NOCMPR2

MOVE  Z  TO  ID2.             MOVE  X:Y  TO  ID2.
```

Because ":" is a separator under Enterprise COBOL, "A:B" is broken up into three separate tokens: "A" ":" and "B." The replacements for A and B are made first.

Message

This difference in behavior between the two releases is flagged by FLAGMIG.

IGYLI0160-W
MIGR The colon will be treated as a separator under the "NOCMPR2" compiler option. Results may be different.

Corrective action for the colon (:) character:

To make the previous piece of code behave in the same manner as with CMPR2, change the REPLACING clauses to:

```
COPY  A  REPLACING  == A:B ==  BY  == Z ==
                    == A ==    BY  == X ==
                    == B ==    BY  == Y ==.
```

Characters that are not valid

Some characters do not fall into the legal COBOL character set. Consider this example:

```
COPY  A  REPLACING  == % ==  BY  == 1 ==.
```

where member A contains:

```
%  XDATA  PIC  X.
```

Here, the "non-COBOL" character is the "%" character.

Under both CMPR2 and NOCMPR2, the member above will be copied with the replacement executed. The Enterprise COBOL compiler will issue an E-level diagnostic message.

IGYLI0163-E
Non-COBOL character "%" was found in column 8. The character was accepted.

In both cases, after processing all COPY statements, a legal COBOL program should result.

Message

This difference in behavior between the two releases is flagged by FLAGMIG.

IGYLI0162-W
MIGR Non-COBOL character "%" found in column 8 will be diagnosed under the "NOCMPR2" compiler option. Results may be different.

Corrective action for characters that are not valid:

You should remove all non-COBOL characters from your source programs and COPY libraries, and replace them with COBOL characters.

This removal of non-COBOL characters will protect you against new problems in later releases of Enterprise COBOL. Future releases may assign meaning to one of these characters (as with the colon) and results might be different.

COPY statement using national extension characters

Whether the characters @, #, and $ can be coded in the text-name and library-name of the COPY statement depends on the setting of the CMPR2/NOCMPR2 option.

CMPR2

National extension characters @, #, and $ are allowed in the text-name and library-name of the COPY statement. For example in `COPY X$3.` the item will be copied.

NOCMPR2

The compiler will issue an E-level diagnostic message.

IGYLI0025-E
Name "X$3" was invalid. It was processed as "X03".

Enterprise COBOL allows national extension characters @, #, and $ in the text-name and library-name, if they are in the form of a nonnumeric literal. For example, to copy X$3 in Enterprise COBOL, code `COPY "X$3".`

Message

The difference in behavior is flagged by FLAGMIG.

IGYLI0115-W
MIGR The name "X$3" did not follow the rules for formation of a program-name. It will be diagnosed under the "NOCMPR2" compiler option.

Corrective action for the COPY statement that uses national extension characters:

You should change all national extension characters in your source programs and COPY libraries, to COBOL characters.

File status codes

The setting of the CMPR2/NOCMPR2 option affects which file status codes are returned and the amount of detail the codes provide about input-output operations.

CMPR2

File status codes based on the '74 COBOL Standard are returned with CMPR2.

NOCMPR2

The file status codes are enhanced with NOCMPR2. New and changed file status codes are returned, and more detail is provided about the status of input-output operations. In addition, problems are detected earlier in some cases, and there are updated definitions and file status conditions for "missing" files.

Message

A program that contains a file status data-name will receive the following message when compiled with the CMPR2 and FLAGMIG compiler options:

IGYGR1188-W
MIGR The file status values are different under the "NOCMPR2" compiler option.

Corrective action for file status codes

Although there is no one-to-one mapping of the CMPR2 status codes to those in Enterprise COBOL, Table 22 on page 113 shows, in general, the relationships between CMPR2 and NOCMPR2 file status codes.. For a comprehensive definition of the Enterprise COBOL file status codes, see *File status key* in the *Enterprise COBOL Language Reference*.

Table 22. QSAM and VSAM file status codes with CMPR2 and NOCMPR2

VSAM file status codes		QSAM file status codes	
CMPR2	**NOCMPR2**	**CMPR2**	**NOCMPR2**
00	00 04 05 14 24 35 39 44	00	00 04 05 07 39 44
02	02		
10	10	10	10
21	21		
22	22		
23	23		
24	24		
30	30 39	30	30 39
		34	34
90	37 90	90	35 37 90
91	91		
92	38 41 42 43 44 47 48 49 92	92	38 41 42 43 46 47 48 49 92
93	93		

Table 22. QSAM and VSAM file status codes with CMPR2 and NOCMPR2 (continued)

VSAM file status codes		QSAM file status codes	
CMPR2	**NOCMPR2**	**CMPR2**	**NOCMPR2**
94	46		
95	39 95		
96	96		
97	97		

Fixed-file attributes and DCB= parameters of JCL

The handling of block sizes, record sizes, and other fixed-file attributes is different between CMPR2 and NOCMPR2. You might need to change your programs and your JCL to migrate to NOCMPR2.

CMPR2

In CMPR2 programs, fixed-file attribute checking is only done at READ/WRITE time, if done at all. An OPEN statement could succeed even if some fixed-file attributes were inconsistent. For example, an OPEN could succeed with different record sizes in:

- RECORD CONTAINS x clause
- JCL DCB=(LRECL=y)
- Actual data-set label

NOCMPR2

In NOCMPR2 programs, 85 COBOL Standard requires that fixed-file attribute checking be done in many cases. As a result, a program with inconsistent fixed file attributes might fail at OPEN time rather than have problems later. The OPEN could fail with either runtime message IGZ0035S or file status 39 (if a file status clause is specified). See Appendix G, “Preventing file status 39 for QSAM files,” on page 305 for more information about preventing file status 39 for QSAM files.

A common source of fixed file attribute inconsistency problems is the DCB= parameter of the JCL DD statement for your file.

Messages

There are no **MIGR** messages for these differences, because fixed-file attributes can be specified outside of the source program.

Recommendation for DCB= parameters of JCL

It is strongly recommended that you take advantage of features of DFSMS and COBOL that let the system determine the block size. (In general, you should not specify DCB= attributes except in the few cases mentioned in the *Enterprise COBOL Programming Guide*.

These are the recommendations:

- For new files, let z/OS determine the block size. To take advantage of system-determined block size:
  - Code BLOCK CONTAINS 0 in your source program or use the BLOCK0 compiler option.
  - Do not code RECORD CONTAINS 0 in your source program.

  - Do not code a BLKSIZE value in the JCL DD statement.
- For existing blocked data sets, use the existing file block size:
  - Code BLOCK CONTAINS 0 in your source program or use the BLOCK0 compiler option.
  - Do not code a BLKSIZE value in the ddname definition.

The one case where you might consider putting BLKSIZE in the JCL is if you require a specific block size for a new file and you need the flexibility to modify that block size without recompiling your program. In this case, follow these guidelines:

- Code BLOCK CONTAINS 0 in your source program or use the BLOCK0 compiler option.
- Code a BLKSIZE value in the ddname definition (DCB=(BLKSIZE=*xxx*) in the JCL DD statement).

Implicit EXIT PROGRAM

To end a program, you must use an EXIT PROGRAM, STOP RUN, or GOBACK statement.

You can use an EXIT PROGRAM for a called subprogram; you can use a STOP RUN for a main program. GOBACK, an IBM extension, can be used for either type of program.

CMPR2

Under CMPR2, if a program does not contain any of the statements above, a compiler warning diagnostic message is issued to suggest that you should analyze the program to verify that it could exit.

Suppose that this is the last line in the program:

```
IF TALLY = 0 THEN STOP RUN.
```

In this case, the compiler diagnostic message would not be issued, and the following runtime message would be issued only if the IF condition tested false:

IGZ0037S
The flow of control in program "program-name" proceeded beyond the last line of the program.

NOCMPR2

Under NOCMPR2, all programs are assumed to end with an EXIT PROGRAM statement. For a called subprogram, then, control can no longer flow beyond the last line of the program, but instead, the program will return to the calling program. In the preceding example, where the program ended with the statement:

```
IF TALLY = 0 THEN STOP RUN.
```

a false test will cause control to be returned to the caller. With CMPR2 behavior, the result is an abend.

For a main program, the EXIT PROGRAM statement has no effect. Therefore, the implicit EXIT PROGRAM that is generated by the compiler will have no effect on the execution of the program; a main program that executes beyond the last line of the program will still abend.

Messages

A program that does not contain a STOP RUN, GOBACK, or EXIT PROGRAM statement will receive the following diagnostic message:

IGYPS2091-W
No "STOP RUN", "GOBACK" or "EXIT PROGRAM" was found in the program. Check program logic to verify that the program will exit.

Also, if the CMPR2 and FLAGMIG compiler options are used, the following message will be issued:

IGYPS2223-W
MIGR An implicit "EXIT PROGRAM" will be executed at the end of this program under the "NOCMPR2" compiler option.

If a program does contain a STOP RUN, GOBACK, or EXIT PROGRAM statement, and the NOOPTIMIZE compiler option is in effect, then use of the FLAGMIG compiler option will result in the following message:

IGYPS2224-W
MIGR An implicit "EXIT PROGRAM" may be executed at the end of this program under the "NOCMPR2" compiler option. Recompile with the "OPTIMIZE" and "FLAGMIG" compiler options. If no "MIGR" message about an implicit "EXIT PROGRAM" is issued then no implicit "EXIT PROGRAM" will be executed.

Upon re-compilation with the OPTIMIZE compiler option, the absence of any such messages indicates that the program will not have an implicit EXIT PROGRAM generated for it, while the presence of the following message indicates otherwise:

IGYOP3210-W
MIGR An implicit "EXIT PROGRAM" will be executed at the end of this program under the "NOCMPR2" compiler option.

Corrective action for implicit EXIT PROGRAM

To preserve CMPR2 behavior, a program can be modified to contain a new section and section-name as the very last section in the program. That new section can then contain error-handling code, such as a call to CEE3ABD.

Any program receiving a message indicating that an EXIT PROGRAM will be implicitly generated should be examined to ensure that it will exit properly.

OPEN statement failing for QSAM files (FILE STATUS 39)

There is a difference in the way CMPR2 and NOCMPR2 handle fixed-file attributes for QSAM files for OPEN statements.

CMPR2

The fixed file attributes for QSAM files do not need to match between COBOL program file definition, JCL, or data-set label for a successful file OPEN.

NOCMPR2

If the following items are inconsistent, an OPEN statement in your program might not run successfully:

- The fixed file attributes of a file from the data set label
- The fixed file attributes specified in the JCL DD statement for a file
- The attributes specified for that file in the SELECT and FD statements of your COBOL program

Inconsistencies in the attributes for file organization, record format (fixed or variable), the code set, or record length result in a file status code 39, and the OPEN statement fails.

Message

There are no **MIGR** messages for this difference, because fixed-file attributes can be specified outside of the source program.

Corrective action for OPEN statement failing for QSAM files (FILE STATUS 39)

To prevent common file status 39 problems, see Appendix G, “Preventing file status 39 for QSAM files,” on page 305.

OPEN statement failing for VSAM files (FILE STATUS 39)

There is a difference in the way CMPR2 and NOCMPR2 handle RECORDSIZE defined in VSAM files associated with IDCAMS.

In CMPR2, the RECORDSIZE defined in your VSAM files associated with IDCAMS was not required to match your COBOL program file definition for successful file OPEN.

CMPR2

The RECORDSIZE defined in your VSAM files associated with IDCAMS was not required to match your COBOL program file definitions for successful file OPEN.

NOCMPR2

The RECORDSIZE defined in your VSAM files associated with IDCAMS are required to match the file definitions for those files in your COBOL program for successful file OPEN.

Message

There are no **MIGR** messages for this difference, because the VSAM RECORDSIZE attribute is outside of the source program.

Corrective action for OPEN statement failing for VSAM files (FILE STATUS 39)

Change your program file definitions or the RECORDSIZE defined in your VSAM files associated with IDCAMS to match according to the following table. The following rules apply to VSAM ESDS, KSDS, and RRDS file definitions:

Table 23. Rules for VSAM file definitions

File type	Rules
ESDS and KSDS VSAM	RECORDSIZE(*avg*,*m*) is specified where *avg* is the average size of the COBOL records, and is strictly less than *m*; *m* is greater than or equal to the maximum size of a COBOL record.
RRDS VSAM	RECORDSIZE(*n*,*n*) is specified where *n* is greater than or equal to the maximum size of a COBOL record.

PERFORM return mechanism

There is a difference in the way CMPR2 and NOCMPR2 handle out-of-line PERFORM statements that might require corrective action.

When a paragraph or a range of paragraphs is executed with a PERFORM statement ("out-of-line PERFORM"), a mechanism at the end of the range of paragraphs causes control to be returned to the point just after the PERFORM statement.

Consider the following example:

```
     PERFORM A
     STOP RUN.
 A.  DISPLAY "Hi".
 B.  DISPLAY "there".
```

After displaying the message "Hi," compiler-generated code will cause the flow of control to return to the STOP RUN statement after performing paragraph A. Without this, control would fall through into paragraph B.

This code mechanism is reset to an initial state the first time a program is called or when a program is cancelled. Under NOCMPR2, it is also reset every time a program is called. Under CMPR2, the mechanism retains its last-used state when a program is called twice in succession without having been cancelled.

This can be important when the program issues an EXIT PROGRAM or GOBACK statement before all of the PERFORM statements have completed their execution.

Now consider this example:

```
     IF FIRST-TIME-CALLED THEN
       PERFORM A
       MOVE ZERO TO N
     ELSE
       SUBTRACT 1 FROM N
       GO TO A.
     GOBACK.
A.   IF N > 1 THEN
       GOBACK.
B.   DISPLAY "Processing continues...".
```

The program is passed a switch, FIRST-TIME-CALLED, which tells the program whether or not the program has been called without having been cancelled. It is also passed a variable, N.

CMPR2

When the program is called for the first time, the PERFORM statement will be executed. If the "N > 1" test succeeds, the program will return to the calling program.

However, this means that the PERFORM statement has not reached normal completion because paragraph A never returned to the point from which it was performed. The compiler-generated mechanism at the end of paragraph A is still "set" to return back to the PERFORM statement.

Thus, on the second call to the program, the ELSE path will be taken, 1 will be subtracted from N, and control will be transferred by the GO TO statement to paragraph A. However, if the test "N > 1" fails, the PERFORM mechanism is still set. So, when the end of paragraph A is reached, instead of falling through into paragraph B, control is "returned" to the MOVE statement after the PERFORM statement.

These results might not be intended. The problem might occur whenever all of the following conditions occur:

1. The program returns to the calling program with an EXIT PROGRAM or GOBACK statement.
2. A PERFORM statement performs a paragraph or a range of paragraphs, and those paragraphs might also be reached by a GO TO statement or by falling through into the paragraph.
3. All such PERFORM statements have not had a chance to return prior to the execution of the EXIT PROGRAM or GOBACK statement.

NOCMPR2

Under NOCMPR2, when the program is called for the first time, the PERFORM statement will be executed and control will flow to paragraph A. Then, depending on the result of the test "N > 1," the program will either immediately return to the calling program, or it will return to the PERFORM, move zero to N, and then return to the calling program.

On subsequent calls to the program, the ELSE path will be taken, 1 will be subtracted from N, and then control will be transferred by the GO TO statement to paragraph A. Then, depending on the result of the test "N > 1," the program will either immediately return to the calling program or fall through into paragraph B, display a message, and continue.

Regardless of the paths taken, the mechanism that controls the PERFORM statement will be reset each time the program is called and no irregular control flow will take place.

Messages

A program that contains an out-of-line PERFORM, and either an EXIT PROGRAM or GOBACK statement, will receive the following messages when compiled with the CMPR2, FLAGMIG, and NOOPTIMIZE compiler options:

IGYPA3205-W
MIGR "EXIT PROGRAM" or "GOBACK" statements assume that ends of "PERFORM" ranges were reached under the "NOCMPR2" compiler option. This program may have different execution results after migration if used as a subprogram.

IGYPA3206-W
MIGR For more information about ends of "PERFORM" ranges, recompile with the "OPTIMIZE" and "FLAGMIG" compiler options. If no messages about ends of "PERFORM" ranges are issued, then this program will not have a migration problem with ends of "PERFORM" ranges.

Upon re-compilation with the OPTIMIZE compiler option, the absence of any such messages indicates that the program will not have any problem with an EXIT PROGRAM or GOBACK statement being executed within the range of an out-of-line PERFORM statement, while the presence of the following messages indicates otherwise:

IGYOP3205-W
MIGR "EXIT PROGRAM" or "GOBACK" statements assume that ends of "PERFORM" ranges were reached under the "NOCMPR2" compiler option. This program may have different execution results after migration if used as a subprogram.

IGYOP3092-W
An "EXIT PROGRAM" or a "GOBACK" statement was encountered in the range of the "PERFORM" statement at "PERFORM (LINE xx.xx)". Re-entry of the program may cause unexpected control flow.

Corrective action for the PERFORM return mechanism:

The CMPR2 behavior of affected programs cannot be preserved without extensive and complex recoding. Such programs should be rewritten to avoid this dependency on the CMPR2 behavior.

PERFORM ... VARYING ... AFTER

Certain identifiers in the VARYING phrase of the PERFORM statement are set and incremented differently depending on whether CMPR2 or NOCMPR2 is in effect.

Identifiers are set and increment differently, for example:

```
PERFORM PARA3 VARYING id-2 FROM id-3 BY id-4
              UNTIL condition-1
        AFTER id-5 FROM id-6 BY id-7
              UNTIL condition-2.
```

CMPR2

Within the VARYING ... AFTER phrase of the PERFORM statement under CMPR2, id-5 is set before id-2 is augmented.

When varying two variables under CMPR2, at the intermediate stage when the inner condition is true, the inner variable (id-5) was set to its current FROM value (id-6) before the outer variable (id-2) was augmented with its current BY value (id-4).

NOCMPR2

However, under NOCMPR2, id-2 is augmented before id-5 is set. This change creates an incompatibility when id-6 is dependent on id-2.

Consider the following example:

```
PERFORM PARA3 VARYING X FROM 1 BY 1 UNTIL X IS GREATER THAN 3
          AFTER Y FROM X BY 1 UNTIL Y IS GREATER THAN 3.
```

In this example, id-6 (X) is dependent on id-2 (X) because they are identical.

Under CMPR2, PARA3 will be executed eight times with the following values:

```
            X:    1   1   1   2   2   2   3   3
            Y:    1   2   3   1   2   3   2   3
```

Under NOCMPR2, PARA3 will be executed six times with the following values:

```
            X:    1   1   1   2   2   3
            Y:    1   2   3   2   3   3
```

A dependency between identifiers occurs if the first identifier is identical to, subscripted with, a partial or full redefinition of, or variably located depending on the second identifier.

Message

First, recompile all programs under an earlier COBOL compiler with the CMPR2 and FLAGMIG compiler options. This will flag any PERFORM ... VARYING statements that have dependencies between the following variables:

- id-6 is (potentially) dependent on id-2
- id-9 is (potentially) dependent on id-5
- id-4 is (potentially) dependent on id-5
- id-7 is (potentially) dependent on id-8

Only PERFORM ... VARYING with the AFTER phrase is affected.

For example, compiling the program under an earlier COBOL compiler with the CMPR2 and FLAGMIG compiler options causes the compiler to issue the following message when id-6 is dependent on id-2:

IGYPA3209-W
MIGR "PERFORM ... VARYING" operand "ID-6 (NUMERIC INTEGER)" was dependent on "ID-2 (NUMERIC INTEGER)". Under the "NOCMPR2" compiler option, the rules for augmenting/setting "PERFORM ... VARYING" operands have changed, and this statement may have incompatible results.

Corrective action for PERFORM . . . VARYING . . . AFTER

If a PERFORM ... VARYING statement is flagged by FLAGMIG, that statement will have to be converted. A possible way of converting a PERFORM ... VARYING statement that has *all four* dependencies is as follows:

```
PERFORM xx
   VARYING id-2 FROM id-3 BY id-4 UNTIL cond-1
     AFTER  id-5 FROM id-6 BY id-7 UNTIL cond-2
     AFTER id-8 FROM id-9 BY id-10 UNTIL cond-3.
```

is converted into:

```
MOVE id-3 TO id-2.
MOVE id-6 TO id-5
MOVE id-9 TO id-8

PERFORM UNTIL cond-1
  PERFORM UNTIL cond-2
    PERFORM UNTIL cond-3
      PERFORM xx
      ADD id-10 TO id-8
    END-PERFORM
    MOVE id-9 TO id-8
    ADD id-7 TO id-5
  END-PERFORM
  MOVE id-6 TO id-5
  ADD id-4 TO id-2
END-PERFORM
```

This example assumes that all id-x are identifiers. If any are index-names, then SET statements must be used in place of MOVE statements.

The example above is a worst-case conversion. It could be refined by changing only the parts of the statement that use those identifiers for which a dependency (potentially) exists. For example, if only id-6 is dependent on id-2 and no other dependency exists, the conversion above can be reduced to:

```
MOVE id-3 TO id-2.
MOVE id-6 TO id-5.

PERFORM UNTIL cond-1
  PERFORM UNTIL cond-2
    PERFORM VARYING  id-8 FROM id-9 BY id-10 UNTIL cond-3
         PERFORM XX
    END-PERFORM
    ADD id-7 TO id-5
  END-PERFORM
  MOVE id-6 TO id-5
  ADD id-4 TO id-2
END-PERFORM
```

PICTURE clause with "A"s and "B"s

A data item that has the symbol B in its PICTURE clause is treated either as alphabetic or alphabetic-edited depending on whether CMPR2 or NOCMPR2 is in effect.

CMPR2

Under CMPR2, a data item with the symbol B in its PICTURE clause is an alphabetic data item.

NOCMPR2

Under NOCMPR2, a data item with the symbol B in its PICTURE clause is an alphanumeric-edited item.

Most functions do not pose a problem with this change. However, there are a few subtleties that you should watch for when upgrading from CMPR2 to Enterprise COBOL, relating to the INITIALIZE, STRING, CALL and CANCEL statements.

Message

If a program is compiled with the CMPR2 and FLAGMIG options, a message is issued for any alphabetic items that had been defined with the symbol B.

IGYDS1105-W
MIGR A "PICTURE" clause was found consisting of symbols "A" and "B". This alphabetic item will be treated as an alphanumeric-edited item under the "NOCMPR2" compiler option.

INITIALIZE statement

Consider the following example:

```
01  ALPHA  PIC AABAABAA.

INITIALIZE ALPHA REPLACING ALPHABETIC DATA BY ALL "3".
```

A statement like this coded under CMPR2 is valid and initialization will take place. However, this statement gives the following warning message under NOCMPR2, and no initialization will take effect:

IGYPS2047-W
"INITIALIZE" statement receiver "ALPHA" was incompatible with the data category(s) of the "REPLACING" operand(s). "ALPHA" was not initialized.

This incompatibility can also happen when a group of items are being initialized. Under NOCMPR2, ALPHA above would be classified as alphanumeric-edited. If ALPHA was defined in a group that was to be initialized, a message like the one above would be issued only if there were no alphabetic items to be initialized. Thus, in the following example, ALPHA is never initialized, but no message alerts you to that fact.

```
01  GROUP1.
    05 ALPHA  PIC AABAA.
```

```
    05 BETA   PIC AAA.

INITIALIZE GROUP1 REPLACING ALPHABETIC DATA BY ALL "5".
```

Corrective action for the INITIALIZE statement

To initialize any of these reclassified data items in the same manner as they had been previously, change the original statement for the first example above to the following statement:

```
INITIALIZE ALPHA REPLACING
           ALPHANUMERIC-EDITED DATA BY ALL "3".
```

In the second example, which shows a group of possibly mixed types, INITIALIZE should be supplemented with an additional phrase. For example:

```
INITIALIZE GROUP1 REPLACING
                  ALPHABETIC DATA BY ALL "5"
                  ALPHANUMERIC-EDITED DATA BY ALL "5".
```

Important: Adding this extra phrase could cause conflicts if you already specified this phrase but used different replacing data *or* if you had other alphanumeric-edited items within the group that you did not want initialized.

STRING statement

With either CMPR2 or NOCMPR2, alphabetic items are allowed to be the STRING...INTO receiving field. However, edited items are not allowed. Therefore, if any CMPR2 programs have an alphabetic item defined with the symbol B in this position of the STRING statement, these statements will get a severe error message from Enterprise COBOL because this item is reclassified as alphanumeric-edited.

IGYPA3104-S
"STRING INTO" identifier "ALPHA (ALPHANUMERIC-EDITED)" was an edited data item or was defined with the "JUSTIFIED" clause. The statement was discarded.

Corrective action for the STRING statement

Because a STRING statement with CMPR2 would automatically overlay any positions represented with the symbol B, all that is really needed is a new alphabetic data-name redefined on the original INTO field. For example:

Statement under CMPR2:

```
01 ALPHA  PIC AABAABAA.
01 VARX   PIC A(3)  VALUE "XXX".
01 VARY   PIC A(3)  VALUE "YYY".

   STRING VARX VARY DELIMITED BY SIZE INTO ALPHA.
```

Statement under NOCMPR2:

```
01 ALPHA  PIC AABAABAA
01 BETA   REDEFINES ALPHA   PIC A(8).
01 VARX   PIC A(3)  VALUE "XXX".
01 VARY   PIC A(3)  VALUE "YYY".

   STRING VARX VARY DELIMITED BY SIZE INTO BETA.
```

BETA is redefined on ALPHA and has a length equal to ALPHA, including all symbols of B. BETA is then used in the STRING statement. After STRING is executed, ALPHA will have the same value as it did with CMPR2.

CALL and CANCEL statements

An IBM extension allows the CALL and CANCEL statement identifier to be an alphabetic data item. However, alphanumeric-edited items are not allowed; therefore, any CMPR2 programs with alphabetic

items defined with the symbol B will get a severe error message. For example, the following program would have worked with CMPR2, but will now get a severe error message:

```
01  CALLDN   PIC  AAAAABB.

      MOVE "PROG1" TO CALLDN.
      CALL CALLDN.
      CANCEL CALLDN.
```

IGYPA3063-S
"CALL" or "CANCEL" identifier "CALLDN (ALPHANUMERIC-EDITED)" was not alphanumeric, zoned decimal nor alphabetic. The statement was discarded.

To compile with Enterprise COBOL, change the definition of CALLDN to all alphabetic or alphanumeric or add a new data-name that redefines CALLDN with a valid data type as shown below.

```
01 CALLDN PIC A(7).
       or
01 CALLDN PIC X(7).
       or

01 CALLDN PIC AAAAABB
01 CALLDN1 REDEFINES CALLDN PIC A(7).

    MOVE "PROG1" TO CALLDN1.
    CALL CALLDN1.
    CANCEL CALLDN1.
```

PROGRAM COLLATING SEQUENCE

The truth value of nonnumeric comparisons determined by the PROGRAM COLLATING SEQUENCE clause might be different under CMPR2 and NOCOMPR2.

CMPR2

The PROGRAM COLLATING SEQUENCE established in the OBJECT COMPUTER paragraph is used to determine the truth value of any nonnumeric comparisons that are:

- Explicitly specified in relation conditions
- Explicitly specified in condition-name conditions
- Implicitly performed as part of the execution of the SORT and MERGE statements, unless overridden by the COLLATING SEQUENCE phrase on the respective SORT or MERGE statement
- Implicitly performed as part of the execution of STRING, UNSTRING, and INSPECT statements

NOCMPR2

The PROGRAM COLLATING SEQUENCE established in the OBJECT COMPUTER paragraph is used to determine the truth value of any nonnumeric comparisons that are:

- Explicitly specified in relation conditions
- Explicitly specified in condition-name conditions
- Implicitly performed as part of the execution of the SORT and MERGE statements, unless overridden by the COLLATING SEQUENCE phrase on the respective SORT or MERGE statement

The *native collating sequence* is used to determine the truth value of any nonnumeric comparisons that are implicitly performed as part of the execution of STRING, UNSTRING, and INSPECT statements.

For most applications, this difference will not affect the results of these statements. The implicit comparisons performed as part of STRING, UNSTRING, and INSPECT statements are always for equality. Therefore, even if the ordering of the characters in the PROGRAM COLLATING SEQUENCE is different than that of the native sequence, the results of these comparisons will be the same.

For an application to be affected by this change, the PROGRAM COLLATING SEQUENCE established in the OBJECT COMPUTER paragraph must identify an alphabet that was defined with the ALSO clause, which assigns several different characters to the same ordinal position.

Messages

Compiling the program with the CMPR2 and FLAGMIG options will cause the compiler to issue messages for all statements that might be affected by this change:

IGYPS3142-W
MIGR The "PROGRAM COLLATING SEQUENCE" will not affect the "STRING" statement under the "NOCMPR2" compiler option.

Corrective action

No correction that is generally applicable exists for programs receiving this message if the PROGRAM COLLATING SEQUENCE contains multiple characters assigned to the same ordinal position.

The CMPR2 behavior of affected programs cannot be preserved without extensive and complex recoding. Such programs must be rewritten to avoid this dependency on the CMPR2 behavior.

READ INTO and RETURN INTO

READ (or RETURN) with the INTO phrase might be performed differently for CMPR2 and NOCMPR2 for fixed-length files that have multiple 01-level record descriptions in which at least one of the descriptions is numeric or numeric-edited.

When deciding which record description to use as the sending field for an implicit MOVE statement, the compiler selects the longest of the 01 record descriptions. If multiple record descriptions have the same length, then the first such record description is chosen. This is true under both CMPR2 and NOCMPR2. However, the method for determining which 01 record description is the longest is different.

CMPR2

Under CMPR2, the length of numeric and numeric-edited record descriptions is calculated by totaling the number of digit positions in the PICTURE. Other types of record descriptions are assigned a length equal to the number of bytes occupied by the record description.

NOCMPR2

Under NOCMPR2, the length of each record description is determined to be the number of bytes occupied by the record description, regardless of whether the record description is numeric, numeric-edited, or otherwise.

Messages

If the FLAGMIG and CMPR2 compiler options are used, a message will be issued for any READ INTO or RETURN INTO statement that might be affected.

A program that is affected by the rule change will receive the following message:

IGYPS2281-I
The "INTO" phrase of the "READ" or "RETURN" statement was specified for fixed-format file "file-name", which contained multiple records. Record "record-name" was selected as the sending field for the move.

This message will be issued under both the CMPR2 and NOCMPR2 compiler options. Therefore, you can compile the program with CMPR2, and then with NOCMPR2, and examine the messages to determine whether the same record was chosen under both CMPR2 and NOCMPR2. If so, then the program need not be changed.

In addition, with the FLAGMIG compiler option, the following message will be issued:

IGYPS2283-W
MIGR The "INTO" phrase of the "READ" or "RETURN" statement was specified for file "file-name", which contained multiple records. A different record might be selected for the sending field for the move under the "NOCMPR2" compiler option.

Corrective action for the READ INTO and RETURN INTO phrases:

By applying the record description rules to each qualified file or by checking the messages, you can determine whether a different record description may be selected under NOCMPR2 than under CMPR2. For example, consider the following record descriptions:

```
01 RECORD-1 PIC X(9) USAGE DISPLAY.
01 RECORD-2 PIC 9(9) USAGE DISPLAY.
```

In this case, each record description is calculated to have a length of "9", under both CMPR2 and NOCMPR2. Therefore, no incompatibility exists.

Suppose, however, that there is a difference in the way that the record description lengths are calculated. Consider the following statements:

```
01 RECORD-3 PIC X(4) USAGE DISPLAY.
01 RECORD-4 PIC 9(9) USAGE COMP.
```

In this case, under NOCMPR2, each record description is calculated to have a length of "4". However, under CMPR2, the length of the numeric record description (RECORD-4) is calculated by counting digits, so its length will be "9" instead of "4". Thus, RECORD-4 will be used as the sending field, even though the byte length of each record description is 4.

After you have detected an incompatibility, change the code to ensure that the CMPR2 behavior will be preserved. You can change the READ INTO or RETURN INTO statement to a READ or RETURN statement, followed by a MOVE statement. The MOVE statement would specify, as a sending field, the required record description (the "longest" one), and, as a receiving field, the item that had been specified as the INTO item.

RECORD CONTAINS n CHARACTERS

The definition of RECORD CONTAINS n CHARACTERS affects existing programs.

Its behavior is different under CMPR2 and NOCMPR2.

Consider the following example:

```
FD FILE1
   RECORD CONTAINS 40.
 01 F1R1 PIC X(20).
 01 F1R2 PIC X(40).


FD FILE2
   RECORD CONTAINS 20 TO 40.
 01 F2R1 PIC X(20).
 01 F2R2 PIC X(40).
```

CMPR2

Under CMPR2, FILE1 and FILE2 have variable-length records.

NOCMPR2

Under NOCMPR2, FILE1 has fixed-length records and FILE2 has variable-length records.

Message

Compiling the program with the CMPR2 and FLAGMIG options will cause the compiler to issue the following message for FILE1:

IGYPS1183-W
MIGR "RECORD CONTAINS" clause with one integer specified is supported differently under the "NOCMPR2" compiler option.

A program that has this difference might get a file status 39 on OPEN after compiling with Enterprise COBOL.

Corrective action for the RECORD CONTAINS n CHARACTERS clause:

To maintain current behavior, remove the RECORD CONTAINS clauses. This change results in FILE1 and FILE2 both having variable-length records.

For maximum clarity, and for any new applications, use RECORD CONTAINS n CHARACTERS for fixed-length records and RECORD IS VARYING FROM integer-1 TO integer-2 for variable-length records. Avoid using RECORD CONTAINS n1 TO n2 CHARACTERS.

SET . . . TO TRUE

SET ... TO TRUE has different effects depending on whether CMPR2 or NOCMPR2 is in effect.

CMPR2

The SET ... TO TRUE statement is performed according to the rules of the MOVE statement.

NOCMPR2

Under NOCMPR2, SET ... TO TRUE follows the rules of the VALUE clause. There are three instances in which this change can cause different results:

- When the data item is described by a JUSTIFIED clause
- When the data item is described by a BLANK WHEN ZERO clause
- When the data item has editing symbols in its PICTURE string

Message

A program that is potentially affected by this change will receive the following message when compiled with the CMPR2 and FLAGMIG options:

IGYPS2219-W
: **MIGR** The "SET" statement with the "TO TRUE" phrase will be performed according to the rules for the "VALUE" clause under the "NOCMPR2" compiler option.

JUSTIFIED clause

When a data item described by a JUSTIFIED clause is the receiving item in a MOVE statement, the sending data is aligned at the rightmost character position in the receiving item. In a VALUE clause, initialization is not affected by the JUSTIFIED clause. This means that the data in a VALUE clause will be aligned at the leftmost character position in the receiving item.

Here's how it works under CMPR2:

```
01 A PIC X(3) JUSTIFIED RIGHT VALUE "a". (Result = "a  ")
   88 V VALUE "a".

SET V TO TRUE                            (Result = "  a")
MOVE "a" TO A                            (Result = "  a")
```

Here's how it works under NOCMPR2:

```
01 A PIC X(3) JUSTIFIED RIGHT VALUE "a". (Result = "a  ")
   88 V VALUE "a".
SET V TO TRUE                            (Result = "a  ")

MOVE "a" TO A                            (Result = "  a")
```

Corrective action for the JUSTIFIED clause

If using NOCMPR2, and you want the same behavior as with CMPR2, adjust the data in the VALUE clause for the 88-level item accordingly:

```
01 A PIC X(3) JUSTIFIED RIGHT VALUE "a". (Result = "a  ")
   88 V VALUE "  a".

SET V TO TRUE                            (Result = "  a")
MOVE "a" TO A                            (Result = "  a")
```

BLANK WHEN ZERO clause

When a data item described by a BLANK WHEN ZERO clause receives the value of zero in a MOVE statement, the item will contain nothing but spaces. In a VALUE clause, initialization is not affected by the BLANK WHEN ZERO clause. This means that if the VALUE clause specifies a value of zero, the data will be placed into the item as is, and the item will contain all zeros instead of spaces.

Here's how it works under CMPR2:

```
01 N PIC 9(3) BLANK WHEN ZERO VALUE ZERO. (Result = "000")
   88 V VALUE ZERO.

SET V TO TRUE                            (Result = "   ")
MOVE ZERO TO N                           (Result = "   ")
```

Here's how it works under NOCMPR2:

```
01 N PIC 9(3) BLANK WHEN ZERO VALUE ZERO. (Result = "000")
   88 V VALUE ZERO.
SET V TO TRUE                            (Result = "000")

MOVE ZERO TO N                           (Result = "   ")
```

If the behavior exhibited under CMPR2 is required under NOCMPR2, the data in the VALUE clause for the 88-level item must be adjusted accordingly:

```
01 N PIC 9(3) BLANK WHEN ZERO VALUE ZERO. (Result = "000")
   88 V VALUE "   ".

SET V TO TRUE                            (Result = "   ")
MOVE ZERO TO N                           (Result = "   ")
```

PICTURE string with editing symbols

When a data item contains editing symbols in its PICTURE string, the character positions represented by those symbols will contain editing characters when data is moved into the data item. In a VALUE clause, initialization is not affected by the editing symbols. This means that the data in the VALUE clause will be placed into the item as is, and editing will not take place as it does in the MOVE statement.

Here's how it works under CMPR2:

```
01 E PIC X/X VALUE SPACE. (Result = "   ")
   88 V VALUE SPACE.

SET V TO TRUE             (Result = " / ")
MOVE SPACE TO E           (Result = " / ")
```

Here's how it works under NOCMPR2:

```
01 E PIC X/X VALUE SPACE. (Result = "   ")
   88 V VALUE SPACE.
SET V TO TRUE             (Result = "   ")

MOVE SPACE TO E           (Result = " / ")
```

If the behavior exhibited under CMPR2 is required under NOCMPR2, the data in the VALUE clause for the 88-level item must be specified in edited form:

```
01 E PIC X/X VALUE SPACE. (Result = "   ")
   88 V VALUE " / ".
```

```
SET V TO TRUE             (Result = " / ")
MOVE SPACE TO E           (Result = " / ")
```

SIZE ERROR on MULTIPLY and DIVIDE

SIZE ERROR behaves differently depending on whether CMPR2 or NOCMPR2 is in effect.

The 74 COBOL Standard and the 85 COBOL Standard state that an intermediate result will be provided by the implementer when a COMPUTE, DIVIDE, or MULTIPLY statement has multiple receiving fields. For example: `MULTIPLY A BY B GIVING C D` should behave like:

```
MULTIPLY A BY B GIVING temp
MOVE temp TO C
MOVE temp TO D
```

where *temp* is an intermediate result provided by the implementer.

The *Enterprise COBOL Programming Guide* describes the use and definition of intermediate results. One such definition says that an intermediate result will have at most 30-digits (31-digits with ARITH(EXTEND)).

So, in the example above, if A, B, C, and D are all defined as PIC S9(18), A will be multiplied by B, yielding a 36-digit result, which will be moved to the 30-digit (or 31-digit) intermediate result, *temp*. Then *temp* will be moved to C and D.

CMPR2

When SIZE ERROR is specified on the MULTIPLY statement example, SIZE ERROR can occur when the 36-digit (immediate) result is moved into the 30-digit (or 31-digit) (intermediate) result, according to the 74 COBOL Standard rules. This differs from the corresponding COMPUTE case, in which SIZE ERROR cannot occur when the 36-digit (immediate) result is moved into the 30-digit (or 31-digit) (intermediate) result.

```
COMPUTE C D = A * B ON SIZE ERROR...
```

This behavior applies to the DIVIDE statement with its corresponding COMPUTE statement as well.

NOCMPR2

However, under NOCMPR2, SIZE ERROR applies only to final results. In the MULTIPLY example, SIZE ERROR cannot occur when the 36-digit (immediate) result is moved into the 30-digit (or 31-digit) (intermediate) result. Consequently, the MULTIPLY and COMPUTE statements become equivalent in this regard. This behavior also applies to the DIVIDE statement.

Such statements will now be flagged by the following compiler message:

IGYPG3113-W
Truncation of high-order digit positions can occur due to precision of intermediate results exceeding 30-digits.

If, at run time, truncation actually does occur, the following message will be issued:

IGZ0036W
Truncation of high order digit positions occurred in program "program-name" on line number "n".

Message

A program that is potentially affected by this change will receive the following message when compiled with the CMPR2 and the FLAGMIG options:

IGYPG3204-W
MIGR The "ON SIZE ERROR" phrase will not be executed for intermediate results under the "NOCMPR2" compiler option.

Corrective action for the SIZE ERROR on MULTIPLY and DIVIDE

The CMPR2 behavior of affected programs cannot be preserved without extensive and complex recoding. Such programs must be rewritten to avoid this dependency on the CMPR2 behavior.

UNSTRING operand evaluation

Subscripting, indexing, and length calculation associated with the UNSTRING statement might generate different results depending on whether CMPR2 or NOCMPR2 is in effect.

In the description below, the following general format of the UNSTRING statement is used for reference:

```
UNSTRING id-1
  DELIMITED BY id-2 OR id-3 ...
  INTO id-4 DELIMITER IN id-5 COUNT IN id-6
       id-7 DELIMITER IN id-8 COUNT IN id-9
  WITH POINTER id-10
  TALLYING IN id-11
  ON OVERFLOW imp-stmt-1
  NOT ON OVERFLOW imp-stmt-2
  END-UNSTRING
```

CMPR2

Under CMPR2, any subscripting, indexing, or length calculation associated with id-1, id-10, and id-11 is to be evaluated only once, at the beginning of execution of the UNSTRING statement. However, any subscripting, indexing, or length calculation associated with id-2, id-3, id-4, id-5, id-6, id-7, id-8, and id-9, (or any repetitions) is to be evaluated immediately before transfer into the respective data item.

NOCMPR2

Under NOCMPR2, any subscripting, indexing, or length calculation associated with any of id-1 through id-11 (or any repetitions) is to be evaluated only once, at the beginning of execution of the UNSTRING statement. This change can lead to different results when certain dependencies exist between id-2 through id-9.

Dependencies involving identifiers id-1, id-10, and id-11 are not affected by this change.

Messages

Most of the UNSTRING statements flagged with messages 3211 through 3214 will generate identical results. Only certain dependencies between the operands in the UNSTRING statement will generate different results.

For example, a dependency can exist between two operands (op-1 and op-2) in an UNSTRING statement in the following ways:

1. op-1 is subscripted, and the subscript value is modified by op-2:
   a. The subscript identifier is used as a receiver in an INTO, DELIMITER IN, or COUNT IN operand.
   b. The subscript identifier is a variably located item, and an ODO object affecting the location of this item is used as a receiver in an INTO, DELIMITER IN, or COUNT IN operand.
2. op-1 is a variable-length group item, and an ODO object affecting the length of this group is modified by op-2:
   a. The ODO object is used as a receiver in an INTO, DELIMITER IN, or COUNT IN operand.
3. op-1 is a variably located item, and an ODO object affecting the location of this item is modified by op-2:
   a. The ODO object is used as a receiver in an INTO, DELIMITER IN, or COUNT IN operand.

Dependencies generated by overlapping operands, or by specifying the same identifier as a DELIMITED BY operand and as one of the sending, INTO, or DELIMITER IN operands are illegal under both Standard COBOL 74 and 85 COBOL Standard and are not addressed here. Generally, results will be unpredictable.

Compiling the program with the CMPR2 and FLAGMIG options causes the compiler to issue messages for all UNSTRING statements that might contain such dependencies.

Any UNSTRING statements not flagged with one of these messages will generate identical results under CMPR2 and NOCMPR2.

All UNSTRING statements flagged with message 2222 will require changes to guarantee identical results.

Corrective action for the UNSTRING OPERAND evaluation:

The individual cases requiring changes are detailed below in order by message number, and with examples illustrating the dependencies and the suggested changes. Only the essential program fragments are included in the examples.

IGYPS2222-W

This message will be issued if one of the "receiver" identifiers in the UNSTRING statement refers to a variable-length group item that contains its own ODO object. Due to the syntax rules and restrictions applying to all UNSTRING statements, this situation can occur only for id-2, id-3, id-4, id-5, id-7, and id-8 (or repetitions).

For example:

```
01 VLG-1.
 02 VLG-1-ODOOBJ PIC 9 VALUE IS 5.
 02 VLG-1-GR.
  03 VLG-1-ODO PIC X OCCURS 1 TO 9 TIMES
                     DEPENDING ON VLG-1-ODOOBJ.
77 S-1 PIC X(20) VALUE IS ALL "123456789".

   UNSTRING S-1
            INTO VLG-1
            END-UNSTRING
```

IGYPS2222-W

MIGR The maximum length of receiver "vlg-1" will be used under the "NOCMPR2" compiler option.

Enterprise COBOL will use the maximum length of vlg-1 to determine both the amount of data extracted from sending item s-1 and the length of the receiving area vlg-1.

Regardless of which identifier is flagged with message 2222, you must replace the identifier with a reference modified version, as in the following example:

```
UNSTRING S-1
         INTO VLG-1(1:LENGTH OF VLG-1)
         END-UNSTRING
```

This form forces the actual length of vlg-1 at the beginning of the UNSTRING statement to be used.

This correction is not affected by the presence of any of the optional phrases of the UNSTRING statement (DELIMITED BY, WITH POINTER, ON OVERFLOW) and it applies equally to all flagged identifiers in any one UNSTRING statement.

IGYPA3211-W

This message will be issued if one of the "DELIMITED BY" identifiers in the UNSTRING statement is subscripted, refers to a variable-length group item, or refers to a variably located item.

For an UNSTRING statement to be affected by this change, the flagged DELIMITED BY operand must depend on one of the INTO receivers.

For example:

```
01 DEL
 02 OCC-DEL-1 PIC X OCCURS 9 TIMES.
 02 VLEN-DEL-2-ODOOBJ PIC 9 VALUE IS 5.
 02 VLEN-DEL-2.
  03 VLEN-DEL-2-ODO PIC X OCCURS 1 TO 9 TIMES
                           DEPENDING ON VLEN-DEL-2-ODOOBJ.
```

```
77 S-1 PIC X(20) VALUE IS ALL "123456789".
77 R-1 PIC X(20) VALUE IS SPACES.
77 R-2 PIC X(20) VALUE IS SPACES.
77 SUB-5 PIC 99 VALUE IS 5.

   UNSTRING S-1
            DELIMITED BY OCC-DEL-1(SUB-5) OR VLEN-DEL-2,
            INTO R-1 DELIMITER IN OCC-DEL-1(SUB-5 + 1)
                     COUNT IN VLEN-DEL-2-ODOOBJ,
                 R-2,
            END-UNSTRING
```

IGYPA3211-W

MIGR In this "UNSTRING" statement, the subscript or "OCCURS DEPENDING ON" calculations for the "DELIMITED BY" operand will be done only once under the "NOCMPR2" compiler option.

No corrections are required for items flagged with message 3211.

IGYPA3212-W

This message will be issued if one of the INTO identifiers in the UNSTRING statement is subscripted, refers to a variable-length group item, or refers to a variably located item.

For an UNSTRING statement to be affected by this change, the flagged INTO identifier must depend on one of the receivers in a preceding INTO phrase.

For example:

```
01 REC.
 02 R-1 PIC X(20) VALUE IS SPACES.
 02 R-2-SUB PIC 9 VALUE IS 9.
 02 OCC-R-2-GR.
  03 OCC-R-2 PIC X OCCURS 9 TIMES.
 02 R-3-ODOOBJ PIC 9 VALUE IS 9.
 02 ODO-R-3.
  03 FILLER PIC X OCCURS 1 TO 9 TIMES
                 DEPENDING ON R-3-ODOOBJ.

77 S-3 PIC X(20) VALUE IS "12 345  6789   .....".

   UNSTRING S-3
            DELIMITED BY ALL SPACES,
            INTO R-1 COUNT IN R-2-SUB,
                 OCC-R-2(R-2-SUB) COUNT IN R-3-ODOOBJ,
                 ODO-R-3,
            END-UNSTRING
```

IGYPA3212-W

MIGR In this "UNSTRING" statement, the subscript or "OCCURS DEPENDING ON" calculations for the "INTO" operand will be done only once under the "NOCMPR2" compiler option.

This UNSTRING statement will generate different results under CMPR2 and NOCMPR2 because the subscript of the second INTO receiver is modified by the COUNT IN receiver of the first INTO phrase. In addition, the length of the third INTO receiver is modified by the COUNT IN receiver of the second INTO phrase.

Under CMPR2, the values that are moved to the COUNT IN identifiers will be used for the subsequent INTO phrases. Under NOCMPR2, the values in effect at the beginning of the execution of the UNSTRING statement will be used for all INTO phrases.

Any UNSTRING statement flagged with message 3212 must be broken into multiple UNSTRING statements. A separate UNSTRING statement must be used for each dependent INTO phrase. However, be aware of the following rules:

- If the original UNSTRING statement specified a WITH POINTER phrase, that phrase must be included in all of the changed UNSTRING statements. If the original UNSTRING statement *did not* specify a WITH POINTER phrase, that phrase must be added to all the changed UNSTRING statements, and the POINTER identifier must be initialized to 1.
- If the original UNSTRING statement specified a TALLYING IN phrase, that phrase must be included in all of the changed UNSTRING statements.

- If the original UNSTRING statement specified the ON OVERFLOW or NOT ON OVERFLOW phrases, those phrases must be included only in the last of the changed UNSTRING statements.

With these changes, the previous example becomes:

```
77 PTR PIC 99.

   MOVE 1 TO PTR
   UNSTRING S-3
            DELIMITED BY ALL SPACES,
            INTO R-1 COUNT IN R-2-SUB,
            WITH POINTER PTR,
            END-UNSTRING
   UNSTRING S-3
            DELIMITED BY ALL SPACES,
            INTO OCC-R-2(R-2-SUB) COUNT IN R-3-ODOOBJ,
            WITH POINTER PTR,
            END-UNSTRING
   UNSTRING S-3
            DELIMITED BY ALL SPACES,
            INTO ODO-R-3,
            WITH POINTER PTR,
            END-UNSTRING
```

IGYPA3213-W

This message will be issued if one of the DELIMITER IN identifiers in the UNSTRING statement is subscripted, refers to a variable-length group item, or refers to a variably located item.

For an UNSTRING statement to be affected by this change, the flagged DELIMITER IN identifier must depend on one of the receivers in a preceding INTO phrase.

Dependencies between identifiers in the same INTO phrase will not affect the result of the UNSTRING statement. CMPR2 behavior delays the effects of these dependencies until the next INTO phrase.

For example:

```
01 DEL.
 02 D-2-SUB PIC 9 VALUE IS 9.
 02 OCC-D-2-GR.
  03 OCC-D-2 PIC X OCCURS 9 TIMES.
 02 D-3-ODOOBJ PIC 9 VALUE IS 9.
 02 ODO-D-3.
  03 FILLER PIC X OCCURS 1 TO 9 TIMES
                DEPENDING ON D-3-ODOOBJ.

77 S-4 PIC X(20) VALUE IS "12 345  6789   .....".
77 R-1 PIC X(20) VALUE IS SPACES.
77 R-2 PIC X(20) VALUE IS SPACES.
77 R-3 PIC X(20) VALUE IS SPACES.

   UNSTRING S-4
            DELIMITED BY ALL SPACES,
            INTO R-1 COUNT IN D-2-SUB,
                 R-2 DELIMITER IN OCC-D-2(D-2-SUB)
                     COUNT IN D-3-ODOOBJ,
                 R-3 DELIMITER IN ODO-D-3,
            END-UNSTRING
```

IGYPA3213-W

MIGR In this "UNSTRING" statement, the subscript or "OCCURS DEPENDING ON" calculations for the "DELIMITER IN" operand will be done only once under the "NOCMPR2" compiler option.

This UNSTRING statement will generate different results under CMPR2 and NOCMPR2 because the subscript of the DELIMITER IN identifier of the second INTO phrase is modified by the COUNT IN receiver of the first INTO phrase. In addition, the length of the DELIMITER IN identifier of the third INTO phrase is modified by the COUNT IN receiver of the second INTO phrase.

With CMPR2 behavior, the values that are moved to the COUNT IN identifiers will be used for the subsequent INTO phrases. With NOCMPR2, the values in effect at the beginning of the execution of the UNSTRING statement will be used for all INTO phrases.

Any UNSTRING statement flagged with message 3213 must be broken into multiple UNSTRING statements; a separate UNSTRING statement must be used for each dependent INTO phrase.

With these changes, the previous example becomes:

```
77 PTR PIC 99.
   MOVE 1 TO PTR
   UNSTRING S-4
            DELIMITED BY ALL SPACES,
            INTO R-1 COUNT IN D-2-SUB,
            WITH POINTER PTR,
            END-UNSTRING
   UNSTRING S-4
            DELIMITED BY ALL SPACES,
            INTO R-2 DELIMITER IN OCC-D-2(D-2-SUB)
                     COUNT IN D-3-ODOOBJ,
            WITH POINTER PTR,
            END-UNSTRING
   UNSTRING S-4
            DELIMITED BY ALL SPACES,
            INTO R-3 DELIMITER IN ODO-D-3,
            WITH POINTER PTR,
            END-UNSTRING
```

IGYPA3214-W

This message will be issued if one of the COUNT IN identifiers in the UNSTRING statement is subscripted or refers to a variably located item.

For an UNSTRING statement to be affected by this change, the flagged COUNT IN identifier must depend on one of the receivers in a preceding INTO phrase.

Dependencies between identifiers in the same INTO phrase will not affect the result of the UNSTRING statement; CMPR2 behavior delays the effects of these dependencies to the next INTO phrase.

For example:

```
01 C-2.
 02 C-2-SUB PIC 9 VALUE IS 9.
 02 OCC-C-2-GR.
  03 OCC-C-2 PIC 9 OCCURS 9 TIMES.

77 S-5 PIC X(20) VALUE IS "12 345  6789........".
77 R-1 PIC X(20) VALUE IS SPACES.
77 R-2 PIC X(20) VALUE IS SPACES.

   UNSTRING S-5
            DELIMITED BY ALL SPACES,
            INTO R-1 COUNT IN C-2-SUB,
                 R-2 COUNT IN OCC-C-2(C-2-SUB),
            END-UNSTRING
```

IGYPA3214-W

MIGR In this "UNSTRING" statement, the subscript or "OCCURS DEPENDING ON" calculations for the "COUNT IN" operand will be done only once under the "NOCMPR2" compiler option.

This UNSTRING statement will generate different results under CMPR2 and NOCMPR2 because the subscript of the COUNT IN identifier of the second INTO phrase is modified by the COUNT IN receiver of the first INTO phrase.

With CMPR2 behavior, the values that are moved to the COUNT IN identifier in the first INTO phrase will be used for the second INTO phrase. With NOCMPR2, the value in effect at the beginning of execution of the UNSTRING statement will be used.

Any UNSTRING statement flagged with message 3214 must be broken into multiple UNSTRING statements; a separate UNSTRING statement must be used for each dependent INTO phrase.

With these changes, the example above becomes:

```
77 PTR PIC 99.

   MOVE 1 TO PTR
   UNSTRING S-5
            DELIMITED BY ALL SPACES,
            INTO R-1 COUNT IN C-2-SUB,
            WITH POINTER PTR,
            END-UNSTRING
```

```
   UNSTRING S-5
            DELIMITED BY ALL SPACES,
            INTO R-2 COUNT IN OCC-C-2(C-2-SUB),
            WITH POINTER PTR,
            END-UNSTRING
```

UPSI switches

Condition-names for the UPSI switches must be defined and referenced differently depending on whether CMPR2 or NOCMPR2 is in effect.

CMPR2

UPSI switches can be defined by specifying condition-names for the ON and OFF settings of the switch. Under CMPR2, the condition-names for all UPSI switches, UPSI-0 through UPSI-7, can be defined with the same names, as follows:

```
SPECIAL-NAMES.
    UPSI-0  ON STATUS IS T  OFF STATUS IS F
    UPSI-1  ON STATUS IS T  OFF STATUS IS F
⋮
    UPSI-7  ON STATUS IS T  OFF STATUS IS F
```

References to the names could be qualified with the UPSI name, as follows:

```
IF T OF UPSI-0 DISPLAY "UPSI-0".
IF T OF UPSI-1 DISPLAY "UPSI-1".
⋮
IF T OF UPSI-7 DISPLAY "UPSI-7".
```

NOCMPR2

The names of the UPSI switches, UPSI-0 through UPSI-7, can no longer be referenced in the PROCEDURE DIVISION under NOCMPR2. The statements above will now be flagged with a message of the following format:

IGYPS2121-S
"T OF UPSI-0" was not defined as a data-name. The statement was discarded.

Message

Using CMPR2 and FLAGMIG, any PROCEDURE DIVISION statement that references an UPSI switch by name will be flagged with the following message:

IGYPS0186-W
MIGR UPSI switches cannot be referenced directly in the PROCEDURE DIVISION under the "NOCMPR2" compiler option.

Corrective action for UPSI switches:

Programs will have to be changed to define unique condition-names, as follows:

```
SPECIAL-NAMES.
  UPSI-0  ON STATUS IS T0  OFF STATUS IS F0
  UPSI-1  ON STATUS IS T1  OFF STATUS IS F1
⋮
  UPSI-7  ON STATUS IS T7  OFF STATUS IS F7
```

and to reference the new condition-names, as follows:

```
IF T0 DISPLAY "UPSI-0".
IF T1 DISPLAY "UPSI-1".
⋮
IF T7 DISPLAY "UPSI-7".
```

Variable-length group moves

The calculation of the length of a sending or receiving ODO object can vary depending on whether CMPR2 or NOCMPR2 is in effect.

CMPR2

All ODO objects in sending and receiving fields involved in a group move, such as a MOVE statement, must be set before the statement is executed. The actual lengths of the sender and receiver are calculated just before the execution of the data movement statement. For a list of affected statements, see the message below.

NOCMPR2

In some cases, NOCMPR2 uses the maximum length of a variable-length group when it is a receiver, whereas CMPR2 uses the actual length. This behavior occurs when the receiver is variable length, contains its own ODO object, and is the last group in a structure. For example:

```
01  ODO-SENDER
    02  SEND-OBJ PIC 99.
    02  SEND-ITEM PIC X OCCURS 1 TO 20 DEPENDING ON SEND-OBJ.

01  ODO-RECEIVER.
    02  RECV-OBJ PIC 99.
    02  RECV-ITEM PIC X OCCURS 1 TO 20 DEPENDING ON RECV-OBJ.
⋮
MOVE 5 TO SEND-OBJ.
MOVE 10 TO RECV-OBJ.
MOVE ODO-SENDER TO ODO-RECEIVER.
⋮
CMPR2:
   Occurrences 1-5 of ODO-SENDER moved to ODO-RECEIVER.
   Occurrences 6-10 of ODO-RECEIVER become spaces.
   Occurrences 11-20 of ODO-RECEIVER are unchanged.
NOCMPR2:
   Occurrences 1-5 of ODO-SENDER moved to ODO-RECEIVER.
   Occurrences 6-20 of ODO-RECEIVER become spaces.
```

The programs that will have negative effects if used under NOCMPR2 are those that reference occurrences of the table that are beyond the value of the ODO object when a data movement statement was executed.

In the example above, if occurrences 11-20 have data in them before the group move, that data will be lost after the group move if run under NOCMPR2.

Message

Compiling the program with the CMPR2 and FLAGMIG compiler options generates the following message for each data movement statement that will behave differently under NOCMPR2:

IGYPS2222-W
MIGR The maximum length of receiver "ODO-RECEIVER" will be used under the "NOCMPR2" compiler option.

This difference in variable-length group moves affects any statement that moves data. The affected statements are:

ACCEPT identifier (Format 1 or Format 2)
MOVE . . . TO identifier
READ . . . INTO identifier
RELEASE identifier FROM . . .
RETURN . . . INTO identifier
REWRITE identifier FROM . . .
STRING . . . INTO identifier
UNSTRING . . . INTO identifier DELIMITER IN identifier
WRITE identifier FROM . . .

Corrective action for variable-length group moves:

You can take the following steps:

- See if any of your COBOL programs have the variable-length data movement statements by compiling them with the CMPR2 and FLAGMIG compiler options. This completion will flag all variable-length group moves with receivers that contain their own ODO objects and are not complex ODO items.
- See if any data that was previously left unchanged and is now being set to blanks is referenced after the data movement statements. In the example, if the ODO object has a value of 5 and a maximum value of 10 and the code uses data in occurrence numbers 6 through 10 after the MOVE, then the program will have different results between CMPR2 and NOCMPR2.
- Change the receiver in the data movement statement to use reference modification to specify explicitly the length of the receiving field. For example:

```
MOVE ODO-SENDER TO ODO-RECEIVER (1:LENGTH OF ODO-RECEIVER).
```

Upgrading SOM-based object-oriented (OO) COBOL programs

SOM-based object-oriented COBOL applications are not supported with Enterprise COBOL. OO COBOL syntax has been retargeted for Java-based object-oriented programming to facilitate interoperation of COBOL and Java.

The Java-based OO COBOL is not compatible with SOM-based OO COBOL, and is not intended as a migration path for OO COBOL programs. In most cases you should rewrite your OO COBOL into procedural COBOL in order to use the Enterprise COBOL compiler. It is possible that you could use the new OO COBOL syntax in place of your existing SOM-based OO syntax, but it is not a straightforward conversion.

For more information about the considerations that apply when you upgrade your IBM COBOL programs that contain SOM-based OO COBOL statements to Enterprise COBOL, see "SOM-based OO COBOL language elements that are not supported" on page 136 and "SOM-based OO COBOL language elements that are changed" on page 137.

SOM-based OO COBOL language elements that are not supported

When you migrate COBOL applications that use SOM-based OO programming to the Java-based OO programming in Enterprise COBOL, be aware of the following SOM elements that are not supported.

Calls to SOM
Calls to SOM services are not supported.

INHERITS clause

- Specification of more than one class name on the INHERITS clause of the CLASS-ID paragraph (multiple inheritance) is not supported.
- COBOL classes must be ultimately derived from the java.lang.Object class (rather than SOMObject or SOMClass). Specification of SOMObject as a base class in the INHERITS clause is not supported.
- Specification of SOMClass as a base class in the INHERITS clause (defining metaclasses) is not supported. Java-based OO COBOL classes can specify a FACTORY section, defining static methods that are logically part of the class-object for the class.

INVOKE

- Argument lists on INVOKE statements and parameter lists for methods are restricted to data types that map to Java types and that are passed BY VALUE.
- Specification of a class-name that qualifies SUPER in the INVOKE statement is not supported. For example you cannot use:

```
INVOKE C OF SUPER "foo"
```

However, the following syntax continues to be supported in Enterprise COBOL:

```
INVOKE SUPER "foo"
```

METACLASS clauses

- The METACLASS IS clause of the CLASS-ID paragraph is not supported.
- The METACLASS OF clause from the USAGE clause, which defines object references, is not supported.

METHODS

- The OVERRIDE clause of the METHOD-ID paragraph is not supported.
- Use of methods from SOM base classes such as somNew, somFree, and somInit are not supported.

Compiler options IDLGEN and TYPECHK

The IDLGEN and TYPECHK options are not available. Both compiler options require SOM-based OO COBOL, which is not available with Enterprise COBOL.

SOM-based OO COBOL language elements that are changed

When you migrate applications that use SOM-based OO programming to the Java-based OO programming in Enterprise COBOL, be aware of the following elements that are changed in Enterprise COBOL.

External names

- External class names that are defined in the REPOSITORY paragraph must be defined with Java naming conventions for fully qualified class names, rather than the CORBA rules of formation for class names.
- Method names that are specified as literals use Java naming conventions rather than CORBA naming conventions.

INVOKE

Instead of somNew, object instances are created with the syntax:

```
INVOKE classname NEW ...
```

METHODS

COBOL methods can override inherited methods and can be overloaded, according to Java rules. However, the OVERRIDE clause is not required or supported on the METHOD-ID paragraph in these cases.

OBJECTS

- Instead of somNew, object instances are created with the syntax:

  ```
  INVOKE classname NEW ...
  ```

- Object instances are freed through Java automatic garbage collection, rather than somFree.
- Object instance data is initialized through VALUE clauses or user-written initialization methods, rather than with somInit.
- OBJECT and END OBJECT syntax must be specified unless the class does not specify any object instance data or object instance methods.

Chapter 11. Compiling IBM COBOL programs

This section contains information about the following topics:

- Default compiler option changes from IBM COBOL
- Compiler options for IBM COBOL programs
- Compiler options not available in Enterprise COBOL

Information specific to IBM COBOL or Enterprise COBOL is noted.

Default compiler options for IBM COBOL programs

The Enterprise COBOL compiler has slightly different default compiler options than IBM COBOL. The compiler options DBCS, FLAG(I,I), RENT, and XREF(FULL) are now default values in the product configuration that is shipped from IBM. The default values for IBM COBOL were NODBCS, FLAG(I), NORENT, and NOXREF.

The DBCS option might cause problems for CICS programs if you are using the COBOL2 CICS translator option. The fix is to use the COBOL3 translator option.

Compiler options for IBM COBOL programs

The Enterprise COBOL and IBM COBOL compilers are very similar. If you will be using the same compiler options that were used in your current IBM COBOL applications, some internal changes might take effect, but basically the behavior is unchanged.

If you do change compiler options settings from the settings you used with IBM COBOL applications, make sure you understand the possible effects on your applications. For information about other compiler options, see the *Enterprise COBOL Programming Guide*.

There are some new compiler options in Enterprise COBOL compared to compiler options in IBM COBOL. Table 24 on page 139 lists the options that affect compatibility between IBM COBOL and Enterprise COBOL.

Table 24. Compiler options for IBM COBOL programs

Compiler option	Comments
ARITH	Use ARITH(COMPAT) to get the same results as COBOL/370, Release 1, thru COBOL for OS/390 & VM, Version 2 Release 1 for intermediate results in arithmetic statements.

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Table 24. Compiler options for IBM COBOL programs (continued)

Compiler option	Comments
INTDATE	Use INTDATE(ANSI) to get the same results as COBOL/370, Release 1 for date intrinsic functions. Use INTDATE(LILIAN) if you store integer values and will be using other languages with the same data. INTDATE(LILIAN) will cause the date intrinsic functions to use the Language Environment start date, which is the same starting date that would be used by PL/I or C programs that use Language Environment date callable services. If integer dates are used only within a single program, such as converting Gregorian to Lilian and back to Gregorian in the same program, the setting of INTDATE is immaterial. If you choose INTDATE(LILIAN) as your installation default, you should recompile all of your COBOL/370, Release 1 programs (and any IBM COBOL programs that used INTDATE(ANSI)) that use intrinsic functions to ensure that all of your code uses the Lilian integer date standard. This method is the safest, because you can store integer dates and pass them between programs, even between PL/I, COBOL, and C programs, and know that the date processing will be consistent.
PGMNAME	Use PGMNAME(COMPAT) to ensure that program names are processed in a manner similar to COBOL/370, Release 1.
NSYMBOL	Controls the interpretation of the "N" symbol used on literals and PICTURE clauses, indicating whether national or DBCS processing is assumed. NSYMBOL(DBCS) provides compatibility with previous releases of IBM COBOL and VS COBOL II.
TRUNC	In releases of COBOL for OS/390 & VM prior to Version 2 Release 2, unsigned binary data items with TRUNC(BIN) were correctly supported only when the binary value contained at most 15 bits for halfwords, 31 bits for fullwords, or 63 bits for doublewords. In other words, the sign bit was not used as part of the numeric value when the data item was unsigned. With Enterprise COBOL and COBOL for OS/390 & VM, Version 2 Release 2, all 16 bits of a halfword, all 32 bits of a fullword, and all 64 bits of a doubleword can be used as part of the numeric value of an unsigned COMP-5 data item or an unsigned binary data item with TRUNC(BIN). For example, in a program compiled with TRUNC(BIN), a data item declared like this `01 X pic 9(2) binary.` correctly supported binary values from 0 through only 32767 in prior releases, but with Version 2 Release 2 now supports values of 0 through 65535. This support necessarily yields different arithmetic results than were obtained with the prior releases, if these very large unsigned binary values were inadvertently used.

Compiler options not available in Enterprise COBOL

Most compiler options that are available in IBM COBOL can be used when you compile with Enterprise COBOL except for the following compiler options:

Table 25. Compiler options not available in Enterprise COBOL

Compiler option	Comments
ANALYZE	The ANALYZE option is not available with Enterprise COBOL. Use the CICS, SQL, and ADATA options instead.
CMPR2	The CMPR2 option is not available. You must convert programs compiled with CMPR2 to 85 COBOL Standard to compile them with Enterprise COBOL
EVENTS	The EVENTS option is not available. To emulate the COBOL/370 EVENTS compiler option: 1. Specify the ADATA compiler option. 2. Allocate SYSADATA and SYSEVENTS. 3. Use the ADEXIT suboption of the EXIT compiler option with the sample exit program IGYADXIT.
FLAGMIG	The FLAGMIG option is not available. FLAGMIG requires CMPR2, which is not available with Enterprise COBOL. Use CCCA, this *Migration Guide*, or a compiler released prior to Enterprise COBOL to compile programs using FLAGMIG.
IDLGEN	The IDLGEN option is not available. IDLGEN requires SOM-based OO COBOL, which is not available with Enterprise COBOL.
NUMPROC(MIG)	Enterprise COBOL does not support the NUMPROC(MIG) option in versions after Version 4. If NUMPROC(MIG) is specified, Enterprise COBOL issues a warning message and the compilation will get the default setting for NUMPROC. This is either the user-customized default or the IBM default, which is NUMPROC(NOPFD). To migrate your programs compiled with NUMPROC(MIG) to Enterprise COBOL V6, consider using the NUMCHECK compiler option to help you migrate to NUMPROC(PFD): 1. Compile your programs with NUMCHECK(ZON,PAC) and NUMPROC(PFD). 2. Run a thorough regression test with a good breadth of input data. If your applications get no NUMCHECK messages or NUMCHECK abends, you can safely compile with NUMPROC(PFD) and NONUMCHECK for production. This will not only solve the invalid data problem, but NUMPROC(PFD) is the most efficient setting for the NUMPROC compiler option. NUMCHECK is introduced in Enterprise COBOL V6.1 with the service PTFs. For details, see *NUMCHECK* in the *Enterprise COBOL Programming Guide*.
TYPECHK	The TYPECHK option is not available. TYPECHK requires SOM-based OO COBOL, which is not available with Enterprise COBOL.
WORD(NOOO)	If you have existing IBM COBOL programs that were compiled with the WORD(NOOO) compiler option, they must be changed if they use any of the following reserved words: CLASS-ID, END-INVOKE, INHERITS, INVOKE, LOCAL-STORAGE, METACLASS, METHOD, METHOD-ID, OBJECT, OVERRIDE, RECURSIVE, REPOSITORY, RETURNING, SELF, SUPER. The IGYCNOOO reserved word table is not shipped with the Enterprise COBOL compiler.

Chapter 12. Upgrading programs from Enterprise COBOL Version 3

To compile with Enterprise COBOL Version 5 or Version 6, Enterprise COBOL Version 3 programs that use any of several features might need to be changed.

Programs that contain any of the following language features might need to be modified:

- Programs with SEARCH ALL
- Programs that use XML PARSE
- Programs that use XML GENERATE
- Programs that use new reserved words as user words. For details, see “New reserved words” on page 91.
- Programs that use SIMVRD feature
- Label declaratives. Programs that contain the format 2 declarative syntax: USE...AFTER...LABEL PROCEDURE..., and optionally the syntax: GO TO MORE-LABELS. The support for these was removed in Enterprise COBOL Version 5.
- Programs using DATE FORMAT and windowed date functions. For details, see “Changes in millennium language extensions in IBM Enterprise COBOL for z/OS, Version 5 and Version 6” on page 159.

SEARCH ALL statements

Refer to this information if you have programs that contain SEARCH ALL statements and that were compiled with V3R4 before the installation of the PTF for APAR PK16765 or with Enterprise COBOL releases V3R1 through V3R3.

Tip: You can tell if your Enterprise COBOL V3R4 compiler has this PTF installed by looking at the page header in the compiler listing. The modification level was changed by this PTF from 0 to 1. If the product name in the header looks like this: "Enterprise COBOL for z/OS 3.4.1", your compiler has the PTF installed.

Upgrading programs that have SEARCH ALL statements

Enterprise COBOL has corrected errors in the implementation of the SEARCH ALL statement. SEARCH ALL statements in earlier releases of COBOL contained errors in the key comparison logic, which caused different results than might have been intended. In particular, the comparison did not produce the same result as an IF statement or a sequential SEARCH statement.

Length mismatch problem: a search argument is longer than the table key

The SEARCH ALL statement comparisons should pad an alphanumeric key with blanks or extend a numeric key with leading zeros if the key is shorter than the SEARCH argument. However, in V3R3 and earlier releases, SEARCH ALL ignored the excess characters in the argument in some cases. For example, an alphanumeric search argument of `01 ARG PIC X(6)` containing "ABCDEF" would incorrectly match a table or array key of `05 MY-KEY PIC X(4)` with value "ABCD". A search argument containing "ABCD??" (where ? is a blank) would match, as expected.

Similar problems occurred with a numeric search argument and keys. For example, a search argument of `01 ARG PIC 9(6)` containing 123456 would incorrectly match a table or array key of `05 MY-KEY PIC 9(4)` with value 3456. A search argument containing 003456 would match, as expected.

Sign mismatch problem: signed numeric argument and unsigned numeric key

A second problem occurs when the search argument is a signed numeric item and the table key is an unsigned numeric item. If the runtime value of the search argument is negative, such as -1234, programs compiled with V3R3 and earlier would match a table key of 1234. These comparisons should be done

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using the rules for a normal COBOL relation condition, and a negative argument such as -1234 should never match a table key that is unsigned.

The correction:

Enterprise COBOL corrected these problems. However, some applications compiled with earlier releases might depend on the incorrect behavior. You must identify and modify these applications before you move them to Enterprise COBOL Version 4 or later.

To assist you in identifying the programs and SEARCH ALL statements that are impacted by these corrections, the following compiler and runtime warning diagnostics are issued.

- Compiler messages: Enterprise COBOL compiler generates the following compiler diagnostics. Whether there is an actual impact depends on the contents of the argument at run time.
  - IGYPG3189-W for all SEARCH ALL statements that have a search argument that is longer than the table key, and hence might be impacted by the first problem
  - IGYPG3188-W when the search argument is a signed numeric item and the table key is an unsigned numeric item, and hence the program might be impacted by the second problem
- Runtime messages: The following runtime messages are generated. Programs that generate either of these runtime messages might be affected by the change.
  - IGZ0194W for all SEARCH ALL statements that have search arguments with excess bytes that are not blank or zero.
  - IGZ0193W when the search argument is a signed numeric item with a negative value and the table key is an unsigned numeric item.

To migrate

To move an application to Enterprise COBOL Version 4 or later, do one of the following sets of steps:

- Act on the compiler messages:
  1. Compile your programs with Enterprise COBOL
  2. Review any SEARCH ALL statements that are flagged with compiler messages IGYPG3188-W or IGYPG3189-W; such statements are potentially impacted.

     Tip: To minimize the possibility of incompatible results, you can force programmers at your site to correct these SEARCH ALL statements by changing the severity of these messages to E or S. To change the severity of these messages, you can use the MSGEXIT suboption of the EXIT compiler option. By doing this, the programs that get these messages cannot be run until the code is corrected. The sample user exit IGYMSGXT has sample code in it to change the severity of IGYPG3188-W and IGYPG3189-W, to IGYPG3188-S and IGYPG3189-S, respectively.
- Act on the runtime messages:
  1. Run the application in a test environment.
  2. Review any SEARCH ALL statements that generate runtime message IGZ0193W or IGZ0194W.

After you have identified which of the SEARCH ALL statements are affected, adjust the application logic appropriately by doing the following steps:

- For SEARCH ALL statements in which the search argument is longer than the table key, do one of the following actions:
  - Ensure that any bytes in the argument in excess of the key length are spaces or zeroes as appropriate.

    Tip: When you have completed this investigation and if you decided not to change your programs, you can change the severity of IGYPG3188-W and IGYPG3189-W, to IGYPG3188-I and IGYPG3189-I, respectively, or suppress these messages entirely, by using the MSGEXIT suboption of the EXIT compiler options. This allows your programs to then compile with RC=0. The sample user exit IGYMSGXT has sample code in it to change the severity of IGYPG3188-W and IGYPG3189-W.
  - Move the argument to a temporary data item of the same size as the key and use the temporary item as the search argument.

– Limit the range of the comparison with reference-modification. For example:

  - in the alphanumeric case of search argument `01 ARG PIC X(6)` and key of `05 MY-KEY PIC X(4)` use this:

    ```
    WHEN MY-KEY (MY-INDEX) = ARG(1:4)
    ```

  - in the numeric case of search argument `01 ARG PIC 9(6)` and array key of `05 MY-KEY PIC 9(4)` use this:

    ```
    WHEN MY-KEY (MY-INDEX) = ARG(3:4)
    ```

  The second and third actions above will prevent the warning message in the future.

- For SEARCH ALL statements in which the search argument is signed and the table key is unsigned, ensure that the search argument is correctly initialized to a positive value before the SEARCH statement is run. Depending on the specific application logic in the COBOL program, it might be possible to make one of the following changes:

  – Change the data description of the argument to be unsigned.

  – Move the search argument to a temporary variable with no sign and use the temporary variable in the SEARCH ALL statement.

  Either action will prevent the warning message in the future.

Upgrading Enterprise COBOL Version 3 programs that have XML PARSE statements

Refer to this information for upgrading Enterprise COBOL Version 3 programs that have XML PARSE statements.

Enterprise COBOL Version 4 introduced new XML PARSE support compared to Enterprise COBOL Version 3. In particular, the z/OS System Services XML parser was supported as the default alternative to the XML parser that is part of the COBOL runtime library. In Version 5 and Version 6, you can choose between the COBOL runtime library parser and the XML System Services parsers.

Originally, Enterprise COBOL V5.1 did not have an XMLPARSE compiler option and required the XMLSS parser. However, with current service applied, V5.1 is the same as V5.2 in this area, and both have the XMLPARSE compiler option so that you can choose the same parser in V5 and V6 that you used with earlier versions of Enterprise COBOL.

- XMLPARSE(COMPAT) specifies that the compiled code will use the COBOL runtime library parser.

  In most cases, you do not have to change your Enterprise COBOL Version 3 programs that have XML PARSE statements to upgrade to Enterprise COBOL V5 or V6. You can have the compatible behavior by specifying the XMLPARSE(COMPAT) compiler option. However, the COMPAT XML parser implementation in Enterprise COBOL V5.2 and later is different in rare cases from that in Version 3. The change does not affect most existing programs, but you should review the unusual cases where the differences could occur. For details, see “COMPAT XML parser considerations” on page 146.

- XMLPARSE(XMLSS) specifies that the compiled code will use the z/OS System Services XML parser.

  You must change your Enterprise COBOL Version 3 programs that use XML PARSE statements if you want to change to use XMLPARSE(XMLSS).

  The z/OS System Services XML parser provides the following benefits:

  – The latest IBM parsing technology

  – Offload of COBOL XML parsing to zAAP specialty processors

  – Improved support for parsing XML documents that use XML namespaces

  – Direct support for parsing XML documents encoded in UTF-8 Unicode

  – Support for parsing large XML documents, a buffer at a time

To optionally modify your Enterprise COBOL Version 3 programs to use XMLPARSE(XMLSS) with Enterprise COBOL Version 5 or Version 6, change the programs to reflect the new, changed, and discontinued XML parsing events. For details, see Appendix J, “Migrating from XMLPARSE(COMPAT) to XMLPARSE(XMLSS),” on page 313.

COMPAT XML parser considerations

User modifications to the XML document during execution of the XML PARSE statement

In versions earlier than Enterprise COBOL V5, the COMPAT XML parser was actively in progress when the XML processing procedure was executing. In V5, any encoding conflicts are resolved and after that, the entire document is parsed, and the XML events are stored in a buffer. After the parse is terminated, the XML events are then presented from this buffer to your program by the PERFORM statement that executes the processing procedure. Thus, if the program modifies the XML document in the processing procedure code, the parser does not detect these modifications. However, in the implementation in earlier versions, those modifications such as correcting an end tag name to match the start tag name would be seen and acted on by the parser.

A limited number of continuable XML EXCEPTION events

For XML EXCEPTION events with XML-CODE values in the range 1-49, if you request continuation by setting XML-CODE to zero, the COMPAT XML parser checks only for further errors and does not present any further non-EXCEPTION XML events. When the V5 COMPAT XML parser continues after an EXCEPTION event, the parser does not expand the XML event buffer and thus might not present all the EXCEPTION events that would otherwise occur. The initial buffer size can accommodate a minimum of 8192 XML events and is expanded as necessary for non-EXCEPTION events.

Differences caused by LE condition handling

In versions earlier than Enterprise COBOL V5, the processing procedure was executed in a stack frame that is subordinate to the stack frame of the active XML parser. The processing procedure for the V5 COMPAT parser runs in the same stack frame as the rest of the COBOL program, after the XML parser has run to completion. This change has the following effects:

- Previously, LE condition handlers that are registered in the XML processing procedure were not in effect after a COMPAT XML PARSE statement is terminated. In the V5 implementation, they remain in effect until unregistered.
- Previously, a branching to an LE service resume point that is set outside the XML processing procedure terminated a COMPAT XML PARSE statement. In V5, the processing procedure must exit normally to terminate an XML PARSE statement. Otherwise, the already active XML PARSE statement causes a runtime error if either the program exits (IGZ0227S) or another XML PARSE statement is executed (IGZ0228S).

  The following program illustrates this difference. As described previously, it executes "correctly" on versions earlier than Enterprise COBOL V5, but it causes runtime errors IGZ0227S or IGZ0228S on Enterprise COBOL V5. After you uncomment the indicated statements in the XML processing procedure, the program runs without error on all versions.

  Process XMLPARSE(COMPAT)

```
*****************************************************************
***  Function:                                                ***
***  Demonstate a difference between XML PARSE COMPAT on      ***
***  V3/V4 and V5 (or XMLSS on any version).                  ***
***                                                           ***
***  In V3/4, the logical branch out of the XML processing    ***
***  procedure by CEEMRCE terminates the XML PARSE. In V5,    ***
***  it does not, resulting in runtime messages such as:      ***
***    IGZ0227S There was an invalid attempt to end an        ***
***             XML PARSE statement.                          ***
***  when the program terminates (or attempts another parse).***
```

```
*****************************************************************
 Identification division.
   Program-id. XMLMIGR1.
 Data division.
  Working-storage section.
   1 XML-document pic x(4) value '<x/>'.
   1 zer0 comp pic 9 value 0.
  Local-storage section.
   1 routine procedure-pointer.
   1 token pointer.
   1 ceesrp-data.
    2 resume-point comp pic s9(9).
    2 state pic x value 'I'.
   1 fdbk-code.
    2 condition-token-value.
      88 fdbk-code-zero value low-value.
     3 pic xx.
     3 msg-no comp pic s9(4).
     3 pic x(4).
    2 pic x(4).
 Procedure division.  Main section.
     Perform register-user-handler
     Call 'CEE3SRP' using resume-point fdbk-code
     Service label.
   Repeat.
     If state = 'I'
       XML parse XML-document processing procedure XML-proc
       Display 'Back from XML parse...'
       Go to Repeat
     Else
       If state = 'R'
         Display 'Resumed after exception; in mainline code.'
       End-if
       Perform unregister-user-handler
       Display 'Another XML parse (P), or exit (E)?'
       Accept state
       If state = 'P'
         Move '<y/>' to XML-document
         XML parse XML-document processing procedure XML-proc.
     Goback.
   Register-user-handler.
     Set routine to entry 'USERHDLR'
     Set token to address of ceesrp-data
     Call 'CEEHDLR' using routine token fdbk-code
     If fdbk-code-zero
       Display 'Registered exception handler successfully.'
     Else
       Display 'Failed to register exception handler!' msg-no
       Move 16 to return-code
       Stop run.
   Unregister-user-handler.
     Set routine to entry 'USERHDLR'
     Call 'CEEHDLU' using routine fdbk-code
     If fdbk-code-zero
       Display 'Unregistered exception handler successfully.'
     Else
       Display 'Failed to unregister exception handler!' msg-no
       Move 16 to return-code
       Stop run.
  XML-proc section.
     Display XML-event '{' XML-text '}'
     If XML-event = 'START-OF-DOCUMENT'
       Display 'XML parse in progress...'
       Move 1 to xml-code
       Go to xp-srp.
     If XML-event = 'START-OF-ELEMENT' and XML-text = 'x'
       Compute tally = 1 / zer0.
     Go to xp-exit.
   Xp-srp.
*** Uncomment the next two lines to move the resume point to ***
*** within the XML processing procedure, thus allowing the   ***
*** XML PARSE statement to terminate normally and correctly. ***
*    Call 'CEE3SRP' using resume-point fdbk-code
*    Service label
     If state = 'R'
       Display 'Resumed after exception; still in XML-proc.'
       Move 'X' to state.
   Xp-exit.
     Continue.
 End program XMLMIGR1.

*****************************************************************
```

```
*** LE user condition handler, invoked when the fixed-point  ***
*** divide exception occurs (system completion code S0C9).   ***
*****************************************************************
 Identification division.
   Program-id. USERHDLR.
 Data division.
  Working-storage section.
   1 fdbk-code.
    2 condition-token-value pic x(8).
      88 fdbk-code-zero value low-value.
    2 pic x(4).
  Linkage section.
   1 ceesrp-data.
    2 resume-point comp pic s9(9).
    2 state pic x.
   1 token pointer.
   1 result comp pic s9(9).
    88 resume value 10.
   1 curr-cond pic x(12).
   1 new-cond pic x(12).
 Procedure division using curr-cond token result new-cond.
     Display 'LE condition handler called...'
     Set address of ceesrp-data to token
     Call 'CEEMRCE' using resume-point fdbk-code
     If not fdbk-code-zero display 'Unable to resume execution!'
     Else Set resume to true Move 'R' to state.
     Goback.
 End program USERHDLR.
```

Upgrading Enterprise COBOL programs that have XML GENERATE statements

Enterprise COBOL introduced five new XML GENERATE exception codes after Enterprise COBOL Version 3.

Programs that use these exception codes might have to be changed to migrate to later versions of Enterprise COBOL.

The XML GENERATE exception codes that were added to Enterprise COBOL are:

415
The receiver was national, but the encoding specified for the document was not UTF-16.

416
The XML namespace identifier contained invalid XML characters.

417
Element character content or an attribute value contained characters that are illegal in XML content. XML generation has continued, with the element tag name or the attribute name prefixed with "hex." and the original data value represented in the document in hexadecimal.

418
Substitution characters were generated by encoding conversion.

419
The XML namespace prefix was invalid.

Converting programs that use new reserved words

Some reserved words have been added since Enterprise COBOL Version 3.

If your programs use any of the new reserved words as user-defined words (such as data item names or paragraph names), then those words must be changed. You can do something similar to what CCCA does and just add a suffix such as -85 to all instances of the word. For example:

```
77 VOLATILE PIC S9(9) BINARY.
Move 0 TO VOLATILE.
```

To compile with Enterprise COBOL V5 or V6, change it to:

```
77 VOLATILE-85 PIC S9(9) BINARY.
Move 0 TO VOLATILE-85.
```

The new reserved words are:

- ALLOCATE
- DEFAULT
- END-JSON
- FREE
- JSON
- JSON-CODE
- VOLATILE
- XML-INFORMATION
- XML-NAMESPACE
- XML-NAMESPACE-PREFIX
- XML-NNAMESPACE
- XML-NNAMESPACE-PREFIX
- XML-SCHEMA

The conversion tool CCCA automatically converts these reserved words for you if you have the PTF for APAR PM86253 installed for Enterprise COBOL Version 5.1, or if you have the PTF for APAR PI32750 installed for Enterprise COBOL Version 5.2, or if you have the PTF for APAR PI55980 installed for Enterprise COBOL Version 6.1. CCCA is included with the IBM Debug Tool product.

For a table comparing reserved words for all of the different COBOL compilers, see Table 46 on page 241.

Upgrading programs that use SIMVRD support

This section describes the actions to upgrade programs that use SIMVRD support. Support for *COBOL simulated variable-length relative-record data sets (RRDS)* is removed for programs compiled with Enterprise COBOL Version 4 or later. These files must be changed to VSAM RRDS files.

In COBOL compilers that supported the NOCMPR2 compiler option before Enterprise COBOL Version 4, it was possible to use *COBOL simulated variable-length RRDS* using a VSAM KSDS when you used the SIMVRD runtime option support.

The coding that you use in a COBOL program to identify and describe VSAM variable-length RRDS and COBOL simulated variable-length RRDS is similar. With Enterprise COBOL Version 4 you must use VSAM variable-length RRDS support. In general, the only action to migrate from COBOL simulated variable-length RRDS to VSAM variable-length RRDS support is to change the IDCAMS definition of the file.

Table 26. Steps for using variable-length RRDS

Step	VSAM variable-length RRDS	COBOL simulated variable-length RRDS
1	Define the file with the ORGANIZATION IS RELATIVE clause.	Same
2	Use FD entries to describe the records with variable-length sizes.	Same, but you must also code RECORD IS VARYING in the FD entry of every COBOL program that accesses the data set.
3	Use the NOSIMVRD runtime option.	Use the SIMVRD runtime option.

Table 26. Steps for using variable-length RRDS (continued)		
Step	**VSAM variable-length RRDS**	**COBOL simulated variable-length RRDS**

4	Define the VSAM file through access-method services as an RRDS.	Define the VSAM file through access-method services as follows:
		`DEFINE CLUSTER INDEXED`
		`KEYS(4,0)`
		`RECORDSIZE(avg,m)`
		avg
		Is the average size of the COBOL records; strictly less than *m*.
		m
		Is greater than or equal to the maximum size COBOL record + 4.

In step 2 for simulated variable-length RRDS, coding other language elements that implied a variable-length record format did not give you COBOL simulated variable-length RRDS. For example, the following elements alone did not cause the use of simulated variable-length RRDS access, and therefore did not require the SIMVRD runtime option:

- Multiple FD records of different lengths
- OCCURS . . . DEPENDING ON in the record definitions
- RECORD CONTAINS *integer-1* TO *integer-2* CHARACTERS

Use the REUSE IDCAMS parameter for files that contain records and that you will open for output.

- Define the file with the ORGANIZATION IS RELATIVE clause.
- Use FD entries to describe the records with variable-length sizes.
- Use the NOSIMVRD runtime option.
- Define the VSAM file through access-method services as an RRDS.

Errors: When you work with simulated variable-length relative data sets and true VSAM RRDS data sets, an OPEN file status 39 occurs if the COBOL file definition and the VSAM data-set attributes do not match.

For more reference information about the commands for using variable-length RRDS, see *z/OS DFSMS: Access Method Services for Catalogs*.

Chapter 13. Compiling Enterprise COBOL Version 3 programs

There have been a number of changes to compiler options and debug behavior since Enterprise COBOL Version 3.

After reading these topics, see also Chapter 17, “Changes with Enterprise COBOL Version 5 and Version 6,” on page 175.

Compiler option changes from IBM Enterprise COBOL for z/OS, Version 3

There have been a number of changes to compiler options.

The following options have been removed.

Table 27. Compiler options not available in Enterprise COBOL Version 5

Compiler option	Comments
DATEPROC	Support for Year 2000 extensions has been removed.
NOLIB	Compiler behaves as though LIB is always in effect.
YEARWINDOW	Support for Year 2000 extensions has been removed.
SIZE(MAX)	The SIZE option has been removed.
NUMPROC(MIG)	NUMPROC(PFD) and NUMPROC(NOPFD) are still available. If NUMPROC(MIG) is specified, Enterprise COBOL V5 or V6 issues a warning message and the compilation will get the default setting for NUMPROC. This is either the user-customized default or the IBM default, which is NUMPROC(NOPFD). To migrate your programs compiled with NUMPROC(MIG) to Enterprise COBOL V6, consider using the NUMCHECK compiler option to help you migrate to NUMPROC(PFD): 1. Compile your programs with NUMCHECK(ZON,PAC) and NUMPROC(PFD). 2. Run a thorough regression test with a good breadth of input data. If your applications get no NUMCHECK messages or NUMCHECK abends, you can safely compile with NUMPROC(PFD) and NONUMCHECK for production. This will not only solve the invalid data problem, but NUMPROC(PFD) is the most efficient setting for the NUMPROC compiler option. NUMCHECK is introduced in Enterprise COBOL V6.1 with the service PTFs. For details, see *NUMCHECK* in the *Enterprise COBOL Programming Guide*.

Table 28. Compiler option not available in Enterprise COBOL Version 6

Compiler option	Comments
LVLINFO	Installation option removed. The build level information is put where LVLINFO used to be, and the SERVICE compiler option can be used for user service level information in place of LVLINFO.

Also note, the SSRANGE compiled-in range checks cannot be disabled at run time using the runtime option `CHECK(OFF)` or `NOSSRANGE`

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For descriptions of new and modified options for Enterprise COBOL V5 and V6, see “Compiler option changes in Enterprise COBOL Version 5 and Version 6” on page 178.

For a detailed list of options supported for the various compiler versions, see Appendix E, “Option comparison,” on page 277.

Differences in the TEST compiler option

This section provides information about changes to the TEST compiler option that you need to know when you upgrade programs and compile with the TEST compiler option. Enterprise COBOL Version 5 and Version 6 has a simplified TEST compiler option compared to earlier compilers. If the TEST option is specified in JCL or CBL/PROCESS statements in COBOL source, you may want to change them. The following TEST suboptions have been removed, but some continue to be tolerated to ease migration. Compiler diagnostics messages are issued if they are used. The removed suboptions may not be specified together with new suboptions in the same TEST option specification.

Table 29. The removed TEST suboptions

Removed suboption	**Behavior if specified with compiler**	**Diagnostic message level or category**
ALL	Diagnostic issued, no hooks generated in object	Error (`Invalid option diagnostic, option discarded`)
BLOCK	Diagnostic issued, no hooks generated in object	Error (`Invalid option diagnostic, option discarded`)
PATH	Diagnostic issued, no hooks generated in object	Error (`Invalid option diagnostic, option discarded`)
STMT	Diagnostic issued, no hooks generated in object	Error (`Invalid option diagnostic, option discarded`)
NONE	Diagnostic issued, no hooks generated in object	Error (`Invalid option diagnostic, option discarded`)
SYM	Diagnostic issued, symbolic debugging information always generated	Error (`Invalid option diagnostic, option discarded`)
NOSYM	Diagnostic issued, symbolic debugging information always generated	Error (`Invalid option diagnostic, option discarded`)
HOOK	Diagnostic issued, no hooks generated in object	Informational message about NOHOOK behavior always in effect (`Suboption tolerated, TEST in effect`)
NOHOOK	Diagnostic issued, no hooks generated in object	Informational message about NOHOOK behavior always in effect (`Suboption tolerated, TEST in effect`)

Table 29. The removed TEST suboptions (continued)		
Removed suboption	**Behavior if specified with compiler**	**Diagnostic message level or category**
SEPARATE	Diagnostic issued, debug information always generated in object module	Informational message about NOSEPARATE behavior always in effect (Suboption `tolerated, TEST in effect`)
NOSEPARATE	Diagnostic issued, debug information always generated in object module	Informational message about NOSEPARATE behavior always in effect (Suboption `tolerated, TEST in effect`)

Note: None of the old TEST suboptions are recognized when specified in IGYCDOPT for setting installation default options.

Debug information changes with Enterprise COBOL Version 5 and Version 6

Programs compiled with Enterprise COBOL V5 or V6 will have different debug information than that of programs compiled with previous versions of the compiler.

IBM Enterprise COBOL Version 5 and Version 6 solves the dilemma of debugging information. In the past you had 2 choices:

- Have the debug data always with the executable at a cost of a large load footprint, or
- Have separate debug data but also have the challenge of keeping it synchronized with the application and finding it when needed.

Now you have the best of both worlds. With NOLOAD debug segments in the program object, the debug data does not increase the size of the loaded program, it always matches the executable and is always available so there is no need to search lists of data sets.

There have been changes to the TEST compiler option used to generate debuggable versions of your application and to the NOTEST option.

- When the TEST option is specified, DWARF debug information is included in the application module.
- If the SOURCE suboption is specified, the DWARF debug information includes the expanded source code, and the compiler listing is not needed by IBM Debug Tool. When the TEST(NOSOURCE) compiler option is specified, the generated DWARF debugging information does not include the expanded source code.
- You can use the NOTEST(DWARF) compiler option to include basic DWARF debugging information in the program object. You cannot debug such programs with Debug Tool, but you can get NOTEST optimization and still enable application failure analysis tools, such as CEEDUMP output and IBM Fault Analyzer.
- To have no debugging information in the program object, use the NOTEST(NODWARF) option.

With Enterprise COBOL V5 and V6, the diagnostic messages are not at the bottom of the listing. Take the following steps to get to the diagnostic messages part of the listing:

1. Type **`F 'end of c'`** on the command line (use the ISPF **`FIND`** command to find the header: `End of compilation`).
2. Press Enter.
3. (Optional) Press Page back.

The following changes apply only to V6:

- The allocation and management of WORKING-STORAGE SECTION have been changed in Enterprise COBOL V6. This does not affect the execution of the COBOL program. Tools or programs that need to locate the starting address of the WORKING-STORAGE SECTION might be affected. For details, see "WORKING-STORAGE SECTION changes" on page 171.
- Enterprise COBOL V6 uses interprocess communication (IPC) message queues. Therefore, if you compile in z/OS UNIX with cob2 and the compiler experiences an internal error and gets terminated with a KILL signal, you will need to query any message queues that are left over when the compiler is killed and remove the stale message queues. You can remove the stale message queues with the following z/OS UNIX commands:

  1. Enter **ipcs -q** to list queues.
  2. Find queues associated with your user ID.
  3. Enter **ipcrm -q** to delete queues.

  If you compile in z/OS batch, you do not have to remove stale message queues after a compiler error.

When debugging your COBOL programs, you will find that there have been a large number of improvements and behavior changes introduced with Enterprise COBOL V5 and V6. For details about changes in debugging with IBM Debug Tool, see "Debug Tool changes with Enterprise COBOL Version 5 and Version 6" on page 208.

Chapter 14. Upgrading from Enterprise COBOL Version 4

To compile with Enterprise COBOL Version 5 or Version 6, Enterprise COBOL Version 4 programs that use any of several features might need to be upgraded.

Programs that contain any of the following language features might need to be modified:

- Programs that use XML PARSE with XMLPARSE(COMPAT)
- V4R1 programs that use XML PARSE with XMLPARSE(XMLSS)
- Programs using DATE FORMAT and windowed date functions. For details, see "Changes in millennium language extensions in IBM Enterprise COBOL for z/OS, Version 5 and Version 6" on page 159.
- Label declaratives. To compile programs with Enterprise COBOL V5 or V6, you must remove any format 2 declarative syntax: USE...AFTER...LABEL PROCEDURE..., and the syntax: GO TO MORE-LABELS. The support for these was removed in Enterprise COBOL Version 5
- Programs that use new reserved words as user words. For details, see "New reserved words" on page 91.

There is a new compiler option, FLAGMIG4, available with APAR PM93450 for Enterprise COBOL V4.2 to help you migrate to Enterprise COBOL V5 or V6. The FLAGMIG4 option identifies language elements in Enterprise COBOL V4 programs that are not supported, or that are supported differently in Enterprise COBOL V5 or V6. The compiler will generate a warning diagnostic message for all such language elements.

Note: The source code changes for COBOL V5 and V6 are rarely used COBOL language features and do not affect 99% of COBOL users.

Tip: It is recommended that you review and apply the Enterprise COBOL V4 PTFs to support the migration to Enterprise COBOL V5 or V6. For details, see http://www.ibm.com/support/docview.wss?uid=swg21982146.

Upgrading Enterprise COBOL Version 4 programs that have XML PARSE statements

You can refer to the following guidelines for upgrading Enterprise COBOL Version 4 programs that have XML PARSE statements.

Whether you were using the COMPAT XML parser that is part of the COBOL runtime library or the the z/OS System Services XML parser with previous versions of Enterprise COBOL, you most likely do not need to make any code changes for Enterprise COBOL Version 5 or Version 6.

If you were using the z/OS System Services XML parser with Enterprise COBOL Version 4.2, you do not need to make any code changes for COBOL V5.2 and V6. Originally, Enterprise COBOL V5.1 did not have an XMLPARSE compiler option and required the XMLSS parser. However, with current service applied, V5.1 is the same as V5.2 in this area, and both have the XMLPARSE compiler option so that you can choose the same parser in V5 and V6 that you used with earlier versions of Enterprise COBOL.

If you were using the z/OS System Services XML parser with Enterprise COBOL Version 4.1, consider information in "Upgrading Enterprise COBOL Version 4 Release 1 programs that have XML PARSE statements and that use the XMLPARSE(XMLSS) compiler option" on page 158.

If you use the COMPAT XML parser that is part of the COBOL runtime library with Enterprise COBOL Version 4 and Version 3, you most likely do not have to change your code. The COMPAT XML parser implementation in Enterprise COBOL Version 5 and Version 6 has two minor differences in special cases compared to Versions 3 and Version 4, so you should review the special considerations to these rare cases where the differences could occur. For details, see "COMPAT XML parser considerations" on page 146.

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COMPAT XML parser considerations

User modifications to the XML document during execution of the XML PARSE statement

In versions earlier than Enterprise COBOL V5, the COMPAT XML parser was actively in progress when the XML processing procedure was executing. In V5, any encoding conflicts are resolved and after that, the entire document is parsed, and the XML events are stored in a buffer. After the parse is terminated, the XML events are then presented from this buffer to your program by the PERFORM statement that executes the processing procedure. Thus, if the program modifies the XML document in the processing procedure code, the parser does not detect these modifications. However, in the implementation in earlier versions, those modifications such as correcting an end tag name to match the start tag name would be seen and acted on by the parser.

A limited number of continuable XML EXCEPTION events

For XML EXCEPTION events with XML-CODE values in the range 1-49, if you request continuation by setting XML-CODE to zero, the COMPAT XML parser checks only for further errors and does not present any further non-EXCEPTION XML events. When the V5 COMPAT XML parser continues after an EXCEPTION event, the parser does not expand the XML event buffer and thus might not present all the EXCEPTION events that would otherwise occur. The initial buffer size can accommodate a minimum of 8192 XML events and is expanded as necessary for non-EXCEPTION events.

Differences caused by LE condition handling

In versions earlier than Enterprise COBOL V5, the processing procedure was executed in a stack frame that is subordinate to the stack frame of the active XML parser. The processing procedure for the V5 COMPAT parser runs in the same stack frame as the rest of the COBOL program, after the XML parser has run to completion. This change has the following effects:

- Previously, LE condition handlers that are registered in the XML processing procedure were not in effect after a COMPAT XML PARSE statement is terminated. In the V5 implementation, they remain in effect until unregistered.
- Previously, a branching to an LE service resume point that is set outside the XML processing procedure terminated a COMPAT XML PARSE statement. In V5, the processing procedure must exit normally to terminate an XML PARSE statement. Otherwise, the already active XML PARSE statement causes a runtime error if either the program exits (IGZ0227S) or another XML PARSE statement is executed (IGZ0228S).

  The following program illustrates this difference. As described previously, it executes "correctly" on versions earlier than Enterprise COBOL V5, but it causes runtime errors IGZ0227S or IGZ0228S on Enterprise COBOL V5. After you uncomment the indicated statements in the XML processing procedure, the program runs without error on all versions.

  Process XMLPARSE(COMPAT)

```
*****************************************************************
***  Function:                                                ***
***  Demonstate a difference between XML PARSE COMPAT on      ***
***  V3/V4 and V5 (or XMLSS on any version).                  ***
***                                                           ***
***  In V3/4, the logical branch out of the XML processing    ***
***  procedure by CEEMRCE terminates the XML PARSE. In V5,    ***
***  it does not, resulting in runtime messages such as:      ***
***    IGZ0227S There was an invalid attempt to end an        ***
***             XML PARSE statement.                          ***
***  when the program terminates (or attempts another parse).***
*****************************************************************
 Identification division.
   Program-id. XMLMIGR1.
 Data division.
  Working-storage section.
   1 XML-document pic x(4) value '<x/>'.
   1 zer0 comp pic 9 value 0.
```

```
  Local-storage section.
   1 routine procedure-pointer.
   1 token pointer.
   1 ceesrp-data.
    2 resume-point comp pic s9(9).
    2 state pic x value 'I'.
   1 fdbk-code.
    2 condition-token-value.
      88 fdbk-code-zero value low-value.
     3 pic xx.
     3 msg-no comp pic s9(4).
     3 pic x(4).
    2 pic x(4).
 Procedure division.  Main section.
     Perform register-user-handler
     Call 'CEE3SRP' using resume-point fdbk-code
     Service label.
   Repeat.
     If state = 'I'
       XML parse XML-document processing procedure XML-proc
       Display 'Back from XML parse...'
       Go to Repeat
     Else
       If state = 'R'
         Display 'Resumed after exception; in mainline code.'
       End-if
       Perform unregister-user-handler
       Display 'Another XML parse (P), or exit (E)?'
       Accept state
       If state = 'P'
         Move '<y/>' to XML-document
         XML parse XML-document processing procedure XML-proc.
     Goback.
   Register-user-handler.
     Set routine to entry 'USERHDLR'
     Set token to address of ceesrp-data
     Call 'CEEHDLR' using routine token fdbk-code
     If fdbk-code-zero
       Display 'Registered exception handler successfully.'
     Else
       Display 'Failed to register exception handler!' msg-no
       Move 16 to return-code
       Stop run.
   Unregister-user-handler.
     Set routine to entry 'USERHDLR'
     Call 'CEEHDLU' using routine fdbk-code
     If fdbk-code-zero
       Display 'Unregistered exception handler successfully.'
     Else
       Display 'Failed to unregister exception handler!' msg-no
       Move 16 to return-code
       Stop run.
  XML-proc section.
     Display XML-event '{' XML-text '}'
     If XML-event = 'START-OF-DOCUMENT'
       Display 'XML parse in progress...'
       Move 1 to xml-code
       Go to xp-srp.
     If XML-event = 'START-OF-ELEMENT' and XML-text = 'x'
       Compute tally = 1 / zer0.
     Go to xp-exit.
   Xp-srp.
*** Uncomment the next two lines to move the resume point to ***
*** within the XML processing procedure, thus allowing the   ***
*** XML PARSE statement to terminate normally and correctly. ***
*    Call 'CEE3SRP' using resume-point fdbk-code
*    Service label
     If state = 'R'
       Display 'Resumed after exception; still in XML-proc.'
       Move 'X' to state.
   Xp-exit.
     Continue.
 End program XMLMIGR1.

*****************************************************************
*** LE user condition handler, invoked when the fixed-point  ***
*** divide exception occurs (system completion code S0C9).   ***
*****************************************************************
 Identification division.
   Program-id. USERHDLR.
 Data division.
  Working-storage section.
```

```
   1 fdbk-code.
    2 condition-token-value pic x(8).
      88 fdbk-code-zero value low-value.
    2 pic x(4).
  Linkage section.
   1 ceesrp-data.
    2 resume-point comp pic s9(9).
    2 state pic x.
   1 token pointer.
   1 result comp pic s9(9).
    88 resume value 10.
   1 curr-cond pic x(12).
   1 new-cond pic x(12).
 Procedure division using curr-cond token result new-cond.
     Display 'LE condition handler called...'
     Set address of ceesrp-data to token
     Call 'CEEMRCE' using resume-point fdbk-code
     If not fdbk-code-zero display 'Unable to resume execution!'
     Else Set resume to true Move 'R' to state.
     Goback.
 End program USERHDLR.
```

Upgrading Enterprise COBOL Version 4 Release 1 programs that have XML PARSE statements and that use the XMLPARSE(XMLSS) compiler option

There are differences in XML PARSE behavior with the XMLPARSE(XMLSS) compiler option in effect between Enterprise COBOL Version 4 Release 1 and Enterprise COBOL Version 4 Release 2 or later. In Enterprise COBOL Version 4 Release 1 when you parsed an XML document using the XMLPARSE(XMLSS) compiler option and it contained character references that could not be expressed in the encoding of the document, the result was a single ATTRIBUTE-CHARACTERS or CONTENT-CHARACTERS XML event in which every unrepresentable character reference was replaced by a hyphen-minus. No indication was given to the program that the substitution occurred.

For example, parsing the content of the following XML element:

```
<elem>abc&#x1234;xyz</elem>
```

under Enterprise COBOL Version 4 Release 1 with encoding CCSID 1140 and with the XMLPARSE(XMLSS) compiler option in effect, resulted in a single CONTENT-CHARACTERS XML event with special register XML-TEXT containing the (EBCDIC) string:

```
abc-xyz
```

and with special register XML-CODE containing zero.

In Enterprise COBOL Version 4 Release 2 and later, when you parse an XML document using the XMLPARSE(XMLSS) compiler option, instead of a single ATTRIBUTE-CHARACTERS or CONTENT-CHARACTERS event, multiple XML events occur. Each unrepresentable character reference previously replaced by a hyphen-minus is instead expressed as an ATTRIBUTE-NATIONAL-CHARACTER or CONTENT-NATIONAL-CHARACTER XML event, depending on the context in which it occurred. These are XML events for the XMLPARSE(XMLSS) compiler option.

Parsing the content of the XML element from before:

```
<elem>abc&#x1234;xyz</elem>
```

under Enterprise COBOL Version 4 Release 2 and later results in the following sequence of XML events:

- CONTENT-CHARACTERS with XML-TEXT containing abc
- CONTENT-NATIONAL-CHARACTER with XML-NTEXT containing NX'1234'
- CONTENT-CHARACTERS with XML-TEXT containing xyz

Converting programs that use new reserved words

Some reserved words have been added since Enterprise COBOL Version 4.

If your programs use any of the new reserved words as user-defined words (such as data item names or paragraph names), then those words must be changed. You can do something similar to what CCCA does and just add a suffix such as -85 to all instances of the word. For example:

```
77 VOLATILE PIC S9(9) BINARY.
Move 0 TO VOLATILE.
```

To compile with Enterprise COBOL V5 or V6, change it to:

```
77 VOLATILE-85 PIC S9(9) BINARY.
Move 0 TO VOLATILE-85.
```

The new reserved words are:

- ALLOCATE
- DEFAULT
- END-JSON
- FREE
- JSON
- JSON-CODE
- VOLATILE
- XML-INFORMATION

The conversion tool CCCA automatically converts these reserved words for you if you have the PTF for APAR PM86253 installed for Enterprise COBOL Version 5.1, or if you have the PTF for APAR PI32750 installed for Enterprise COBOL Version 5.2, or if you have the PTF for APAR PI55980 installed for Enterprise COBOL Version 6.1. CCCA is included with the IBM Debug Tool product.

For a table comparing reserved words for all of the different COBOL compilers, see Table 46 on page 241.

Changes in millennium language extensions in IBM Enterprise COBOL for z/OS, Version 5 and Version 6

The Millennium Language Extensions are no longer supported.

The elements that have been removed are:

- DATE FORMAT clause
- DATEVAL intrinsic function
- UNDATE intrinsic function
- YEARWINDOW intrinsic function
- DATEPROC compiler option
- YEARWINDOW compiler option

These language elements must be removed in order to compile with Enterprise COBOL Version 5 or Version 6.

Chapter 15. Compiling Enterprise COBOL Version 4 programs

There have been a number of changes to compiler options and debug behavior for Enterprise COBOL Version 4 programs.

After reading these topics, see also Chapter 17, “Changes with Enterprise COBOL Version 5 and Version 6,” on page 175.

Compiler option changes from IBM Enterprise COBOL for z/OS, Version 4

There have been a number of changes to compiler options.

The following options have been removed.

Table 30. Compiler options not available in Enterprise COBOL Version 5

Compiler option	Comments
DATEPROC	Support for Year 2000 extensions has been removed.
NOLIB	Compiler behaves as though LIB is always in effect.
YEARWINDOW	Support for Year 2000 extensions has been removed.
SIZE	The SIZE option has been removed.
NUMPROC(MIG)	NUMPROC(PFD) and NUMPROC(NOPFD) are still available. If NUMPROC(MIG) is specified, Enterprise COBOL V5 or V6 issues a warning message and the compilation will get the default setting for NUMPROC. This is either the user-customized default or the IBM default, which is NUMPROC(NOPFD). To migrate your programs compiled with NUMPROC(MIG) to Enterprise COBOL V6, consider using the NUMCHECK compiler option to help you migrate to NUMPROC(PFD): 1. Compile your programs with NUMCHECK(ZON,PAC) and NUMPROC(PFD). 2. Run a thorough regression test with a good breadth of input data. If your applications get no NUMCHECK messages or NUMCHECK abends, you can safely compile with NUMPROC(PFD) and NONUMCHECK for production. This will not only solve the invalid data problem, but NUMPROC(PFD) is the most efficient setting for the NUMPROC compiler option. NUMCHECK is introduced in Enterprise COBOL V6.1 with the service PTFs. For details, see *NUMCHECK* in the *Enterprise COBOL Programming Guide*.

Table 31. Compiler option not available in Enterprise COBOL Version 6

Compiler option	Comments
LVLINFO	Installation option removed. The build level information is put where LVLINFO used to be, and the SERVICE compiler option can be used for user service level information in place of LVLINFO.

Also note, the compiled-in range checks (for programs compiled with the SSRANGE compiler option) cannot be disabled at run time using the runtime options `CHECK(OFF)` or `NOSSRANGE`.

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For descriptions of new and modified options for Enterprise COBOL Version 5 and Version 6, see "Compiler option changes in Enterprise COBOL Version 5 and Version 6" on page 178.

For a detailed list of options supported for the various compiler versions, see Appendix E, "Option comparison," on page 277.

For detailed descriptions of all options, see the *Enterprise COBOL Programming Guide*.

Debug information changes with Enterprise COBOL Version 5 and Version 6

Programs compiled with Enterprise COBOL V5 or V6 will have different debug information than that of programs compiled with previous versions of the compiler.

IBM Enterprise COBOL Version 5 and Version 6 solves the dilemma of debugging information. In the past you had 2 choices:

- Have the debug data always with the executable at a cost of a large load footprint, or
- Have separate debug data but also have the challenge of keeping it synchronized with the application and finding it when needed.

Now you have the best of both worlds. With NOLOAD debug segments in the program object, the debug data does not increase the size of the loaded program, it always matches the executable and is always available so there is no need to search lists of data sets.

There have been changes to the TEST compiler option used to generate debuggable versions of your application and to the NOTEST option.

- When the TEST option is specified, DWARF debug information is included in the application module.
- If the SOURCE suboption is specified, the DWARF debug information includes the expanded source code, and the compiler listing is not needed by IBM Debug Tool. When the TEST(NOSOURCE) compiler option is specified, the generated DWARF debugging information does not include the expanded source code.
- You can use the NOTEST(DWARF) compiler option to include basic DWARF debugging information in the program object. You cannot debug such programs with Debug Tool, but you can get NOTEST optimization and still enable application failure analysis tools, such as CEEDUMP output and IBM Fault Analyzer.
- To have no debugging information in the program object, use the NOTEST(NODWARF) option.

With Enterprise COBOL V5 and V6, the diagnostic messages are not at the bottom of the listing. Take the following steps to get to the diagnostic messages part of the listing:

1. Type **F 'end of c'** on the command line (use the ISPF **FIND** command to find the header: `End of compilation`).
2. Press Enter.
3. (Optional) Press Page back.

The following changes apply only to V6:

- The allocation and management of WORKING-STORAGE SECTION have been changed in Enterprise COBOL V6. This does not affect the execution of the COBOL program. Tools or programs that need to locate the starting address of the WORKING-STORAGE SECTION might be affected. For details, see "WORKING-STORAGE SECTION changes" on page 171.
- Enterprise COBOL V6 uses interprocess communication (IPC) message queues. Therefore, if you compile in z/OS UNIX with cob2 and the compiler experiences an internal error and gets terminated with a KILL signal, you will need to query any message queues that are left over when the compiler is killed and remove the stale message queues. You can remove the stale message queues with the following z/OS UNIX commands:

  1. Enter **ipcs -q** to list queues.

2. Find queues associated with your user ID.
3. Enter **ipcrm -q** to delete queues.

If you compile in z/OS batch, you do not have to remove stale message queues after a compiler error.

When debugging your COBOL programs, you will find that there have been a large number of improvements and behavior changes introduced with Enterprise COBOL V5 and V6. For details about changes in debugging with IBM Debug Tool, see "Debug Tool changes with Enterprise COBOL Version 5 and Version 6" on page 208.

Part 4. What is new and different with Enterprise COBOL Version 5 and Version 6?

There are many changes to the compiler and runtime library with Enterprise COBOL V5 and V6. There are changes in compiling, binding (link-editing), execution, and even changed Debug Tool behavior.

- To find out changes with V6 specifically, see Chapter 16, “Changes with Enterprise COBOL Version 6,” on page 167.
- To find out changes with V5 and V6, see Chapter 17, “Changes with Enterprise COBOL Version 5 and Version 6,” on page 175.

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Chapter 16. Changes with Enterprise COBOL Version 6

For more information about changes with Enterprise COBOL V6 specifically, read this section.

The V6 changes mainly fall into the following categories:

- Prerequisite software level changes
- COBOL source code differences
- Compiler option changes
- Dependence on system MEMLIMIT setting for large programs
- Runtime changes
- Changes that might affect vendor tools

Prerequisite software level changes for Enterprise COBOL Version 6

To use these products with Enterprise COBOL V6, they must be at the following levels:

- z/OS V2R1 or later
- CICS Transaction Server for z/OS, V4 or later
- IBM DB2 V10 or later
- IBM IMS V12 or later
- PD Tools V13 or later (Debug Tool, Fault Analyzer, Application Performance Analyzer)
- Rational Developer for System z® (RDz) V9.5 or later

COBOL source code differences in Enterprise COBOL Version 6

In Enterprise COBOL V5 and earlier versions, a non-88 level VALUE clause in the LINKAGE SECTION or FILE SECTION was treated as a comment. However, starting in Enterprise COBOL V6.1, the VALUE clause for LINKAGE SECTION and FILE SECTION items is now syntax checked and has meaning. This means that a program that is compiled with RC=0 with COBOL V5 could get RC=12 with COBOL V6.

For example, with Enterprise COBOL V5 and earlier versions:

```
  000224          LINKAGE SECTION.
  000225            01 ALPH-ITEM  PIC X(4)  VALUE 1234.


==000225==> IGYDS1158-I A non-level-88 "VALUE" clause was found in the
"FILE SECTION" or "LINKAGE SECTION". The "VALUE" clause was treated as comments.
```

With Enterprise COBOL V6:

```
  000224          LINKAGE SECTION.
  000225            01 ALPH-ITEM  PIC X(4)  VALUE 1234.


==000225==> IGYGR1080-S A "VALUE" clause literal was not compatible with the data
category of the subject data item. The "VALUE" clause was discarded.
```

Compiler option changes in Enterprise COBOL V6

The following options are added:

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Table 32. Compiler options new with Enterprise COBOL Version 6

Compiler option	Comments
COPYLOC	New option from Enterprise COBOL V6.1 with the service PTFs. It can be used to add either a PDSE (or PDS) dataset or z/OS UNIX directory as an additional location to be searched for copy members during the library phase.
INITCHECK	New option from Enterprise COBOL V6.1 with the service PTFs. It controls whether to check for uninitialized data items and issue warning messages when they are used without being initialized.
INLINE	New option in Enterprise COBOL V6.1 with the service PTFs and from V6.2 and later versions. It controls the compiler to consider whether to inline procedures referenced by PERFORM statements in the source program. INLINE is a potential performance boosting option. (Note that INLINE was always in effect in COBOL V5.)
NUMCHECK	New option from Enterprise COBOL V6.1 with the service PTFs. It controls whether to generate implicit numeric class tests for zoned decimal and packed decimal data items that are used as sending data items, and whether to generate SIZE ERROR checking for binary data items.
PARMCHECK	New option from Enterprise COBOL V6.1 with the service PTFs. It tells the compiler to generate an extra data item following the last item in WORKING-STORAGE. This buffer data item is then used at run time to check whether a called subprogram corrupted data beyond the end of WORKING-STORAGE.
SUPPRESS	New option from Enterprise COBOL V6.1. It controls whether to ignore the SUPPRESS phrase of COPY statements.
VSAMOPENFS	New option from Enterprise COBOL V6.1. It affects the user file status reported from successful VSAM OPEN statements that require verified file integrity check.

The following options are modified:

Table 33. Compiler option changed with Enterprise COBOL Version 6

Compiler option	Comments
INITCHECK	From Enterprise COBOL V6.1 with the service PTFs, new suboptions LAX | STRICT are added to the INITCHECK option to control whether the compiler will issue warning messages for data items unless they are initialized on at least one, or on all, logical paths to a statement.

LANGUAGE	To change to uppercase English or Japanese compiler messages in COBOL V6, in addition to using the LANGUAGE compiler option, you must also set the Language Environment runtime option NATLANG at compile time. We recommend using CEEOPTS DD in the compile JCL.
	For example, to change messages to Japanese, use the LANGUAGE(JA) compiler option and also specify the NATLANG LE runtime option at compile time:
	`//CEEOPTS DD *`
	`NATLANG(JPN)`
	`/*`

Table 33. Compiler option changed with Enterprise COBOL Version 6 (continued)

Compiler option	Comments
SSRANGE	The compiled-in range checks cannot be disabled at run time using the runtime options CHECK(OFF) or NOSSRANGE. From Enterprise COBOL V6.1, new suboptions ZLEN | NOZLEN are added to the SSRANGE compiler option to control how the compiler checks reference modification lengths. From Enterprise COBOL V6.1 with the service PTFs, new suboptions MSG | ABD are added to the SSRANGE compiler option to control the runtime behavior of the COBOL program when a range check fails. **Note:** The compiler option NOSSRANGE is still supported.

The following option is removed:

Table 34. Compiler option not available in Enterprise COBOL Version 6

Compiler option	Comments
LVLINFO	From Enterprise COBOL V6.1, the LVLINFO installation option is removed. The build level information is put where LVLINFO used to be, and the SERVICE compiler option can be used for user service level information in place of LVLINFO.

For a detailed list of options supported for the various compiler versions, see Appendix E, "Option comparison," on page 277.

For a detailed list of compiler options that can affect performance, see *How to tune compiler options to get the most out of V6* in the *Enterprise COBOL Performance Tuning Guide*.

For detailed descriptions of all the compiler options, see *Compiler options* in the *Enterprise COBOL Programming Guide*.

Changes in compiling with Enterprise COBOL Version 6

z/OS MEMLIMIT changes

In Enterprise COBOL V6, the compiler may start using storage above the 2 GB BAR to compile very large programs. This means that the z/OS MEMLIMIT parameter would have to be set to a nonzero value. The z/OS default for MEMLIMIT is 2 GB, but if you compile a very large program and your z/OS setting for MEMLIMIT is not high enough, you could get this compiler message: `IGYCB7145-U Insufficient memory in the compiler to continue compilation`.

Listing file changes

Starting in Enterprise COBOL V6.1, the build level information (of the form PYYMMDD) is always included in the header of the listing file, which assists with determining the maintenance level of the compiler. Here is an example of the listing header:

```
PP 5655-EC6 IBM Enterprise COBOL for z/OS 6.1.0 P160318
```

JCL changes

To change to uppercase English or Japanese compiler messages in COBOL V6, in addition to using the LANGUAGE compiler option, you must also set the Language Environment runtime option NATLANG at compile time. We recommend using CEEOPTS DD in the compile JCL.

For example, to change messages to Japanese, use the LANGUAGE(JA) compiler option and also specify the NATLANG LE runtime option at compile time:

```
//CEEOPTS DD *
          NATLANG(JPN)
/*
```

Compiler phases in shared storage changes

Starting in Enterprise COBOL V6.1, the installation customization for placing compiler phases into shared storage is removed, since in modern systems most users have lots of storage available, and do not need to conserve storage by placing compiler phases in shared storage. As a result of this change to the compiler, the language for placing compiler phases in shared storage is no longer supported, so if you have a saved copy of the IGYCDOPT customization that has a specification of compiler phases being IN or OUT of shared storage, that language must be removed before you can assemble IGYCDOPT. If you do not have any statements in IGYCDOPT that specify IN or OUT for compiler phases, then you will not be affected by this change.

Changes at run time with Enterprise COBOL Version 6

- With Enterprise COBOL V6.1, WORKING-STORAGE is acquired from HEAP storage in all cases, so that there are no exceptions to when the STORAGE runtime option will affect WORKING-STORAGE. In Enterprise COBOL V5, this was only true in CICS and some special cases in non-CICS.
- File status changes in V6.1:
  - WRITE statement on line-sequential file with a record size mismatch.

    In prior releases of Enterprise COBOL, when an attempt is made to write a record to a line-sequential file with mismatched record size, file status 48 is incorrectly returned. This is corrected in Enterprise COBOL V6.1 to return file status 44.
  - OPEN INPUT on a line-sequential file when the UNIX file attribute is write-only.

    In prior releases of Enterprise COBOL, an OPEN statement with the INPUT phrase on a line-sequential file that has the write-only attribute, such as a z/OS UNIX file with DD PATHOPTS=(OWRONLY,...) or a COBOL program that has the write access permission only, incorrectly returned file status 0 (successful). An OPEN statement attempted on a file that does not support the open access mode should return file status 37.

    Note: "write-only" here does not mean the APPLY WRITE-ONLY clause that is not applicable to line-sequential files. Line-sequential files are files created in the z/OS UNIX file system.

    In Enterprise COBOL V6.1, this OPEN statement is detected with file status 37.
  - OPEN INPUT, I-O, EXTEND on VSAM file with file attributes mismatch.

    In prior releases of Enterprise COBOL, when an OPEN INPUT, I-O or EXTEND statement is attempted on a VSAM file that is not defined as OPTIONAL, and a file attributes mismatch is detected, file status 35 is incorrectly returned. This is corrected inEnterprise COBOL V6.1 to return file status 39.

    Note: Similar file attributes mismatch condition for OPEN OUTPUT, and for OPEN INPUT, I-O, and EXTEND when the VSAM file is defined as OPTIONAL, are already correctly reported as file status 39.

Changes with Enterprise COBOL Version 6 that might affect vendor tools

- The allocation and management of WORKING-STORAGE SECTION have been changed in Enterprise COBOL V6. This does not affect the execution of the COBOL program. Tools or programs that need to locate the starting address of the WORKING-STORAGE SECTION might be affected. For details, see “WORKING-STORAGE SECTION changes” on page 171.

- Enterprise COBOL V6 uses interprocess communication (IPC) message queues. Therefore, if you compile in z/OS UNIX with cob2 and the compiler experiences an internal error and gets terminated with a KILL signal, you will need to query any message queues that are left over when the compiler is killed and remove the stale message queues. You can remove the stale message queues with the following z/OS UNIX commands:

  1. Enter **ipcs -q** to list queues.
  2. Find queues associated with your user ID.
  3. Enter **ipcrm -q** to delete queues.

  If you compile in z/OS batch, you do not have to remove stale message queues after a compiler error.

WORKING-STORAGE SECTION changes

The allocation and management of WORKING-STORAGE SECTION have been changed in Enterprise COBOL V6. This does not affect the execution of the COBOL program. Tools or programs that need to locate the starting address of the WORKING-STORAGE SECTION might be affected. You can use the following method to locate the WORKING-STORAGE in Enterprise COBOL V5 and V6 programs at run time.

To find the start of WORKING-STORAGE in COBOL V5 and V6, you need to know how to locate the PPA4 (Program Prologue Area 4) in a dump.

How to find the PPA4 (Program Prolog Area 4) in a dump?

1. Find the start of the program in the dump from the traceback.
2. At the starting address + x'0C' is an offset value. This is the offset to the PPA1 from the start of the program.
3. Starting address + PPA1 offset = PPA1.
4. Go there in the dump.
5. At PPA1 + x'04' is an offset value. This is the offset to the PPA2 from the start of the program.
6. Starting address + PPA2 offset = PPA2.
7. Go there in the dump.
8. At PPA2 + x'08' is an offset value. This is the offset to the PPA4 from the PPA2 address.
9. PPA2 + PPA4 offset = PPA4.
10. Go there in the dump. You are now at the PPA4.

Next, you need to know the layout of the PPA4.

PPA4 layout

For information about the layout of PPA4 and each PPA4 offset, length, and description, see COBOL V5+ 32-bit PPA4 layout in the *z/OS Language Environment Vendor Interfaces*.

Next, you need to know some terminology.

Terms to know

NORENT static area
: This storage area is allocated in the executable for each program that was compiled with NORENT. A NORENT program's WORKING-STORAGE will be located here.

LE's writable static area (WSA)
: Every COBOL V5 or V6 program object (executable) has this storage area.

RENT static area
This storage area is allocated inside the WSA for every program that is statically bound into the executable and compiled with RENT. Each program has their own RENT static area. A program's WORKING-STORAGE may or may not be located here.

Program static area
This storage area is allocated outside of the WSA only if certain conditions are met. In those cases, the program's WORKING-STORAGE will be located here, instead of in the RENT static area.

Next, you need to understand that there are three locations where WORKING-STORAGE can reside.

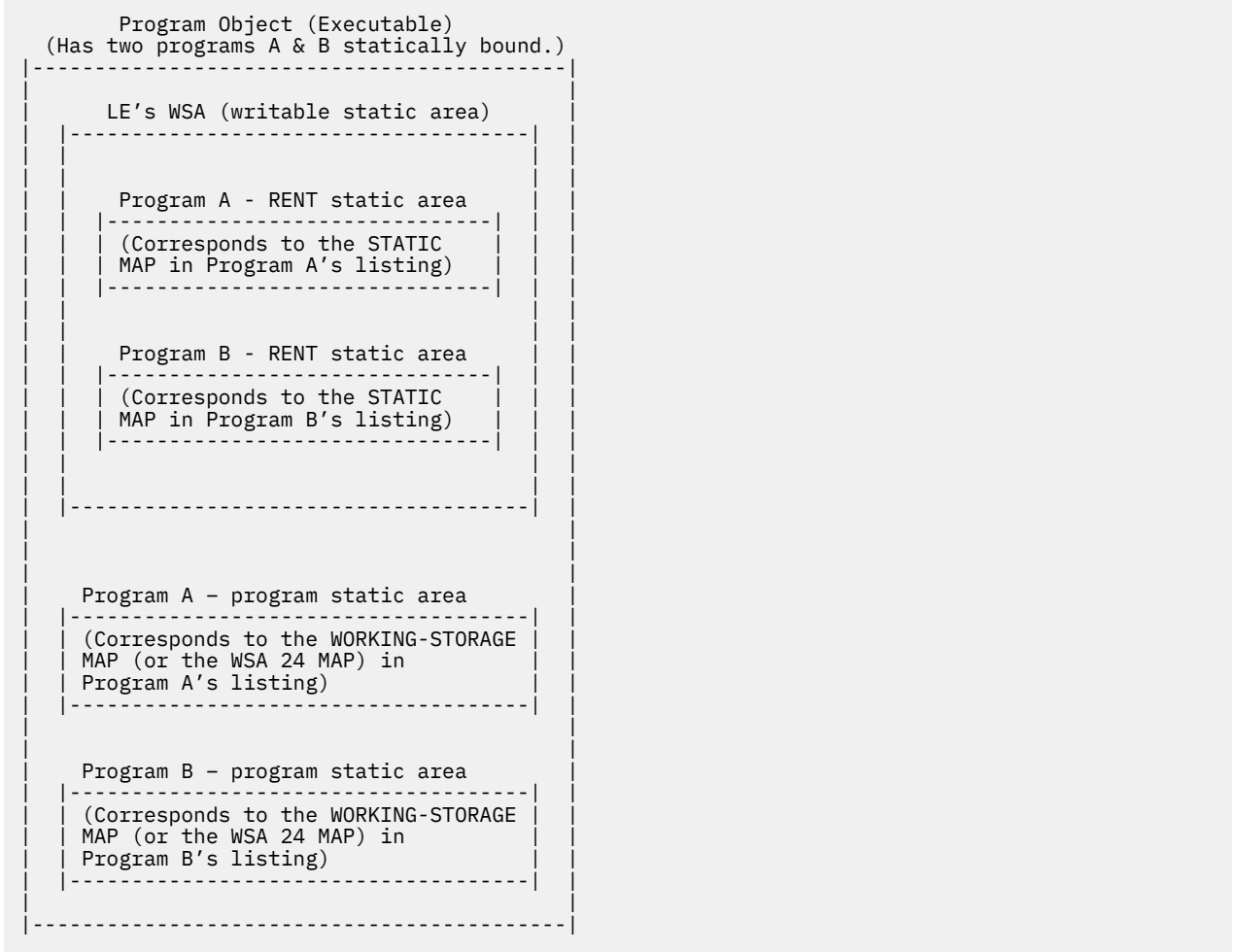
Explanation of the areas where WORKING-STORAGE can reside

There are three different locations where WORKING-STORAGE can reside:

- Inside the program object (executable). All programs compiled with the NORENT option have a NORENT static area reserved within the executable and WORKING-STORAGE resides here.
- All programs compiled with the RENT option have a RENT static area allocated inside LE's WSA (writable static area). WORKING-STORAGE could reside here.
- Instead of being located in the RENT static area, some COBOL V5 or later RENT programs have their WORKING-STORAGE allocated outside of LE's WSA, in an area called the program static area.

The rules for determining where WORKING-STORAGE resides are located in the next section.

The picture below shows how storage is laid out for RENT programs whose WORKING-STORAGE resides in the program static area:



Once you understand the three areas where WORKING-STORAGE could reside, you need to know how to determine where a program's WORKING-STORAGE actually does reside. For details, see *WORKING-STORAGE location* and *Layout of the Language Environment WSA, STATIC, PROGRAM STATIC, and User Working Storage* in IGZXAPI in the *z/OS Language Environment Vendor Interfaces*.

How to determine the area where WORKING-STORAGE is located?

Table 35. Area where WORKING-STORAGE is located

COBOL versions	Compiler options	Where is WORKING-STORAGE located?
COBOL V5	NORENT	In the program's NORENT static area
	RENT, DATA(31)	In the program's RENT static area inside the WSA
	RENT, DATA(24) or RENT, WSOPT[1]	In the program's program static area outside the WSA
COBOL V6 or later versions	NORENT	In the program's NORENT static area
	RENT, DATA(31) & SPANNED RECORDS (i.e. the WSOPT bit is OFF)[2]	In the program's RENT static area inside the WSA
	RENT, DATA(24) (i.e. the WSOPT bit is ON)[2]	In the program's program static area outside the WSA
	RENT, DATA(31) & NO SPANNED RECORDS (i.e. the WSOPT bit is ON)[2]	In the program's program static area outside the WSA

Notes:

1. In COBOL V5, there is a WSOPT compiler option. In COBOL V6, there is no longer a WSOPT compiler option, but rather a signature information bit for WSOPT that is automatically set by the compiler.
2. For SPANNED RECORDS, the WSOPT signature information bit is OFF. For NO SPANNED RECORDS, the WSOPT signature information bit is ON.
   - You can scan your programs for 'RECORDING MODE' and look for any files set to 'S' to determine if SPANNED RECORDS are used.
   - Another alternative is to check the signature information bytes in the listing for the WSOPT bit, which is signature byte 8, bit 3. For example, take the following from a listing:

     ```
     =X'001000000000'   INFO. BYTES 7-12
     ```

     Byte 8 is x'10', which is b'00010000'. Numbering the bits from left to right as 01234567, because bit 3 is on, WSOPT is on.

Once you know what area the WORKING-STORAGE resides in, then you will know how to find it.

How to find WORKING-STORAGE in a dump?

Table 36. How to find the PPA4, NORENT static area, LE's WSA, RENT static area, and program static area in a dump?

What to find?	How to find it in a dump?
PPA4	See the instructions above.
NORENT static area	The address is located in storage at <PPA4 + x'08'>
LE's WSA	The address is located in storage at <CEECAA (or R12) + x'1F4'>. This is called CEECAARENT in a dump.
RENT static area	The address is located in storage at <The address in storage at CEECAA (or R12) + x'1F4'> + <the offset in the program's PPA4 + x'0C'>
Program static area	The address is located in storage at <The address in storage at CEECAA (or R12) + x'1F4'> + <the offset in the program's PPA4 + x'0C'> + <the offset in the program's PPA4 + x'10'>

Once you find these areas in a dump, then you can compare that to the compile listing.

In a COBOL listing:

- The STATIC MAP shows the layout of the RENT static area or the NORENT static area.
- The WORKING-STORAGE MAP or the WSA 24 MAP shows the layout of the program static area.

Use the LE vendor interface IGZXAPI to query the WORKING-STORAGE address

The COBOL-specific vendor interface routine, IGZXAPI, can also be used to query the WORKING-STORAGE address. With Enterprise COBOL V6.1, the LE vendor interface IGZXAPI is enhanced with new function code 8 to request information about the WORKING-STORAGE SECTION length and address for a COBOL program. The returned address corresponds to the STATIC MAP section in the COBOL compiler listing. Other information, such as the program name from PROGRAM-ID and signature information bytes (correspond to the "Compiler Options and Program Information Section" of the compiler listing), are also returned.

This enhancement is introduced in COBOL Runtime LE PTF for APAR PI49703. For more information about IGZXAPI, see IGZXAPI in the *z/OS Language Environment Vendor Interfaces*.

related tasks
Reading LIST output (*Enterprise COBOL Programming Guide*)

related references
Example: Program prolog areas (*Enterprise COBOL Programming Guide*)
Common interfaces and conventions (*z/OS Language Environment Vendor Interfaces*)

Chapter 17. Changes with Enterprise COBOL Version 5 and Version 6

There are a few differences from all previous compilers to consider when using Enterprise COBOL V5 or V6. After reading the section about migrating a program or application from the compiler you are currently using, read this section.

The changes with Enterprise COBOL V5 and V6 mainly fall into the following categories:

- Prerequisite software and service
- Source code differences
- Compiler option differences
- Compiling behavior differences
- Binding (link-editing) differences
- Differences at run time
- Debug information and Debug Tool behavior changes

Migrating to COBOL V5 or V6 is different from earlier COBOL migrations in that we recommend regression testing to see if your programs use invalid data and get different results with COBOL V5 or V6. Previous COBOL compilers generated the same code and the same data layout, so invalid data would get the same results from version to version.

With current service applied, Enterprise COBOL V5.1 is equivalent to Enterprise COBOL V5.2 for migration purposes.

The performance characteristics of Version 5 of the compiler are similar to those of Version 6. Except where otherwise noted, the changes and migration recommendations in this section are applicable to both Version 5 and Version 6.

Prerequisite software and service for Enterprise COBOL Version 5 and Version 6

Updates are required for other products to compile programs with Enterprise COBOL V5 and V6 and also to bind, run and debug those programs. Now, with Enterprise COBOL V5 and V6, you can use FIXCAT to find required service.

Prerequisite levels of related software products

To use these products with Enterprise COBOL V5, they must be at the following levels:

- z/OS V1R13 or later
- CICS Transaction Server for z/OS, V3 or later
- IBM DB2 V9 or later
- IBM IMS V11 or later
- PD Tools V12 or later (Debug Tool, Fault Analyzer, Application Performance Analyzer)
- Rational Developer for System z (RDz) V9.5 or later

To use these products with Enterprise COBOL V6, they must be at the following levels:

- z/OS V2R1 or later
- CICS Transaction Server for z/OS, V4 or later
- IBM DB2 V10 or later
- IBM IMS V12 or later

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- PD Tools V13 or later (Debug Tool, Fault Analyzer, Application Performance Analyzer)
- Rational Developer for System z (RDz) V9.5 or later

Determining service required

You no longer need to find lists of APARs and PTFs in PSP buckets. As of Enterprise COBOL for z/OS V5, you must use SMP/E FIXCATs to identify the required PTFs on other products to work with Enterprise COBOL V5 and V6. The required service PTFs for COBOL for z/OS V5 and V6 are not documented in this Migration Guide, are not included in PSP buckets, and are not included in any handouts for conferences.

SMP/E FIXCATs allow you to have the most up to date and correct information about Enterprise COBOL V5 and V6 required service. It is the easiest way to quickly determine if you have all the necessary required service PTFs installed. For Enterprise COBOL V5 and V6, you should use SMP/E V3R5 or later support for FIXCAT HOLDDATA to do programmatic target system PTF verification. These PTFs are identified with a FIXCAT category name in HOLDDATA. There are now 3 for COBOL.

- For COBOL V5.1: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V5R1`
- For COBOL V5.2: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V5R2`
- For COBOL V6.1: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R1`

A HOLDDATA type FIXCAT (fix category) is used to associate an APAR to a particular category of fix for necessary target system PTFs. To help identify PTFs required but not yet installed for your upgrade to Enterprise COBOL V5 or V6 on your current system, use the SMP/E **REPORT MISSINGFIX** command. Here is a sample command used to run against your z/OS CSI for COBOL V6.1 (and earlier versions):

```
SET BDY(GLOBAL).
REPORT MISSINGFIX ZONES(ZOS13T)
FIXCAT(IBM.TargetSystem-RequiredService.Enterprise-COBOL.V5R1,
       IBM.TargetSystem-RequiredService.Enterprise-COBOL.V5R2,
       IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R1)
```

For complete information about the **REPORT MISSINGFIX** command, see *SMP/E Commands*.

Enterprise COBOL V4.2 aids for migration to Enterprise COBOL V5 or V6

Fixes for previous versions of Enterprise COBOL are not handled by FIXCAT. The following APAR fixes contain aids for helping you migrate from Enterprise COBOL V4.2 to Enterprise COBOL V5 or V6.

- PM93450 - FLAGMIG4. This one helps you identify if you have COBOL statements that are unsupported in V5 or V6.

  Note: The source code changes for COBOL V5 and V6 are rarely used COBOL language features and do not affect 99% of COBOL users.
- PM85035 - new function to support XML-INFORMATION special register. This one helps you migrate to XMLPARSE(XMLSS) and therefore to V5 or V6.
- PI40323 - ZONECHECK. This option helps you find cases of invalid COBOL data in numeric DISPLAY zoned decimal data items. Invalid data can get different results in COBOL V5 or V6 compared to previous COBOL compiler releases.
- Language Environment, V1.13 PM87347 for XML-INFORMATION support at run time if you have installed the related Enterprise COBOL V4 APAR, PM85035.

COBOL source code differences in Enterprise COBOL Version 5 and Version 6

Several language elements have been removed or modified in Enterprise COBOL V5 and V6 that may require updates to your source programs.

Millennium Language Extensions

The Millennium Language Extensions are no longer supported. If your programs have any of these language elements, they must be removed before you can compile and run these programs with Enterprise COBOL V5 or V6 :

- DATE FORMAT clause
- DATEVAL intrinsic function
- UNDATE intrinsic function
- YEARWINDOW intrinsic function

LABEL declarative

There have been changes to LABEL declarative support. If your programs have any of these language elements, they must be removed before you can compile and run these programs with Enterprise COBOL V5 or V6 :

- Format 2 declarative syntax: `USE...AFTER...LABEL PROCEDURE...` is no longer supported
- The syntax: `GO TO MORE-LABELS` is no longer supported.

VOLATILE reserved word

Starting in Enterprise COBOL V5.2, VOLATILE is a new reserved word. Existing programs that use VOLATILE as a user-defined word (for example, as a data name or paragraph name) will get S-level diagnostic messages with Enterprise COBOL V5.2 and V6. You must change these instances of VOLATILE to other words such as VOLATILE-X, or you can use the CCCA utility to do it for you.

INSPECT...TALLYING behavior

For `INSPECT...TALLYING`, previous versions of the compiler insert zone nibbles in a signed numeric display inspected item before performing the INSPECT. This will, for example, change SPACES to ZEROS. COBOL V5 and later versions no longer do this zone normalization. Having `INSPECT` without a `REPLACING` clause update the inspected item was unexpected, and COBOL V5 and later versions do not do this.

There is no way to have COBOL V5 and later versions behave in the same unexpected way as COBOL V4. Adding or removing REPLACING will not replicate COBOL V4 and earlier behavior, which we consider to be in error. To avoid the unexpected behavior in COBOL V4, you can add a NUMERIC class test before the INSPECT, avoid moving spaces or alphanumeric data into the inspected item, or move zeroes into the inspected item. COBOL V5 and later versions will not unexpectedly modify the inspected data item.

For example:

```
01 TEST-DATA.
  02  NUM-DISP  PIC S9(9).

. . .

MOVE 0 To TALLY
MOVE SPACES TO TEST-DATA
INSPECT NUM-DISP TALLYING TALLY FOR ALL ZEROES
IF TALLY > 0 THEN
   DISPLAY 'This is COBOL V4 or earlier'
ELSE
   DISPLAY 'This is COBOL V6'
```

If your programs rely on this behavior, then you can change your program to do INSPECT, with REPLACING to, for example, replace SPACES with ZEROS in COBOL V6 programs:

```
INSPECT NUM-DISP REPLACING ALL SPACES BY '0'
```

This is effectively what COBOL V4 did, but you might have to replace other nonnumeric content of the signed numeric display data item.

Move instruction

When moving a 16-bit COMP-5 sender (PICTURE clause PIC 9(2) through PIC 9(4)), with value x'8000' or higher, to an alphanumeric data item, Enterprise COBOL V4.2 incorrectly uses an instruction that loads the value as a 32-bit value with the high sixteen bits all ones. This incorrectly changes the value that is moved to the PIC X(9) receiver. Enterprise COBOL V5 and V6 correctly load the 16-bit value as a 32-bit value with the high sixteen bits all zeros, which is correct, but is different from Enterprise COBOL V4.2.

Changes apply to Enterprise COBOL V6 only

In Enterprise COBOL V5 and earlier versions, a non-88 level VALUE clause in the LINKAGE SECTION or FILE SECTION was treated as a comment. However, starting in Enterprise COBOL V6.1, the VALUE clause for LINKAGE SECTION and FILE SECTION items is now syntax checked and has meaning. This means that a program that is compiled with RC=0 with COBOL V5 could get RC=12 with COBOL V6.

For example, with Enterprise COBOL V5 and earlier versions:

```
  000224          LINKAGE SECTION.
  000225            01 ALPH-ITEM  PIC X(4)  VALUE 1234.


==000225==> IGYDS1158-I A non-level-88 "VALUE" clause was found in the
"FILE SECTION" or "LINKAGE SECTION". The "VALUE" clause was treated as comments.
```

With Enterprise COBOL V6:

```
  000224          LINKAGE SECTION.
  000225            01 ALPH-ITEM  PIC X(4)  VALUE 1234.


==000225==> IGYGR1080-S A "VALUE" clause literal was not compatible with the data
category of the subject data item. The "VALUE" clause was discarded.
```

Compiler option changes in Enterprise COBOL Version 5 and Version 6

A number of changes are made to compiler options in Enterprise COBOL V5 and V6.

The following options are new:

Table 37. Compiler options new with Enterprise COBOL Version 5 and Version 6

Compiler option	Comments
AFP	New option. It controls the compiler usage of the Additional Floating Point (AFP) registers that are provided by z/Architecture processors. AFP(VOLATILE) is the default.
ARCH	New option. It specifies the machine architecture for which the executable program instructions are to be generated. • In Enterprise COBOL V5.1, ARCH(6) is the default. • In Enterprise COBOL V5.2 and V6.1, ARCH(6) is no longer accepted. A new higher level of ARCH(11) is accepted, and ARCH(7) is the default.

Table 37. Compiler options new with Enterprise COBOL Version 5 and Version 6 (continued)

Compiler option	Comments
COPYLOC	New option from Enterprise COBOL V6.1 with the service PTFs. It can be used to add either a PDSE (or PDS) dataset or z/OS UNIX directory as an additional location to be searched for copy members during the library phase.
COPYRIGHT	New option from Enterprise COBOL V5.2. It places a string in the object module if the object module is generated.
DISPSIGN	New option. It controls output formatting for DISPLAY of signed numeric items. DISPSIGN(COMPAT) is the default.
HGPR	New option. It controls the compiler usage of the 64-bit registers provided by z/Architecture processors. HGPR(PRESERVE) is the default.
INITCHECK	New option in Enterprise COBOL V5.2 with the service PTFs and from V6.1 with the service PTFs. It controls whether to check for uninitialized data items and issue warning messages when they are used without being initialized.
INLINE	New option in Enterprise COBOL V6.1 with the service PTFs and from V6.2 and later versions. It controls the compiler to consider whether to inline procedures referenced by PERFORM statements in the source program. INLINE is a potential performance boosting option. (Note that INLINE was always in effect in COBOL V5.)
MAXPCF	New option. It instructs the compiler not to optimize code if the program contains a complexity factor greater than *n*.
NUMCHECK	New option in Enterprise COBOL V5.2 with the service PTFs and from V6.1 with the service PTFs. It controls whether to generate implicit numeric class tests for zoned decimal and packed decimal data items that are used as sending data items, and whether to generate SIZE ERROR checking for binary data items.
PARMCHECK	New option from Enterprise COBOL V6.1 with the service PTFs. It tells the compiler to generate an extra data item following the last item in WORKING-STORAGE. This buffer data item is then used at run time to check whether a called subprogram corrupted data beyond the end of WORKING-STORAGE.
QUALIFY	New option from Enterprise COBOL V5.2. It affects qualification rules and controls whether to extend qualification rules so that some data items that cannot be referenced under COBOL Standard rules can be referenced.
RULES	New option from Enterprise COBOL V5.2. It requests information about your program from the compiler to improve the program by flagging certain types of source code at compile time.
SERVICE	New option from Enterprise COBOL V5.2. It places a string in the object module if the object module is generated.
SQLIMS	New option in Enterprise COBOL V5.1 with the service PTFs and from V5.2. It enables the new IMS SQL coprocessor (called SQL statement coprocessor by IMS). The new coprocessor handles your source programs that contain embedded SQLIMS statements.
STGOPT	New option. It controls storage optimization. NOSTGOPT is the default.
SUPPRESS	New option from Enterprise COBOL V6.1. It controls whether to ignore the SUPPRESS phrase of COPY statements.

Table 37. Compiler options new with Enterprise COBOL Version 5 and Version 6 (continued)

Compiler option	Comments
VLR	New option in Enterprise COBOL V5.1 with the service PTFs and from V5.2. It affects the READ statement processing of variable length records that have length conflicts. VLR(STANDARD) is the default. For details, see "Variable length records - wrong length READ" on page 191.
VSAMOPENFS	New option from Enterprise COBOL V6.1. It affects the user file status reported from successful VSAM OPEN statements that require verified file integrity check.
XMLPARSE	New option in Enterprise COBOL V5.1 with the service PTFs and from V5.2. It enables you to choose between parsing with the compatibility-mode COBOL XML parser from the COBOL library, or with the z/OS XML System Services parser. It can ease your migration to the Enterprise COBOLV5 or V6 compilers. XMLPARSE(XMLSS) is the default.
ZONECHECK	New option in Enterprise COBOL V5.2 with the service PTFs and V6.1. It tells the compiler to generate IF NUMERIC class tests for zoned decimal data items that are used as sending data items. From Enterprise COBOL V6.1 with the service PTFs, ZONECHECK is deprecated but is tolerated for compatibility. Consider using NUMCHECK(ZON) instead. For details, see *NUMCHECK* in the *Enterprise COBOL Programming Guide*.
ZONEDATA	New option from Enterprise COBOL V5.2. It tells the compiler whether data in USAGE DISPLAY and PACKED-DECIMAL data items is valid, and if not, what the behavior of the compiler should be. Originally, Enterprise COBOL V5.2 at base level did not have the NOPFD suboption. In V5.2 with the service PTFs and from V6.1, the NOPFD suboption is added to let the compiler generate code that performs comparisons of zoned decimal data in the same manner as COBOL V4 does when using NUMPROC(NOPFD|PFD) in COBOL V4. To ease your migration to COBOL V5 or V6: • If your digits, sign code, and zone bits are valid, use ZONEDATA(PFD) and the same NUMPROC setting that you used with COBOL V4 when using COBOL V5 or V6. • If you have invalid digits, invalid sign code, or invalid zone bits: – If you used NUMPROC(MIG) with COBOL V4, use ZONEDATA(MIG) and NUMPROC(NOPFD) with COBOL V5 or V6. – If you used NUMPROC(NOPFD) with COBOL V4, use ZONEDATA(NOPFD) and NUMPROC(NOPFD) with COBOL V5 or V6. – If you used NUMPROC(PFD) with COBOL V4, use ZONEDATA(NOPFD) and NUMPROC(PFD) with COBOL V5 or V6. **Note:** It is not always possible to entirely match the behaviour of the old compiler even with these options when faced with clearly invalid data.

For new compiler options in Enterprise COBOL Version 6, see Compiler options new with Enterprise COBOL Version 6.

The following options are modified:

Table 38. Compiler options changed with Enterprise COBOL Version 5 and Version 6

Compiler option	Comments
EXIT	The EXIT compiler option is no longer mutually exclusive with the DUMP compiler option, and the compiler exits rules are updated.
INITCHECK	From Enterprise COBOL V6.1 with the service PTFs, new suboptions LAX | STRICT are added to the INITCHECK option to control whether the compiler will issue warning messages for data items unless they are initialized on at least one, or on all, logical paths to a statement.

LANGUAGE	To change to uppercase English or Japanese compiler messages in COBOL V6, in addition to using the LANGUAGE compiler option, you must also set the Language Environment runtime option NATLANG at compile time. We recommend using CEEOPTS DD in the compile JCL.
	For example, to change messages to Japanese, use the LANGUAGE(JA) compiler option and also specify the NATLANG LE runtime option at compile time:
	`//CEEOPTS DD *`
	`NATLANG(JPN)`
	`/*`

MAP	In Enterprise COBOL V5.1 with the service PTFs and from V5.2, new suboptions HEX | DEC are added to the MAP compiler option to control whether hexadecimal or decimal offsets are shown for MAP output in the compiler listing. Previous versions of Enterprise COBOL always showed hexadecimal offsets in MAP output, but Enterprise COBOL V5.1 at base level originally showed decimal offsets for MAP output. In Enterprise COBOL V5.1 with the service PTFs and from V5.2, new suboptions HEX and DEC are added to the MAP option. If MAP is specified with no suboption, it will be accepted as MAP(HEX). This will give you the same behavior in Enterprise COBOL V5 or V6 as in earlier COBOL compilers. Thus, it can ease your migration to Enterprise COBOL V5 or V6 compilers.
MDECK	The MDECK option no longer has a dependency on the LIB option, as the compiler behaves as though the LIB option is always enabled.
NORENT	NORENT can no longer be used with RMODE(ANY). Execution of NORENT programs above the 16 MB line is not supported.
OPTIMIZE	The OPTIMIZE option is modified to allow more levels of performance optimization for your application. The previous OPTIMIZE option format is deprecated but is tolerated for compatibility. **Note:** Although OPT(0) is equivalent to the NOOPTIMIZE option in previous compilers, it now removes some code that previously was not removed. The storage optimization provided by the old FULL suboption of OPT is now provided by the new compiler option STGOPT.
RMODE(ANY)	RMODE(ANY) can no longer be used with NORENT

Table 38. Compiler options changed with Enterprise COBOL Version 5 and Version 6 (continued)

Compiler option	Comments
SSRANGE	The compiled-in range checks cannot be disabled at run time using the runtime options CHECK(OFF) or NOSSRANGE. In Enterprise COBOL V5.2 with the service PTFs and from V6.1, new suboptions ZLEN | NOZLEN are added to the SSRANGE compiler option to control how the compiler checks reference modification lengths. From Enterprise COBOL V6.1 with the service PTFs, new suboptions MSG | ABD are added to the SSRANGE compiler option to control the runtime behavior of the COBOL program when a range check fails. **Note:** The compiler option NOSSRANGE is still supported.
TEST	From Enterprise COBOL V5.1, the HOOK | NOHOOK and SEPARATE | NOSEPARATE suboptions of the TEST compiler option have been removed. If specified, • HOOK - compiled in hooks are not available. • NOHOOK - NOHOOK behavior is always in effect • SEPARATE - Compiler always places debugging info in object • NOSEPARATE - NOSEPARATE behavior is always in effect New suboptions SOURCE and NOSOURCE are added to the TEST compiler option. **Note:** EJPD and NOEJPD subotions are still supported. With Debug Tool V12 with APAR PM75819 or Debug Tool V13 or later, you can do JUMPTO or GOTO even if you compile with the TEST(NOEJPD) option and a non-zero OPTIMIZE level. You must, however, use the Debug Tool command SET WARNING OFF and you may get unpredictable results. The NOTEST option is enhanced to include the suboptions DWARF and NODWARF. **Note:** Even though DWARF debugging information is always placed in the object program as NOLOAD segments, these NOLOAD segments will not take storage at runtime, unless Debug Tool, CEEDUMP, Fault Analyzer, Application Performance Analyzer or a 3rd-party vendor tool that uses DWARF debugging data is used

For modified compiler options in Enterprise COBOL Version 6, see Compiler option changed with Enterprise COBOL Version 6.

The following options are removed:

Table 39. Compiler options not available in Enterprise COBOL Version 5 and Version 6

Compiler option	Comments
DATEPROC	Support for Year 2000 extensions has been removed.
LVLINFO	From Enterprise COBOL V6.1, the LVLINFO installation option is removed. The build level information is put where LVLINFO used to be, and the SERVICE compiler option can be used for user service level information in place of LVLINFO.
NOLIB	Compiler behaves as though LIB is always in effect.

Table 39. Compiler options not available in Enterprise COBOL Version 5 and Version 6 (continued)

Compiler option	Comments
NUMPROC(MIG)	NUMPROC(PFD) and NUMPROC(NOPFD) are still available. If NUMPROC(MIG) is specified, Enterprise COBOL V5 or V6 issues a warning message and the compilation will get the default setting for NUMPROC. This is either the user-customized default or the IBM default, which is NUMPROC(NOPFD). To migrate your programs compiled with NUMPROC(MIG) to Enterprise COBOL V6, consider using the NUMCHECK compiler option to help you migrate to NUMPROC(PFD): 1. Compile your programs with NUMCHECK(ZON,PAC) and NUMPROC(PFD). 2. Run a thorough regression test with a good breadth of input data. If your applications get no NUMCHECK messages or NUMCHECK abends, you can safely compile with NUMPROC(PFD) and NONUMCHECK for production. This will not only solve the invalid data problem, but NUMPROC(PFD) is the most efficient setting for the NUMPROC compiler option. NUMCHECK is introduced in Enterprise COBOL V6.1 with the service PTFs. For details, see *NUMCHECK* in the *Enterprise COBOL Programming Guide*.
SIZE	• In Enterprise COBOL V5.1, the SIZE option value is no longer an upper-limit for the total storage used by a COBOL compilation. In addition, the SIZE suboption value MAX is no longer supported. The default value for the SIZE option is SIZE(5000000). For more information about compiler memory requirements, see "Changes in compiling with Enterprise COBOL Version 5 and Version 6" on page 184. • From Enterprise COBOL V5.2, the SIZE option has been removed.
YEARWINDOW	Support for Year 2000 extensions has been removed.

For removed compiler options in Enterprise COBOL Version 6, see Compiler option not available in Enterprise COBOL Version 6.

The following options were obsolete in Enterprise COBOL V4, but were tolerated with informational or warning messages to ease migration from V3 or prior versions. With Enterprise COBOL V5 and V6, these options are no longer tolerated, and specifying any of them will result in an error message.

- CMPR2
- EVENTS
- FDUMP
- FLAGSAA
- PFDSIGN
- RES

For a detailed list of options supported for the various compiler versions, see Appendix E, "Option comparison," on page 277.

For a detailed list of compiler options that can affect performance, see *How to tune compiler options to get the most out of V6* in the *Enterprise COBOL Performance Tuning Guide*.

For detailed descriptions of all the compiler options, see *Compiler options* in the *Enterprise COBOL Programming Guide*.

Changes in compiling with Enterprise COBOL Version 5 and Version 6

There are a number of changes to Enterprise COBOL V5 and V6 that result in different behaviors.

The COBOL runtime library, the Language Environment component of z/OS, must now be available at compilation time. In addition, Language Environment must be updated with the APAR fixes (PTFs) for compiling programs with Enterprise COBOL V5 or V6 and for running programs that were compiled with Enterprise COBOL V5 or V6. For details about prerequisite software levels and required maintenance, see "Prerequisite software and service for Enterprise COBOL Version 5 and Version 6" on page 175.

Compile-time storage requirements are substantially increased compared to prior versions of Enterprise COBOL. The compiler requires a minimum of 200 M region size to run. In Enterprise COBOL Version 5.1, the compiler option SIZE(MAX) is no longer supported, but gets tolerated and interpreted as SIZE(5000K). Your SIZE option setting should be in the range of 5000 K to 20000 K for V5.1.

It is not necessary to specify a high SIZE value for every large program. You must raise the default SIZE value only when you encounter this error message during compilation: `IGYPG5062-U THERE WAS INSUFFICIENT STORAGE FOR COMPILER PROCESSING.` This message indicates that the compiler front end has run out of memory while still processing the program, and you must use the SIZE option to allocate more memory for the front end.

However, note that the memory allocated to the front end using the SIZE option is not available to later phases of the compilation. Therefore, carefully calibrate the SIZE value to avoid depriving the code generation and optimization steps of memory. Otherwise, the compiler might abend in those later phases with the following message: `IGYCB7145-U INSUFFICIENT MEMORY IN THE COMPILER TO CONTINUE COMPILATION.`

In Enterprise COBOL V5.2 and later, the compiler option SIZE is no longer supported. Your region size must also be at least 200 M. The region size must be large especially at higher optimization levels, that is, programs compiled with the `OPT(1)` or `OPT(2)` compiler option.

Note: If you get unexpected compiler abends or this message: `IEW4000I FETCH FOR MODULE IGYCBE FROM DDNAME STEPLIB FAILED BECAUSE INSUFFICIENT STORAGE WAS AVAILABLE`, make sure that your region size is at least 200 M. REGION=0M in JCL gives you the maximum amount allowed by the JES system defaults set up by your system programmer. It may be less than needed. In that case your system programmer must increase the user limit of region size.

In Enterprise COBOL V6, the compiler may start using storage above the 2 GB BAR to compile very large programs. This means that the z/OS MEMLIMIT parameter would have to be set to a nonzero value. The z/OS default for MEMLIMIT is 2 GB, but if you compile a very large program and your z/OS setting for MEMLIMIT is not high enough, you could get this compiler message: `IGYCB7145-U Insufficient memory in the compiler to continue compilation.`

Consider also the following changes:

- The Language Environment member ID for Enterprise COBOL Version 5 Release 1 or later is 4 (The member ID for all previous COBOL versions was 5).
- Compile-time CPU time requirements are substantially increased, compared to prior versions of Enterprise COBOL. The compiler may take more than five times as long to compile as the older compilers.
- Compile time and run time diagnostic messages might differ, and might be generated at different times or locations.
  - Presence or absence of informational and warning level diagnostic messages might differ
  - Diagnostic messages for programs that define excessive and unsupported amounts of storage might be issued either by the binder at bind time, or by Language Environment at run time, instead of by the compiler at compilation time.
- The compiler output is in GOFF format. This format allows the compiler to create more efficient generated code and also to put out the NOLOAD debug information (DWARF) segments.

- There is no SYSDEBUG data set created for debug information.
- Compiler listing format and contents differ from prior versions of Enterprise COBOL. You can find details on these changes in the *Enterprise COBOL Programming Guide*.
- Starting in Enterprise COBOL V6.1, the build level information (of the form PYYMMDD) is always included in the header of the listing file, which assists with determining the maintenance level of the compiler. Here is an example of the listing header:

```
PP 5655-EC6 IBM Enterprise COBOL for z/OS 6.1.0 P160318
```

- Several compiler limits are increased with Enterprise COBOL V5 and V6. For details, see Appendix F, "Compiler limit comparison," on page 299.
- Starting in Enterprise COBOL V6.1, the installation customization for placing compiler phases into shared storage is removed, since in modern systems most users have lots of storage available, and do not need to conserve storage by placing compiler phases in shared storage. As a result of this change to the compiler, the language for placing compiler phases in shared storage is no longer supported, so if you have a saved copy of the IGYCDOPT customization that has a specification of compiler phases being IN or OUT of shared storage, that language must be removed before you can assemble IGYCDOPT. If you do not have any statements in IGYCDOPT that specify IN or OUT for compiler phases, then you will not be affected by this change.

If you are using IBM Enterprise COBOL Value Unit Edition (VUE) for z/OS, V5.2 and later versions, you cannot invoke the compiler multiple times from the same task (for example, invoking the compiler multiple times from the same task by using the MVS LINK macro).

Compiler output to uninitialized data sets not supported

There are a couple of cases where the compiler fails if it tries to write to uninitialized data sets.

Sequential data sets

With Enterprise COBOL Version 4 and earlier, the compiler could write to a pre-allocated object file with no specific attributes from a previous compile step. This is not possible with Enterprise COBOL Version 5 and Version 6.

For example, with Enterprise COBOL Version 4, the compiler could write to a pre-allocated data set with no specified attributes (DISP=MOD) from a previous step. When the compiler had written to the data set, it had the following attributes:

```
RECFM=FB LRECL=80 BLKSIZE=3200 DSORG=PS
```

With Enterprise COBOL Version 5 and Version 6, the attributes are not changed and the attempt to write to the file fails.

The file attributes will be

```
RECFM=U LRECL=** BLKSIZE=6144 DSORG=PS
```

This is not valid input to the binder.

To address this, you can provide data control block (DCB) information as follows on the preallocation:

```
DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
```

PDS or PDSE data set

With earlier versions of Enterprise COBOL, the compiler could write to a pre-allocated PDS object file with no specific attributes from a previous compile step. This is not supported with Enterprise COBOL Version 5 and Version 6.

For example, with Enterprise COBOL Version 4, the compiler could write to a pre-allocated PDS or PDSE with no specified attributes (DISP=MOD) from a previous step. The compiler will create an object file of attributes:

```
RECFM=FB LRECL=80 BLKSIZE=3200 DSORG=PO
```

With Enterprise COBOL Version 5 and Version 6, DISP=MOD is not supported for PDS or PDSE data sets.

If the PDS has undefined format (such as ouput from a previous step with no DCB), and you use DISP=SHR or DISP=OLD, Enterprise COBOL Version 5 will write but will not change the attributes. They will be left as:

```
RECFM=U LRECL=** BLKSIZE=6144 DSORG=PO
```

which is not valid input to the binder.

To fix this, specify DCB information on the allocation step as:

```
DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
```

Do not use DISP=MOD. Use only DISP=SHR or DISP=OLD.

JCL and packaging changes for Enterprise COBOL Version 5 and Version 6

There have been a number of changes to the packaging, installation and JCL with Enterprise COBOL V5 and V6.

The SIGYCOMP data set is now a PDSE, rather than a PDS data set as in prior versions.

Enterprise COBOL V5 and V6 requires additional data sets:

- When compiling under z/OS TSO or batch, the COBOL compiler now requires 15 utility data sets, SYSUT1 to SYSUT15
- The SYSMDECK data set is now required for all compilations. SYSMDECK may be specified as a utility (temporary) data set if the NOMDECK option is specified. When MDECK is specified, the SYSMDECK DD allocation must specify a permanent data set.
- The alternate DDNAME list parameter, used when the COBOL compiler is invoked from an assembly language program, is expanded with entries for the additional work data sets.

The following JCL cataloged procedures are no longer supported, and have been deleted with Enterprise COBOL V5 and V6. Because they all use the Language Environment Prelinker or the DFSMS Loader, which are no longer supported for use with Enterprise COBOL V5 and V6.

- IGYWCG
- IGYWCPG
- IGYWCPL
- IGYWCPLG
- IGYWPL

The catalogued procedures that ship with Enterprise COBOL V5 and V6 have been modified.

- IGYWC
- IGYWCL
- IGYWCLG

The following change applies only to V6.1:

To change to uppercase English or Japanese compiler messages in COBOL V6, in addition to using the LANGUAGE compiler option, you must also set the Language Environment runtime option NATLANG at compile time. We recommend using CEEOPTS DD in the compile JCL.

For example, to change messages to Japanese, use the LANGUAGE(JA) compiler option and also specify the NATLANG LE runtime option at compile time:

```
//CEEOPTS DD *
          NATLANG(JPN)
/*
```

Compilation restrictions for user-written condition handlers with Enterprise COBOL Version 5 and Version 6

Refer to the restrictions for user-written condition handlers with Enterprise COBOL V5 and V6, and the differences between V5.1 and V5.2.

User-written condition handlers with Enterprise COBOL V5.1

With Enterprise COBOL V5.1, all COBOL programs in an application that use the Language Environment service CEEHDLR to register a user-written condition handler must be compiled with one of the following configurations of compiler options:

- OPTIMIZE(0)
- OPTIMIZE(1) and TEST
- OPTIMIZE(2) and TEST

Use of user-written condition handling services is incompatible with the advanced optimizations done with OPTIMIZE(1) or OPTIMIZE(2) and NOTEST, and can cause unpredictable results. You must specify the TEST option along with OPTIMIZE(1) or OPTIMIZE(2), which reduces the amount of optimization performed.

User-written condition handlers with Enterprise COBOL V5.2 and V6

With Enterprise COBOL V5.2 and V6, a new VOLATILE clause is added to the format 1 data description entry, which helps to address issues with using higher levels of optimization for programs that use Language Environment (LE) condition handlers registered via the LE service CEEHDLR. When OPTIMIZE(1) or OPTIMIZE(2) is used without the TEST compiler option for such programs, care must be taken. In particular, if a condition handler program accesses data items that are not defined local to the condition handler program itself (for example, data items defined in the application as EXTERNAL), such data items must be defined with the VOLATILE clause in every program where a condition can occur. Otherwise, the handler program might not use the latest value of the data item. In this case, the use of the VOLATILE clause is preferred over the use of the TEST option for performance considerations.

For condition handler scenarios that also use the SERVICE LABEL compiler-directing statement with the LE service CEE3SRP to set a resume point, the optimization of such programs can be significantly reduced.

Note: VOLATILE is now a reserved word in Enterprise COBOL. Existing programs that use VOLATILE as a user-defined word (for example, as a data name or paragraph name) will get S-level diagnostic messages with Enterprise COBOL V5.2 and V6. You must change these instances of VOLATILE to other words such as VOLATILE-X, or you can use the CCCA utility to do it for you.

For more information about the VOLATILE clause, see *VOLATILE clause* in the *Enterprise COBOL Language Reference*.

Binding (link-editing) changes with Enterprise COBOL Version 5 and Version 6

There have been a number of changes to binding (link-editing) Enterprise COBOL V5 or V6 programs.

- The DFSMS Program Management Binder must be used to bind (link-edit) Enterprise COBOL V5 or V6 applications. The Language Environment Prelinker is no longer supported.

- Executables are program objects, not load modules. The Program Management Loader (IEWBLDG0) is no longer supported.
- Executables cannot reside in PDS (only in PDSE) data sets.
- NOLOAD segments will not take storage at run time, unless Debug Tool, CEEDUMP, Fault Analyzer, Application Performance Analyzer or a 3rd-party vendor tool that uses DWARF debugging data is used
- When a program object contains any of the following programs, the binder option RMODE(24) must be specified:
  - An Enterprise COBOL program that is compiled with the RMODE(24) or NORENT compiler options.
  - A VS COBOL II program that is compiled with the NORENT option.
  - An assembler program that contains a CSECT with RMODE 24.
  - COBOL programs compiled with a compiler earlier than V5 that run with AMODE 24 and statically call a COBOL program compiled with COBOL V5 or later.

Changes at run time with Enterprise COBOL Version 5 and Version 6

There are a number of changes to runtime behavior with Enterprise COBOL V5 and V6.

If a z/OS system does not have Language Environment PTFs installed to support Enterprise COBOL Version 5 or Version 6 programs, you cannot run Enterprise COBOL Version 5 or Version 6 programs on that system.

- Runtime option changes. For details, see "Language Environment option changes" on page 190.
- Interoperability. Enterprise COBOL V5 and V6 has some restrictions with interoperability with older versions of COBOL. For details, see "Interoperability with older levels of IBM COBOL programs" on page 21.
- Invalid data might get different results with COBOL V5 and V6 than in earlier COBOL versions. Some users have found that they get different results with the newer compilers than with previous compilers, and/or that they get different results with different OPT or ARCH settings. These are normally due to invalid data that is brought into the COBOL programs at run time. One way to find out whether your programs will have this problem is to follow our new migration recommendation:

  1. Compile with NUMCHECK, PARMCHECK, and SSRANGE, and then run regression tests.
  2. Check whether there are any problems:
     - If no problems found, recompile with NONUMCHECK, NOPARMCHECK, NOSSRANGE, and INITCHECK. At this point, check for compile-time warnings from INITCHECK. If there are none, then run a final test and move the application into production.
     - If problems are found, then either correct the programs and or data, or in the case of bad data in zoned decimal data items, use the ZONEDATA compiler option to tolerate the invalid data.

  Note: You do not have to do this extra testing for programs that have already been compiled with Enterprise COBOL V5 or V6.
- All of the AMODE and RMODE scenarios supported by Enterprise COBOL Version 4 are now supported with Version 5 and Version 6, except that programs compiled with the NORENT compiler option must be RMODE 24. After binding, executable COBOL programs can have any of the following combinations of AMODE and RMODE attributes:
  - AMODE 31 and RMODE ANY
  - Either AMODE ANY or AMODE 31, and RMODE 24
  - AMODE 24 and RMODE 24

  The resolved AMODE and RMODE settings depend on the COBOL language constructs used, the compiler options specified, the binder options specified, and the AMODE and RMODE attributes of the input object modules that are bound into the executable module.

- In some cases, AMODE 24 execution is not supported and the applications must run in AMODE 31. For details, see "Restrictions for AMODE" on page 191.
- For applications compiled with Enterprise COBOL V5 or V6, the compiled-in range checks cannot be disabled at run time using the runtime option CHECK(OFF) or NOSSRANGE .
- The ILBOABN0 interface for requesting an ABEND in a COBOL environment can be called dynamically with Enterprise COBOL V5 and later versions. When called by a program compiled with Enterprise COBOL compiler, it will has the same result as calling CEE3ABD using ACTION code 1.

  Your are strongly recommended to migrate and use the CEE3ABD interface, because the CEE3ABD interface provides extra flexibility to control the level of details provided in the CEEDUMP produced.

  When your application is called by Enterprise COBOL programs, it might ABEND in an unexpected way if it has an older version of ILBOABN0 (before LE's SCEELKED) statically linked. To fix the unexpected ABEND, you can follow one of the advises below:

  – Migrate to CEE3ABD.
  – Relink your application with the REPLACE ILBOABN0 in the LINK step, against LE's SCEELKED.
  – Change the COBOL program to use dynamic call for ILBOABN0.
- The IGZERRE and ILBOSTP0 interfaces for managing a reusable COBOL environment are not supported for applications containing programs compiled with Enterprise COBOL V5 or V6.
- The IGZBRDGE macro, for converting static calls to dynamic calls, is not supported for programs compiled with Enterprise COBOL V5 or V6.
- A new compiler option, VLR(COMPAT|STANDARD), controls how Enterprise COBOL handles conflicts with record length in READ statements for variable-length record files. For details, see "Variable length records - wrong length READ" on page 191.
- VSAM record areas for reentrant COBOL programs are allocated above 16 MB, by default. Programs that pass data in VSAM file records as CALL … USING parameters to AMODE 24 subprograms may be impacted. Such programs can be recompiled with the DATA(24) compiler option, or the Language Environment HEAP() option can be used, to ensure that the records are addressable by the AMODE 24 programs.
- CICS System Definition (CSD) file might need to be updated to include Enterprise COBOL V5 and V6 runtime modules. For details, see "CSD setup differences with Enterprise COBOL V5 and V6" on page 213.
- When COBOL programs perform an IEEE (decimal or binary) floating point division-by-zero operation, the division operation raises an IEEE divide-by-zero exception. For details, see "Using object oriented COBOL or interoperating with C programs" on page 194.

For COBOL V5 and later, procedure and function pointers point to a function descriptor rather than directly to the entry point. If your code expects these pointers to point directly to the entry point, for example of a data-only module, this requires a code change. For details, see Using procedure and function pointers (*Enterprise COBOL Programming Guide*).

For COBOL V5 and later, calls to procedure and function pointers must be from a module with an LE stack frame, which is the case for any high-level programming language. If such a call is to be made from an assembler module, an LE stack frame must be provided by using the CEEENTRY and CEETERM macros, along with the associated register content requirements.

The following changes apply only to V6.1:

- With Enterprise COBOL V6.1, WORKING-STORAGE is acquired from HEAP storage in all cases, so that there are no exceptions to when the STORAGE runtime option will affect WORKING-STORAGE. In Enterprise COBOL V5, this was only true in CICS and some special cases in non-CICS.
- File status changes in V6.1:

  – WRITE statement on line-sequential file with a record size mismatch.

In prior releases of Enterprise COBOL, when an attempt is made to write a record to a line-sequential file with mismatched record size, file status 48 is incorrectly returned. This is corrected in Enterprise COBOL V6.1 to return file status 44.

– OPEN INPUT on a line-sequential file when the UNIX file attribute is write-only.

  In prior releases of Enterprise COBOL, an OPEN statement with the INPUT phrase on a line-sequential file that has the write-only attribute, such as a z/OS UNIX file with DD PATHOPTS=(OWRONLY,...) or a COBOL program that has the write access permission only, incorrectly returned file status 0 (successful). An OPEN statement attempted on a file that does not support the open access mode should return file status 37.

  Note: "write-only" here does not mean the APPLY WRITE-ONLY clause that is not applicable to line-sequential files. Line-sequential files are files created in the z/OS UNIX file system.

  In Enterprise COBOL V6.1, this OPEN statement is detected with file status 37.

– OPEN INPUT, I-O, EXTEND on VSAM file with file attributes mismatch.

  In prior releases of Enterprise COBOL, when an OPEN INPUT, I-O or EXTEND statement is attempted on a VSAM file that is not defined as OPTIONAL, and a file attributes mismatch is detected, file status 35 is incorrectly returned. This is corrected inEnterprise COBOL V6.1 to return file status 39.

  Note: Similar file attributes mismatch condition for OPEN OUTPUT, and for OPEN INPUT, I-O, and EXTEND when the VSAM file is defined as OPTIONAL, are already correctly reported as file status 39.

Language Environment option changes

There have been a number of changes to runtime options for Enterprise COBOL Version 5 and Version 6 programs.

The following options have different behavior for programs compiled with Enterprise COBOL Version 5 or Version 6.

Table 40. Runtime option changes with Enterprise COBOL Version 5 and Version 6

Option	Comments
HEAP	• With COBOL V5, in some cases under non-CICS (such as batch, TSO, or IMS), WORKING-STORAGE space (for programs compiled with RENT) is not acquired from HEAP and therefore the HEAP (and STORAGE) option has no effect on it. WORKING-STORAGE under non-CICS is not acquired from HEAP when the COBOL V5 program is statically linked to a C, C++ or PL/I program and the main entry point of the program object is not COBOL V5. • With COBOL V6 and later, WORKING-STORAGE space (for programs compiled with RENT) is acquired from HEAP. Therefore, the HEAP (and STORAGE) option does have an effect on it.
CHECK(OFF)	CHECK(OFF) does not disable runtime subscript range checking for COBOL V5 or V6 programs compiled with SSRANGE.
NOSSRANGE	The NOSSRANGE runtime option does not disable runtime subscript range checking for COBOL V5 or V6 programs compiled with SSRANGE. **Note:** The NOSSRANGE compiler option is still fully supported.
STORAGE	In a few special cases with COBOL V5, STORAGE initial values for HEAP no longer affect WORKING-STORAGE initial values. For details about the cases, see the discussion of the HEAP option above.

Restrictions for AMODE

AMODE 24 execution is not supported in the following cases, and the applications must run in AMODE 31. This is the same set of AMODE 24 restrictions as COBOL V3 and V4.

- Programs containing XML PARSE statements
- Programs containing XML GENERATE statements
- Program objects containing COBOL bound together with C, C++, or PL/I programs, and communicating via static CALL
- Programs containing object-oriented language syntax, such as INVOKE statements, or object-oriented class definitions
- Programs compiled with any of the following compiler options:
  - DLL
  - PGMNAME(LONGUPPER)
  - PGMNAME(LONGMIXED)
- Multithreaded applications

  Note: A program compiled with the THREAD option can run in AMODE 24, but only in an application that does not have multiple threads or PL/I tasks.
- Programs run from the z/OS UNIX file system

  Note: An AMODE 31 driver program resident in the z/OS UNIX file system can contain a dynamic call to an AMODE 24 program module resident in an MVS PDSE.
- Programs used as COBOL compiler exit modules that are specified on the EXIT compiler option
- Language Environment enclaves that use XPLINK, including either the enclaves that contain non-COBOL programs compiled with the XPLINK compiler option, or run with the XPLINK runtime option

Note: To run COBOL programs with addressing mode 24, you must compile all COBOL programs with Enterprise COBOL V5.1.1, or later versions; or Enterprise COBOL V4.2 or earlier versions. If any component of a program object is compiled with Enterprise COBOL V5.1.0, the program object must run in addressing mode 31. COBOL programs that run with addressing mode 24 must be linked with the binder option RMODE(24).

Variable length records - wrong length READ

Originally, Enterprise COBOL V5.1 changed the behavior for wrong length READ compared to previous COBOL compilers; but for Enterprise COBOL V5.1 with current service applied, V5.2, and later versions, that behavior can be changed via a new compiler option, VLR(COMPAT|STANDARD) that was introduced to control whether you get the original standard-conforming behavior of COBOL V5.1 without service applied, or the behavior that is compatible with earlier COBOL compilers. It eases your migration from earlier versions to Enterprise COBOL V5 and V6, if your programs have READ statements that result in a record length conflict.

The 85 COBOL standard specifies the following rules as part of the processing of READ statements: "If the number of character positions in the record that is read is less than the minimum size specified by the record description entries for the file, the portion of the record area which is to the right of the last valid character read is undefined. If the number of character positions in the record that is read is greater than the maximum size specified by the record description entries for file-name-1, the record is truncated on the right to the maximum size. In either of these cases, the READ statement is successful and an I-O status value of 04 is set indicating that a record length conflict has occurred."

This logic was correctly implemented in VS COBOL II, COBOL/370, COBOL for MVS & VM (except those compilers with the following APAR fixes installed), and Enterprise COBOL V5.1 without service applied, you would get the status value of 04 when READ statements encountered a record length conflict. However, if your programs are compiled with one of the following compilers, you get the status value of 00, which is the nonstandard result for READ statements.

- VS COBOL II V1.3 with PTFs for APAR PN34704 installed
- VS COBOL II V1.4 with PTFs for APAR PN38730 installed
- COBOL/370 V1.1 or V1.2 with PTFs for APAR PN36445 installed
- COBOL for OS/390 & VM, V2
- Enterprise COBOL V3 or V4

The inconsistent behavior could have inhibited the migration to Enterprise COBOL V5 and V6. Thus, in Enterprise COBOL V5.1 with current service applied, V5.2, and later versions, you can choose to have the compatible and nonstandard behavior available with the `VLR(COMPAT)` compiler option.

- If you specify `VLR(COMPAT)`, you get `File Status 00` when READ statements encounter a record length conflict or "wrong length READ".

  If your program performs a "wrong length READ" and your code checks for `File Status=0` after reading variable-length record files, your code will take the "zero" path, just as it did in Enterprise COBOL V4 and earlier versions.

  Note: This setting can hide I/O problems that can arise with the wrong length READ situation. Use the `VLR(COMPAT)` option with caution, and check for correct READ statements.
- If you specify `VLR(STANDARD)`, you get `File Status 04` when READ statements encounter a record length conflict or "wrong length READ". Using this setting, you can check for FS=04 and then add code to avoid accessing undefined data in a record and also avoid getting protection exceptions for attempting to reference a part of the record that was truncated.

  If your program performs a "wrong length READ" and your code checks for `File Status=0` after reading variable-length record files, your code will take the "Not zero" path. You can change your code to test for FS=0, while FS=4 and other values will all be a failed READ. For FS=4, you can add code to avoid the bad data in variables or protection exceptions.

Using VLR(STANDARD) can result in more reliable code and fewer I/O problems because the file status will tell you when a "wrong length READ" might occur. A new compiler message, MSGIGYP3178, can also help you avoid I/O problems by telling you if a program has a possibility of a "wrong length READ". This message can be used to assist with migration from VLR(COMPAT) to VLR(STANDARD) by indicating the possible "wrong length READ" that you can solve by correcting the File Definition (FD). You can also raise the severity of the message so that the program must be corrected in order to run. To do this, use the MSGEXIT suboption of the EXIT compiler option to change the severity of message MSGIGYP3178 from I (RC=0) to S (RC=12), E (RC=8), or W (RC=4). If you are not interested in seeing this message, you can suppress the message completely.

Error behavior changes for incorrect programs

Incorrect COBOL programs might behave differently with Enterprise COBOL V5 and V6 than with prior versions. You must consider more vigorous testing for migrating to Enterprise COBOL V5 or V6 than you did for migrating to Enterprise COBOL V4.

- Programs that use unsupported (yet undiagnosed) COBOL language syntax.
- Programs that move data to and from data items that at run time contain values not conforming to the PICTURE clause in the data description entry. For example:
  - A fullword binary item with picture S9(6) USAGE BINARY, which contains an oversize value of +123456789 (unless the TRUNC(BIN) option was specified)
  - A two-byte packed-decimal item with picture S99 PACKED-DECIMAL, which contains an oversize value of 123 (for example, 123C in hexadecimal).
  - A packed-decimal or zoned-decimal item that contains an invalid or non-preferred sign, which does not conform to the sign requirements of the data description entry.
- Programs with undiagnosed subscript range errors (when the SSRANGE compiler option was not specified), that reference storage outside the storage allocation for the base data item.

- Applications with low-level dependencies on specific generated code sequences, register conventions, or internal IBM control blocks might behave differently with Enterprise COBOL V5 and V6 than with prior versions. The information such as PROGRAM-ID, COMPILED TIME, and COMPILED DATE included in the initialization code of Enterprise COBOL V4 or earlier is not included in the initialization code of Enterprise COBOL V5 or later, so the program it depends on might behave differently with Enterprise COBOL V5 and V6.
- Not all incorrect programs are diagnosed as incorrect. For example, see the following program that sets the value of an ODO object to outside of the legal range:

```
77 VAR1 COMP-3 PIC 9(3).
01 X.
   02 VAR2 PIC X OCCURS 0 to 1 depending on VAR1.

   MOVE 128 to VAR1
   MOVE ALL 'C' to X *> This is illegal!
```

  Results:

  – For V2, V3 and V4: 128 bytes of 'C' were moved
  – For V5 and V6: 1 byte of 'C' and 127 bytes of junk were moved

- Programs with parameter length mismatches:

```
WORKING-STORAGE SECTION.
. . .
77 GRP1 PIC X(100). *> The last item in WORKING-STORAGE SECTION
PROCEDURE DIVISION.
. . .
   CALL 'SUBP' USING GRP1.

PROGRAM-ID. SUBP.
LINKAGE SECTION.
01 GRP2 PIC X(500).
PROCEDURE DIVISION USING GRP2
   MOVE 'STUFF' TO GRP2(300:20) *> This is illegal!
```

  Results:

  In the example above, GRP1 and GRP2 lengths do not match. The MOVE to GRP2 results in an overlay of storage following the last data item in WORKING-STORAGE in the calling program.

  – For V2, V3 and V4: The illegal MOVE did not result in a failure because there was usually unused storage after the last data-item in WORKING-STORAGE (see CALLER), so the overwrite went undetected.
  – For V5 and V6: The file control blocks immediately follow the last data-item in WORKING-STORAGE. Therefore, the file-status information in the CALLER gets overlaid, which can subsequently change the flow of the program.

- Programs using zoned decimal data (numeric with USAGE DISPLAY) with bad zone bits in numeric comparisons. In this example, byte 3 of VAR2 is x'40' that has zone bits x'4', which is invalid; all zone bits must be x'F'.

```
WORKING-STORAGE SECTION.
01 VAR1 PIC X(5) VALUE '00 0'.              <* Value x'F0F040F0'
   02 VAR2 REDEFINES VAR1 PIC 9(5).
. . .
   IF VAR2 = ZERO
      DISPLAY "EQUAL TO ZERO"
   ELSE
      DISPLAY "NOT EQUAL TO ZERO"
   END-IF.
```

  Results:

  – For V4 with NUMPROC(MIG) and V5.1 with OPT(0), the program displays "EQUAL TO ZERO"
  – For V4 with NUMPROC(PFD) or NUMPROC(NOPFD), and V5.1 with OPT(1) or OPT(2), the program displays "NOT EQUAL TO ZERO"

If your data doesn't always have the correct zone bits in zoned decimal data items, compile with the ZONEDATA(MIG) compiler option so that the zone bits will always be ignored.

Using object oriented COBOL or interoperating with C programs

Some programming languages, such as Java and C, expect division-by-zero operations to result in infinity. Others, such as PL/I and COBOL, expect division-by-zero operations to cause an exception. COBOL programs set the processor to run in a mode whereby division-by-zero operations cause an exception. If a COBOL program is object oriented and invokes a Java method or if a COBOL program interoperates with a C program, and if the Java or C program executes a division-by-zero operation, the program could terminate.

To avoid program termination, you can follow the instructions in the IGZXDIVZ sample to compile and link the condition handler into the SCEERUN data set and use the Language Environment runtime option USRHDLR(IGZXDIVZ) with the affected application.

ILBOABN0 considerations

The ILBOABN0 interface for requesting an ABEND in a COBOL environment can be called dynamically with Enterprise COBOL V5 and later versions. When called by a program compiled with Enterprise COBOL compiler, it will has the same result as calling CEE3ABD using ACTION code 1.

Your are strongly recommended to migrate and use the CEE3ABD interface, because the CEE3ABD interface provides extra flexibility to control the level of details provided in the CEEDUMP produced.

When your application is called by Enterprise COBOL programs, it might ABEND in an unexpected way if it has an older version of ILBOABN0 (before LE's SCEELKED) statically linked. To fix the unexpected ABEND, you can follow one of the advises below:

- Migrate to CEE3ABD.
- Relink your application with the REPLACE ILBOABN0 in the LINK step, against LE's SCEELKED.
- Change the COBOL program to use dynamic call for ILBOABN0.

Using DFSORT option NOBLKSET

The BLKSET option is the default when you invoke DFSORT. This allows DFSORT to use the efficient BLOCKSET techniques. When NOBLKSET is in effect, DFSORT falls back to use the conventional technique. The recommended setting is BLKSET.

DFSORT also uses the conventional technique in the following cases:

1. Use tape device for intermediate work storage. You can avoid this restriction by using disk device instead of tape. Intermediate storage is specified using SORTWKdd statements.
2. Use L5 in the RECORD statement of DFSORT OPTION control. L5 specifies the average record length. Instead of using L5, the same can be specified by using the AVGRLEN=n statement.

The use of DFSORT conventional technique is allowed by COBOL V4.2 or earlier versions. It is strongly recommended that programs upgrading to COBOL V5 or later versions take the opportunity to migrate away from the conventional technique of DFSORT.

To provide compatibility with COBOL V4.2 and earlier versions and to tolerate this usage in COBOL V5 or later versions, apply runtime LE PTFs UI67483(V2R2)/UI67485(V2R3)/UI67486(V2R4) and follow the instructions to set up the JCL when executing the program.

Note: Those runtime PTFs apply to AMODE 31 only. DFSORT conventional technique is not supported by COBOL programs running in AMODE 64.

Debug information changes with Enterprise COBOL Version 5 and Version 6

Programs compiled with Enterprise COBOL V5 or V6 will have different debug information than that of programs compiled with previous versions of the compiler.

IBM Enterprise COBOL Version 5 and Version 6 solves the dilemma of debugging information. In the past you had 2 choices:

- Have the debug data always with the executable at a cost of a large load footprint, or
- Have separate debug data but also have the challenge of keeping it synchronized with the application and finding it when needed.

Now you have the best of both worlds. With NOLOAD debug segments in the program object, the debug data does not increase the size of the loaded program, it always matches the executable and is always available so there is no need to search lists of data sets.

There have been changes to the TEST compiler option used to generate debuggable versions of your application and to the NOTEST option.

- When the TEST option is specified, DWARF debug information is included in the application module.
- If the SOURCE suboption is specified, the DWARF debug information includes the expanded source code, and the compiler listing is not needed by IBM Debug Tool. When the TEST(NOSOURCE) compiler option is specified, the generated DWARF debugging information does not include the expanded source code.
- You can use the NOTEST(DWARF) compiler option to include basic DWARF debugging information in the program object. You cannot debug such programs with Debug Tool, but you can get NOTEST optimization and still enable application failure analysis tools, such as CEEDUMP output and IBM Fault Analyzer.
- To have no debugging information in the program object, use the NOTEST(NODWARF) option.

With Enterprise COBOL V5 and V6, the diagnostic messages are not at the bottom of the listing. Take the following steps to get to the diagnostic messages part of the listing:

1. Type **F 'end of c'** on the command line (use the ISPF **FIND** command to find the header: End of compilation).
2. Press Enter.
3. (Optional) Press Page back.

The following changes apply only to V6:

- The allocation and management of WORKING-STORAGE SECTION have been changed in Enterprise COBOL V6. This does not affect the execution of the COBOL program. Tools or programs that need to locate the starting address of the WORKING-STORAGE SECTION might be affected. For details, see "WORKING-STORAGE SECTION changes" on page 171.
- Enterprise COBOL V6 uses interprocess communication (IPC) message queues. Therefore, if you compile in z/OS UNIX with cob2 and the compiler experiences an internal error and gets terminated with a KILL signal, you will need to query any message queues that are left over when the compiler is killed and remove the stale message queues. You can remove the stale message queues with the following z/OS UNIX commands:

  1. Enter **ipcs -q** to list queues.
  2. Find queues associated with your user ID.
  3. Enter **ipcrm -q** to delete queues.

  If you compile in z/OS batch, you do not have to remove stale message queues after a compiler error.

When debugging your COBOL programs, you will find that there have been a large number of improvements and behavior changes introduced with Enterprise COBOL V5 and V6. For details about

changes in debugging with IBM Debug Tool, see “Debug Tool changes with Enterprise COBOL Version 5 and Version 6” on page 208.

WORKING-STORAGE SECTION changes

The allocation and management of WORKING-STORAGE SECTION have been changed in Enterprise COBOL V6. This does not affect the execution of the COBOL program. Tools or programs that need to locate the starting address of the WORKING-STORAGE SECTION might be affected. You can use the following method to locate the WORKING-STORAGE in Enterprise COBOL V5 and V6 programs at run time.

To find the start of WORKING-STORAGE in COBOL V5 and V6, you need to know how to locate the PPA4 (Program Prologue Area 4) in a dump.

How to find the PPA4 (Program Prolog Area 4) in a dump?

1. Find the start of the program in the dump from the traceback.
2. At the starting address + x'0C' is an offset value. This is the offset to the PPA1 from the start of the program.
3. Starting address + PPA1 offset = PPA1.
4. Go there in the dump.
5. At PPA1 + x'04' is an offset value. This is the offset to the PPA2 from the start of the program.
6. Starting address + PPA2 offset = PPA2.
7. Go there in the dump.
8. At PPA2 + x'08' is an offset value. This is the offset to the PPA4 from the PPA2 address.
9. PPA2 + PPA4 offset = PPA4.
10. Go there in the dump. You are now at the PPA4.

Next, you need to know the layout of the PPA4.

PPA4 layout

For information about the layout of PPA4 and each PPA4 offset, length, and description, see COBOL V5+ 32-bit PPA4 layout in the *z/OS Language Environment Vendor Interfaces*.

Next, you need to know some terminology.

Terms to know

NORENT static area
This storage area is allocated in the executable for each program that was compiled with NORENT. A NORENT program’s WORKING-STORAGE will be located here.

LE’s writable static area (WSA)
Every COBOL V5 or V6 program object (executable) has this storage area.

RENT static area
This storage area is allocated inside the WSA for every program that is statically bound into the executable and compiled with RENT. Each program has their own RENT static area. A program’s WORKING-STORAGE may or may not be located here.

Program static area
This storage area is allocated outside of the WSA only if certain conditions are met. In those cases, the program’s WORKING-STORAGE will be located here, instead of in the RENT static area.

Next, you need to understand that there are three locations where WORKING-STORAGE can reside.

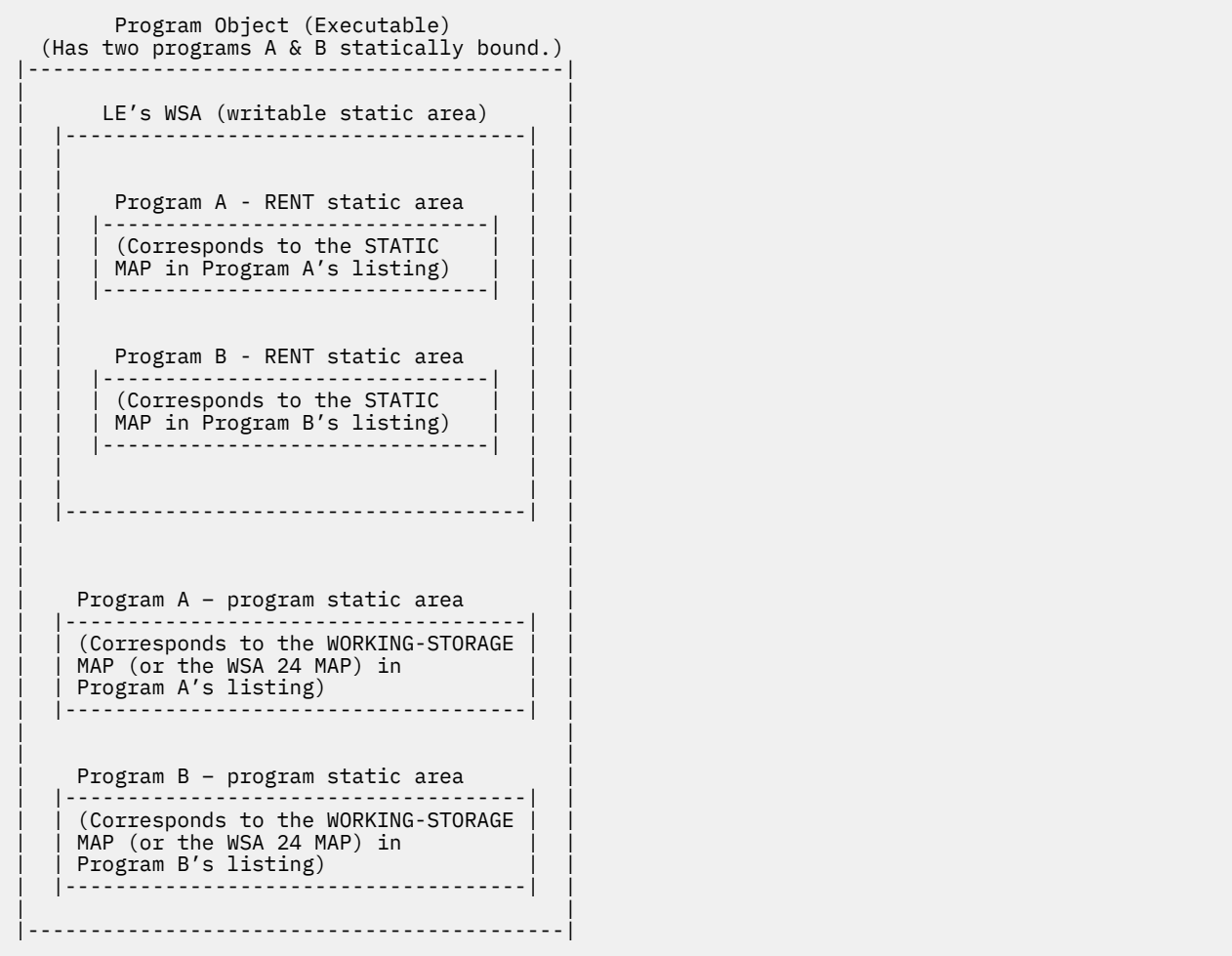
Explanation of the areas where WORKING-STORAGE can reside

There are three different locations where WORKING-STORAGE can reside:

- Inside the program object (executable). All programs compiled with the NORENT option have a NORENT static area reserved within the executable and WORKING-STORAGE resides here.
- All programs compiled with the RENT option have a RENT static area allocated inside LE's WSA (writable static area). WORKING-STORAGE could reside here.
- Instead of being located in the RENT static area, some COBOL V5 or later RENT programs have their WORKING-STORAGE allocated outside of LE's WSA, in an area called the program static area.

The rules for determining where WORKING-STORAGE resides are located in the next section.

The picture below shows how storage is laid out for RENT programs whose WORKING-STORAGE resides in the program static area:



Once you understand the three areas where WORKING-STORAGE could reside, you need to know how to determine where a program's WORKING-STORAGE actually does reside. For details, see *WORKING-STORAGE location* and *Layout of the Language Environment WSA, STATIC, PROGRAM STATIC, and User Working Storage* in IGZXAPI in the *z/OS Language Environment Vendor Interfaces*.

How to determine the area where WORKING-STORAGE is located?

Table 41. Area where WORKING-STORAGE is located

COBOL versions	Compiler options	Where is WORKING-STORAGE located?
COBOL V5	NORENT	In the program's NORENT static area
	RENT, DATA(31)	In the program's RENT static area inside the WSA
	RENT, DATA(24) or RENT, WSOPT[1]	In the program's program static area outside the WSA
COBOL V6 or later versions	NORENT	In the program's NORENT static area
	RENT, DATA(31) & SPANNED RECORDS (i.e. the WSOPT bit is OFF)[2]	In the program's RENT static area inside the WSA
	RENT, DATA(24) (i.e. the WSOPT bit is ON)[2]	In the program's program static area outside the WSA
	RENT, DATA(31) & NO SPANNED RECORDS (i.e. the WSOPT bit is ON)[2]	In the program's program static area outside the WSA

Notes:

1. In COBOL V5, there is a WSOPT compiler option. In COBOL V6, there is no longer a WSOPT compiler option, but rather a signature information bit for WSOPT that is automatically set by the compiler.
2. For SPANNED RECORDS, the WSOPT signature information bit is OFF. For NO SPANNED RECORDS, the WSOPT signature information bit is ON.
   - You can scan your programs for 'RECORDING MODE' and look for any files set to 'S' to determine if SPANNED RECORDS are used.
   - Another alternative is to check the signature information bytes in the listing for the WSOPT bit, which is signature byte 8, bit 3. For example, take the following from a listing:

     ```
     =X'001000000000'   INFO. BYTES 7-12
     ```

     Byte 8 is x'10', which is b'00010000'. Numbering the bits from left to right as 01234567, because bit 3 is on, WSOPT is on.

Once you know what area the WORKING-STORAGE resides in, then you will know how to find it.

How to find WORKING-STORAGE in a dump?

Table 42. How to find the PPA4, NORENT static area, LE's WSA, RENT static area, and program static area in a dump?

What to find?	How to find it in a dump?
PPA4	See the instructions above.
NORENT static area	The address is located in storage at <PPA4 + x'08'>
LE's WSA	The address is located in storage at <CEECAA (or R12) + x'1F4'>. This is called CEECAARENT in a dump.

Table 42. How to find the PPA4, NORENT static area, LE's WSA, RENT static area, and program static area in a dump? (continued)

What to find?	How to find it in a dump?
RENT static area	The address is located in storage at <The address in storage at CEECAA (or R12) + x'1F4'> + <the offset in the program's PPA4 + x'0C'>
Program static area	The address is located in storage at <The address in storage at CEECAA (or R12) + x'1F4'> + <the offset in the program's PPA4 + x'0C'> + <the offset in the program's PPA4 + x'10'>

Once you find these areas in a dump, then you can compare that to the compile listing.

In a COBOL listing:

- The STATIC MAP shows the layout of the RENT static area or the NORENT static area.
- The WORKING-STORAGE MAP or the WSA 24 MAP shows the layout of the program static area.

Use the LE vendor interface IGZXAPI to query the WORKING-STORAGE address

The COBOL-specific vendor interface routine, IGZXAPI, can also be used to query the WORKING-STORAGE address. With Enterprise COBOL V6.1, the LE vendor interface IGZXAPI is enhanced with new function code 8 to request information about the WORKING-STORAGE SECTION length and address for a COBOL program. The returned address corresponds to the STATIC MAP section in the COBOL compiler listing. Other information, such as the program name from PROGRAM-ID and signature information bytes (correspond to the "Compiler Options and Program Information Section" of the compiler listing), are also returned.

This enhancement is introduced in COBOL Runtime LE PTF for APAR PI49703. For more information about IGZXAPI, see IGZXAPI in the *z/OS Language Environment Vendor Interfaces*.

related tasks
Reading LIST output (*Enterprise COBOL Programming Guide*)

related references
Example: Program prolog areas (*Enterprise COBOL Programming Guide*)
Common interfaces and conventions (*z/OS Language Environment Vendor Interfaces*)

Chapter 18. Adding Enterprise COBOL Version 5 or Version 6 programs to existing COBOL applications

When you add an Enterprise COBOL V5 or V6 program to an existing application, you are either recompiling an existing program with Enterprise COBOL V5 or V6 or including a newly written Enterprise COBOL V5 or V6 program.

Note: You should use this Migration Guide only if you have completed the runtime migration to Language Environment. This means that the following conditions have been met:

- The Language Environment data set SCEERUN is installed in LNKLST or LPALST.
- There are no instances of COBLIB, VSCLLIB, or COB2LIB in LNKLST or LPALST.
- There are no instances of COBLIB, VSCLLIB, or COB2LIB in JCL STEPLIB or JOBLIB statements or in CICS startup JCL.
- All statically bound runtime library routines for programs that are compiled with NORES have been REPLACEd with routines from Language Environment.
- IGZEBST bootstrap modules for VS COBOL II programs that are compiled with RES were either linked with the VS COBOL II runtime version of IGZEBST that has APAR PN74000 applied, or IGZEBST was REPLACEd with IGZEBST from Language Environment.

If these steps have not been completed, please first complete all runtime migration activities in the *Enterprise COBOL V4.2 Compiler and Runtime Migration Guide* at http://publibfp.dhe.ibm.com/epubs/pdf/igy3mg50.pdf prior to following the steps here.

When you add Enterprise COBOL V5 or V6 programs to your existing applications, you have the ability to:

- Upgrade your existing programs incrementally, as your shop's needs dictate
- Use Language Environment condition handling

If you have a program object that includes a COBOL program linked with C, C++, or Enterprise PL/I programs, the program object has slightly different behavior when the COBOL program is changed to Enterprise COBOL V5 or V6. This occurs when such program objects are fetched (that is, using either C fetch or PL/I fetch) more than once. In the subsequent fetches, external and static variables in these other LE languages may retain their last used state, following COBOL rules, instead of getting their initial values. With prior versions of COBOL linked in, the C, C++ and PL/I programs would retain C/C++ or PL/I behavior.

Using Language Environment with Enterprise COBOL V5 or V6 and VS COBOL II programs

When running a mixture of VS COBOL II programs and Enterprise COBOL V5 or V6 programs:

- A current version of IGZEBST is required:
  - For statically CALLed programs in CICS, you will need to replace IGZEBST in applications with VS COBOL II programs with the IGZEBST from LE with the PTFs for APAR PI33330 installed.

    Note: IGZEBST from LE with the PTFs for APAR PI33330 installed can also be used with any COBOL programs VS COBOL II and later without COBOL V5 or V6 programs.
  - For dynamically CALLed CICS programs, you just need to install the PTFs for APAR PI25079 on SCEERUN.

    Note: For statically CALLed programs in non-CICS, performance will be better if you replace IGZEBST in applications with VS COBOL II programs with the IGZEBST from LE with the PTFs for APAR PI33330 installed. It is not required. There is no issue with IGZEBST for dynamically called programs in non-CICS for calling VS COBOL II programs from COBOL V5 or V6 programs.

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- A current version of CEEBETBL, the Language Environment externals table, is required. If you are including object code bound some time ago with your new COBOL V5 or V6 object code, you might be indirectly including an old version of CEEBETBL.

  If the length of CEEBETBL you bind is less than x'28' (or the length of the CEEBETBL in the current SCEELKED library), it is old and needs to be replaced, or you will encounter runtime abends or a terminating runtime message.

  If you rebind older object code with COBOL V5 or V6 as part of your migration, it is recommended that you specifically INCLUDE a current copy of CEEBETBL prior to INCLUDEs of the older object code, taking care that you do not inadvertently make CEEBETBL the entry point.

AMODE restrictions with Enterprise COBOL Version 5 or Version 6 programs

AMODE 24 execution of Enterprise COBOL V5.2 or V6 programs is supported in all the same cases as in earlier Enterprise COBOL compilers.

Note: To run COBOL V5 or V6 programs with AMODE 24, you must compile all COBOL programs with Enterprise COBOL V5.1.1 or later versions; or Enterprise COBOL V4.2 or earlier versions. If any component of a program object is compiled with Enterprise COBOL V5.1.0, the program object must run in AMODE 31. COBOL programs that run with AMODE 24 must be linked with the binder option RMODE(24).

Run time differences with Enterprise COBOL Version 5 or Version 6 programs

You cannot mix Enterprise COBOL V5 or V6 programs with:

- OS/VS COBOL programs. You must migrate to Enterprise COBOL. To find any OS/VS COBOL programs you can:
  - Use the LMA tool of Debug Tool to scan load libraries for OS/VS COBOL programs
  - Use the free COBOL Analyzer from http://cbttape.org/cbtdowns.htm to scan load libraries for OS/VS COBOL programs. It is named as *File # 321 COBOL Analyzer from Roland Schiradin & post processor* on that web page.
  - Install the fix for APAR PM86742 to your Language Environment and look for a warning message about detected OS/VS COBOL programs at run time
- VS COBOL II NORES programs. You must migrate to Enterprise COBOL.

The `ILBOABN0` interface for requesting an ABEND in a COBOL environment can be called dynamically with Enterprise COBOL V5 and later versions. When called by a program compiled with Enterprise COBOL compiler, it will have the same result as calling `CEE3ABD` using ACTION code 1.

Your are strongly recommended to migrate and use the `CEE3ABD` interface, because the `CEE3ABD` interface provides extra flexibility to control the level of details provided in the `CEEDUMP` produced.

When your application is called by Enterprise COBOL programs, it might ABEND in an unexpected way if it has an older version of `ILBOABN0` (before LE's SCEELKED) statically linked. To fix the unexpected ABEND, you can follow one of the advises below:

- Migrate to `CEE3ABD`.
- Relink your application with the REPLACE `ILBOABN0` in the LINK step, against LE's SCEELKED.
- Change the COBOL program to use dynamic call for `ILBOABN0`.

RMODE restrictions with Enterprise COBOL Version 5 or Version 6 programs

- Reentrant programs may be RMODE 24 or RMODE ANY
- Non-reentrant programs must be RMODE 24.

AMODE and RMODE considerations

Static calls between AMODE 24 and AMODE 31 programs are not supported by Enterprise COBOL V5.1.0 programs. Static calls between AMODE 24 programs and Enterprise COBOL V5.1.1 and later programs are supported for the cases where AMODE 24 is supported for Enterprise COBOL V5.1.1 and later programs.

Note: There was not an official release of Enterprise COBOL called V5.1.1, but the modification level of V5.1.0 was updated by service to show that AMODE 24 capability was added to that service level of the compiler.

In addition, NORENT programs can no longer reside above the line. The following diagram shows the types of calls that can be dynamic or static and those that can only be dynamic. It also shows configurations of data and program location with respect to the 16 MB line.

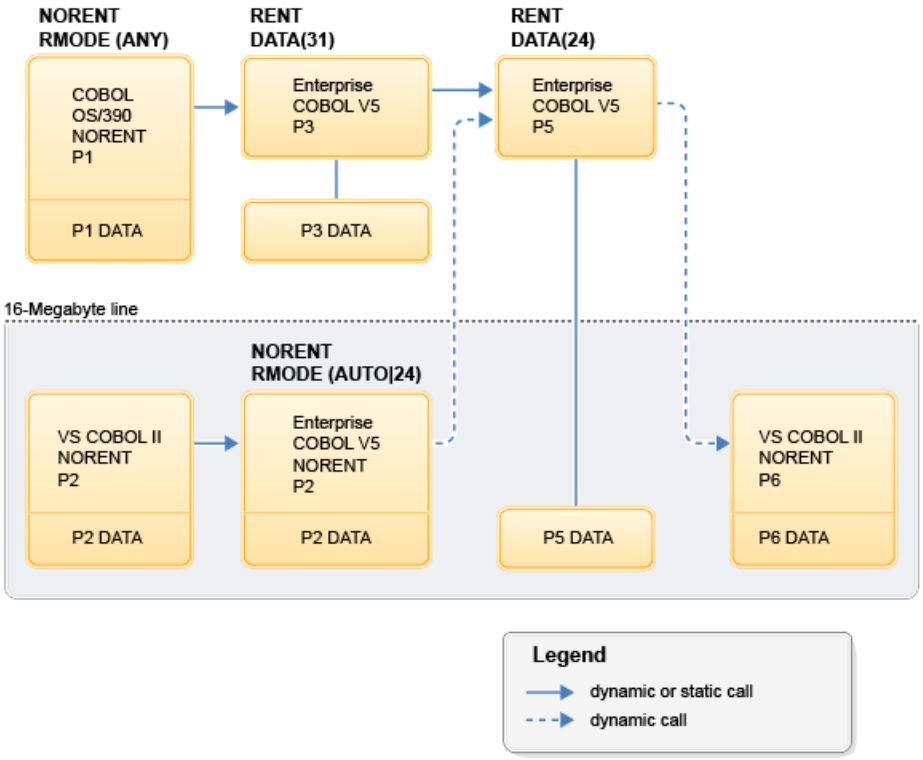

Figure 5. Valid dynamic and static calls between different AMODE and RMODE COBOL programs

Note: For other AMODE 24 programs, no calls are allowed between Enterprise COBOL V5 or V6 programs and either OS/VS COBOL or VS COBOL II NORES programs.

Part 5. Enterprise COBOL migration and other IBM products

Enterprise COBOL V5 and V6 gives you access to CICS, DB2, IMS and other data and transactional systems. It can also be used with Debug Tool.

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Chapter 19. Debug tool

Debug Tool is a program analyzer that runs within Language Environment and supports a number of high-level languages, including Enterprise COBOL.

Debug Tool provides support for VS COBOL II Release 3.0 and all subsequent COBOL compilers.

Initiating Debug Tool

When you use Debug Tool, the application program starts first and the Language Environment TEST runtime option controls the invocation of Debug Tool.

You can also invoke Debug Tool directly from your application by using the Language Environment callable service CEETEST. A brief description of these two methods follows.

TEST runtime option

The Language Environment TEST runtime option is used to determine if Debug Tool is to be invoked when an application program is run with Language Environment. Invocation can be immediate or deferred, depending on the option subparameters.

The IBM-supplied default is NOTEST. This specifies that Debug Tool is not to be initialized to process the initial command string nor is it to be initialized for any program condition that might arise when you run the program. However, if debugging services are needed, you can invoke Debug Tool by using the library service CEETEST.

For detailed information about the Language Environment TEST option subparameters and suboptions, see the *Language Environment Programming Reference*.

CEETEST

Language Environment provides callable service CEETEST to allow Debug Tool to gain control, and to specify a string of commands to be passed to Debug Tool. Calling this service, causes Debug Tool to be initialized and invoked. (If Debug Tool is already initialized, then this re-entry is similar to a breakpoint.)

When using CEETEST to invoke Debug Tool, the string parameter containing a command list is optional. If you do use a command list, the commands are passed to Debug Tool and executed. If the command list does not contain any GO, GOTO, STEP, or QUIT commands, commands will then be requested from the terminal or the primary commands file. If the GO command is encountered at any point (command list, terminal, or commands file), Debug Tool returns to the application program at the point following the service call and your program continues running.

For detailed information and examples of the Language Environment callable service CEETEST, see the *Language Environment Programming Reference*.

Debug information changes with Enterprise COBOL Version 5 and Version 6

Programs compiled with Enterprise COBOL V5 or V6 will have different debug information than that of programs compiled with previous versions of the compiler.

IBM Enterprise COBOL Version 5 and Version 6 solves the dilemma of debugging information. In the past you had 2 choices:

- Have the debug data always with the executable at a cost of a large load footprint, or
- Have separate debug data but also have the challenge of keeping it synchronized with the application and finding it when needed.

Now you have the best of both worlds. With `NOLOAD` debug segments in the program object, the debug data does not increase the size of the loaded program, it always matches the executable and is always available so there is no need to search lists of data sets.

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There have been changes to the TEST compiler option used to generate debuggable versions of your application and to the NOTEST option.

- When the TEST option is specified, DWARF debug information is included in the application module.
- If the SOURCE suboption is specified, the DWARF debug information includes the expanded source code, and the compiler listing is not needed by IBM Debug Tool. When the TEST(NOSOURCE) compiler option is specified, the generated DWARF debugging information does not include the expanded source code.
- You can use the NOTEST(DWARF) compiler option to include basic DWARF debugging information in the program object. You cannot debug such programs with Debug Tool, but you can get NOTEST optimization and still enable application failure analysis tools, such as CEEDUMP output and IBM Fault Analyzer.
- To have no debugging information in the program object, use the NOTEST(NODWARF) option.

With Enterprise COBOL V5 and V6, the diagnostic messages are not at the bottom of the listing. Take the following steps to get to the diagnostic messages part of the listing:

1. Type **F 'end of c'** on the command line (use the ISPF **FIND** command to find the header: End of compilation).
2. Press Enter.
3. (Optional) Press Page back.

The following changes apply only to V6:

- The allocation and management of WORKING-STORAGE SECTION have been changed in Enterprise COBOL V6. This does not affect the execution of the COBOL program. Tools or programs that need to locate the starting address of the WORKING-STORAGE SECTION might be affected. For details, see "WORKING-STORAGE SECTION changes" on page 171.
- Enterprise COBOL V6 uses interprocess communication (IPC) message queues. Therefore, if you compile in z/OS UNIX with cob2 and the compiler experiences an internal error and gets terminated with a KILL signal, you will need to query any message queues that are left over when the compiler is killed and remove the stale message queues. You can remove the stale message queues with the following z/OS UNIX commands:

  1. Enter **ipcs -q** to list queues.
  2. Find queues associated with your user ID.
  3. Enter **ipcrm -q** to delete queues.

  If you compile in z/OS batch, you do not have to remove stale message queues after a compiler error.

When debugging your COBOL programs, you will find that there have been a large number of improvements and behavior changes introduced with Enterprise COBOL V5 and V6. For details about changes in debugging with IBM Debug Tool, see "Debug Tool changes with Enterprise COBOL Version 5 and Version 6" on page 208.

Debug Tool changes with Enterprise COBOL Version 5 and Version 6

Programs compiled with Enterprise COBOL Version 5 and Version 6 will have many debugging advantages over programs compiled with previous versions of COBOL when debugged with Debug Tool.

For details about Debug Tool interfaces with COBOL applications, see the documentation available at: http://www.ibm.com/software/awdtools/debugtool/library/.

Most of these differences apply to all debugging modes: full screen, batch, and remote. Complete details of Debug Tool commands are described in *Debug Tool References and Messages*.

DESCRIBE ATTRIBUTES commands

The PIC string shown in Debug Tool appears as it is specified in the source and not normalized as it was prior to Enterprise COBOL Version 5.

Level members are shown as written in the source code and not normalized as they were prior to Enterprise COBOL Version 5.

There are clearer data descriptions. For example, you could now see:

```
 S9(5) SIGN LEAD SEP DISP
```

instead of

```
S9(5) DSLS
```

`DESCRIBE ATTRIBUTES` shows the length and type of symbolic characters with Enterprise COBOL V5 and V6. With prior versions of the compiler, only zeros were shown.

For condition names (level 88) , an address of `000000000` is no longer shown.

There is more compact and clearer output for an array and array element. For example:

- `INDEX` is displayed for type instead of `IX`
- The level 00 is not displayed
- There is no repetition of the type for each array element, the element type is shown only once.

Debug Tool no longer displays an address for `DESCRIBE ATTRIBUTES` of a register, such as `%GPR0`, because registers do not have addresses.

LIST command and AUTOMON output

LIST or AUTOMON of tables always shows the new Debug Tool, V12.1 option `SET LIST BY SUBSCRIPT` format.

When listing a record or group that contains a zero length ODO table, any data items that follow that table within the record or group are displayed. Previously, they were not.

No message is displayed for program entry when AUTOMONITOR is active.

Debug Tool variables of category Alphanumeric will be displayed within a pair of apostrophes. For example, if you execute `LIST %SYSTEM`, you will now see `%SYSTEM = 'MVS'`.

The output of `LIST %HEX` has improved. The output of `LIST %HEX( var )` no longer shows `%HEX` in the output. Now the output is `SBIN0_5 = X'00003039'` instead of `%HEX ( SBIN0_5 ) = X'00003039'`. The `X'` indicates a hex representation.

The output of `LIST varname` no longer includes the block qualification. For example, the result could be `varname = 5` instead of `block_name ::>varname = 5`.

The output of the `LIST NAMES` command now displays 01 and 77 level data items. In previous versions, all data items, including subordinate data items within a record or group hierarchy were shown. To see the entire expanded structure, use `DESCRIBE ATTRIBUTES varname`.

`LIST NAMES LABEL` now only displays labels in active blocks in nested programs. Previously, all labels for the program were displayed regardless of which block you were in.

`LIST TITLED` output for nested programs is modified. Now only variables in active blocks are displayed.

The formatted display of an array after the `LIST` command has changed for COBOL. When the elements of an array are groups, all members of that group are listed together for a given element, followed by the members of the group for the following element, and so on. Previously, a given member would be listed across all array elements, and then the next member of the group would be listed across all array elements. The keyword SUB is no longer displayed.

AUTOMONITOR output shows `ADDRESS OF` *`var`* and `LENGTH OF` *`var`* as single references.

AT APPEARANCE and LIST NAMES CUS has changed. Debug Tool is aware of cus. For example, if the main program object in your application is MYMAIN, the main program is MYMAIN, and the second program in the program object is MYSUB1, you can stop at MYMAIN::>MYMAIN 1, you will see the following new behaviors:

- When you issue LIST NAMES CUS, the display shows the program object MYMAIN, and both the main program MYMAIN and the subprogram MYSUB1.
- When you issue an AT APPEARANCE breakpoint for MYSUB1, the breakpoint is accepted.

Enterprise COBOL V5 and V6 assigns a save area for each nested program. You can see these save areas with commands, such as LIST CALL.

MOVE, COMPUTE, IF commands

The MOVE and COMPUTE commands in Debug Tool have expanded to allow the same data types as the compiler for receivers and senders. This enhancement removes previous restrictions on the use of those commands.

The IF command has been expanded. Allowable comparisons for relational conditions are expanded in Debug Tool with Enterprise COBOL V5 and V6. The allowable comparison for relational conditions (involving data items, literals, and figurative constants) are implemented according to the Enterprise COBOL Language Reference.

Index changes also improve the use of these commands:

- There is relative subscripting of index names with Enterprise COBOL V5 and V6.
- To conform to COBOL language rules, you can no longer index an array with index data items.
- To conform to COBOL language rules, you can no longer use IN or OF qualifiers for an index name.

STEP command

You can STEP and set breakpoints for the WHEN phrase of EVALUATE.

STEP OVER with PERFORM is now supported.

Support for COBOL types

Debug Tool now supports the correct maximum value in all binary data types. For example, an 8-byte, unsigned COMP-5 data item can contain a maximum value of 18,446,744,073,709,551,615, which is 20 digits.

INDEX (IX) and Arrays

With Enterprise COBOL V5 and V6, you cannot use a data item of type INDEX as a subscript. For example, if you have defined a data item as 77 IXDI1 USAGE IS INDEX, you cannot execute LIST ARR(IXDI1).

Index names are in the debug infomation in the same way as top-level (01 or 77) data items, although index names do not have level numbers. In earlier versions of Enterprise COBOL, index names are shown in the debug information along with table elements, like children of the array to which they belong. In Enterprise COBOL V5 and V6, index names are not shown when table information is listed, they are only shown when listed explicitly by name. This change is reflected in the output from the following commands:

- LIST NAMES
- LIST TITLED
- DESCRIBE ATTRIBUTES (with no argument)

With Enterprise COBOL V5 and V6, you cannot qualify an INDEX name using the name of the array to which it belongs. You also can no longer qualify a containing group or record name, as if it were a

subordinate data item. For example IX3 of REC1. This was possible with earlier versions of Enterprise COBOL.

Enterprise COBOL V5 and V6 supports an increment (+) or decrement (-) operator as part of the INDEX of an array. Enterprise COBOL V4 did not support this.

With Enterprise COBOL V5 and V6 programs, Debug Tool defaults to 1 if you do not specify the index of an array. With previous versions, Debug Tool listed all members of the array. If the array is declared as shown below, and you issue LIST X, Debug Tool only displays the first element in the array ARR(1) as LIST X(1). LIST ARR(n) will show X and Y for the specified index, and LIST ARR will show X and Y for all members.

```
05 ARR OCCURS 10
10 X PIC 99
10 Y PIC 99
```

For previous versions of Enterprise COBOL, when you list a single element of an array, the format of the output is as if it is an array of size 1. For Enterprise COBOL V5 and V6, the output is the same as a variable of the given type, not as an array of size 1.

Other changes

The AT CALL entry name is not supported for Enterprise COBOL V5 and V6.

Several changes are implemented for the DESCRIBE CUS command. These changes are:

- New compiler name: IBM COBOL 5.2.0
- Time Stamp is displayed: * Compiler: IBM COBOL 5.2.0 2014/11/27 13:08
- There have been many changes to compiler options.
- The type of linkage is displayed: * Its linkage is Language Environment FastLink. This is the default linkage for the compiler.

Line numbering with the NUM option and sequence of programs is different with Enterprise COBOL V5 and V6. In prior versions, a batch compile (sequence of programs in a single source) with NUM and NOLIB the line numbers start over in the second program. With Enterprise COBOL V5 and V6, the NOLIB option has been removed. The compiler behaves as though LIB is always enabled and therefore the second program in a sequence has line numbers that continue from those of the first program.

Display of National data items will include N with Enterprise COBOL V5 and V6. For example: listing of 01 nat pic N(5) value "abcde" national is NAT= N'abcde' V4: NAT = 'abcde'.

The number of digits displayed in arithmetic expressions is different with Enterprise COBOL V5 and V6. The number of digits resulting from arithmetic operations are defined in the Enterprise COBOL Programming Guide.

Sign is handled differently with Enterprise COBOL V5 and V6. The result of an arithmetic expression will have a sign if either operands are signed. In earlier versions, the sign of the result depended on the answer. The exception is the case of results from subtraction and unary minus which are always signed to guarantee correctness of the result.

If the program being debugged was compiled with the QUALIFY(EXTEND) option, Debug Tool will apply the new name resolution rules in any command that references a data item, for example, LIST, MOVE, COMPUTE, and other commands. This makes Debug Tool consistent with the compiler when it comes to resolving data item references.

Debug Tool has been updated to handle data items that have been defined with the VOLATILE keyword, allowing such data items to be used in all of the same commands as nonvolatile data items.

Full Screen Mode changes with Enterprise COBOL Version 5 and Version 6

These changes apply to the Full Screen Mode commands and functions.

The following commands are different between Enterprise COBOL V5 and V6 programs and those of previous compilers:

- `PANEL LISTINGS` and `PANEL SOURCES`. Both commands show the program name.
- `SET DEFAULT LISTINGS`. The source listing information is embedded in the object for COBOL V5 and V6 programs.
- `SET DYNDEBUG OFF`. COBOL V5 and V6 compiler does not support compiled-in hooks. You must have `SET DYNDEBUG ON` if you want to step or set breakpoints in a COBOL V5 or V6 program.
- `SET LIST BY SUBSCRIPT`. With COBOL V5 and V6 programs, Debug Tool displays arrays as if `LIST BY SUBSCRIPT ON` is always enabled. With Enterprise COBOL V4 programs, the default display on an array was `SET LIST BY SUBSCRIPT OFF`.
- `SET PROGRAMMING LANGUAGE`. The programming language for COBOL V5 and V6 is COBOL.
- `SET SOURCE`. The source listing information is embedded in the object. An error message is displayed when you issue this command for a COBOL V5 or V6 program.

Debug Tool changes for remote mode with Enterprise COBOL Version 5 and Version 6

This section lists changes that apply to the remote debugger interfaces.

The changes are:

- With Enterprise COBOL V5 and V6, nodes in the tree of a monitored expression show the level number, for example, `05 VAR1`. With Enterprise COBOL V4, it showed `VAR1`.
- With Enterprise COBOL V5 and V6, `PIC` is shown as part of the type information, for example, `05 SBIN1 PIC 99 COMP`.
- With Enterprise COBOL V4, array type was shown as ARRAY. With Enterprise COBOL V5 and V6, it is shown by using appropriate COBOL terminology such as, `9 COMP OCCURS 2`. This matches the behavior of batch/Full Screen Mode.
- With Enterprise COBOL V5 and V6, record types are shown as known to the language. For example, `ALPHANUMERIC GROUP` or `NATIONAL GROUP`. With Enterprise COBOL V4, record types were shown as CHARACTER, STRUCT, or ARRAY
- With programs compiled by Enterprise COBOL V5 and V6, array subscripts can be separated by a semicolon. This was not allowed for programs compiled with Enterprise COBOL V4 and is not allowed in full screen mode.
- With programs compiled by Enterprise COBOL V5 and V6, nested programs will now show in the Debug View.
- COBOL language provides a DECLARATIVES section to handle exceptional conditions. With Enterprise COBOL V5 and V6, when a DECLARATIVES section gets control in a Debug Tool session, the debug view shows a separate frame for it.

Chapter 20. CICS conversion considerations

To run COBOL V5 and later programs under CICS, you need to be familiar with the required CSD and DFHRPL updates. You should also be familiar with compiler options for CICS. Finally, you may want to migrate to the integrated CICS translator.

Consider the following topics:

- "CSD setup differences with Enterprise COBOL V5 and V6" on page 213
- "DFHRPL setup differences with Enterprise COBOL V5 and V6" on page 213
- "Compiler options for programs that run under CICS" on page 214
- "Migrating from the separate CICS translator to the integrated translator" on page 216
- "Static calls from COBOL V5 or V6 programs to VS COBOL II programs under CICS" on page 218

OS/VS COBOL restriction

OS/VS COBOL programs no longer run under CICS. Any OS/VS COBOL programs to be run under CICS must be upgraded to Enterprise COBOL.

DFHRPL setup differences with Enterprise COBOL V5 and V6

To run programs under CICS, consider the DFHRPL setup differences.

You must update the JCL that starts CICS. Include the hlq.SEQAMOD data set of Debug Tool if debugging in the region, and the Language Environment runtime libraries (SCEECICS, SCEERUN, and if required by your applications, SCEERUN2) in the DFHRPL concatenation. The DFHRPL concatenation is in the CICS region startup JCL.

If you are running Enterprise COBOL V5.1 or later programs compiled with the TEST compiler option under CICS, except when using TEST(...,SEPARATE) exclusively, you must also add system libraries MIGLIB and SIEAMIGE in the DFHRPL DD concatenation to support binder access to debug segments in the applications.

For the binder to access the debug segments, the CICS region userid needs read access to the libraries in the DFHRPL DD concatenation. Failure to provide the read access will produce the following diagnostic messages:

```
IEW2716S D801 OPEN FAILED FOR DDNAME DFHRPL.
IEW2146S 02D9 CONFLICTING INPUT SPECIFICATIONS ON AN INCLUDE CALL.
```

CSD setup differences with Enterprise COBOL V5 and V6

With the following CICS TS versions, CICS uses *system autoinstall* to install the required Enterprise COBOL V5 and V6 runtime modules so you do not need to update the CICS System Definition (CSD) file:

- CICS TS V5.4 and later
- CICS TS V5.3 with the PTF for APAR PI60389 applied
- CICS TS V5.1 and V5.2 with PTFs for APARs PI60388 and PI73184 applied

Without those PTFs applied or for earlier CICS TS versions, you must update the CICS CSD file to include the modules required by the Enterprise COBOL V5 and V6 runtime that will be used under CICS. The member CEECCSD in the Language Environment SCEESAMP data set provides an example of this definition file and can be used to build the CICS CSD file.

You can also manually add the following lines to your existing CSD file if you are not at a CICS level that supports autoinstall and choose not to use the CEECCSD example:

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```
DEFINE PROGRAM(CEEEV004) GROUP(CEE)
DEFINE PROGRAM(IGZXLPKA) GROUP(CEE)
DEFINE PROGRAM(IGZXD24)  GROUP(CEE)
DEFINE PROGRAM(IGZXDMR)  GROUP(CEE)
DEFINE PROGRAM(IGZLLIBV) GROUP(CEE)
DEFINE PROGRAM(IGZXLPKC) GROUP(CEE)
DEFINE PROGRAM(IGZXLPIO) GROUP(CEE)
DEFINE PROGRAM(IGZXAPI)  GROUP(CEE)
DEFINE PROGRAM(IEWBNDD)  GROUP(CEE)
DEFINE PROGRAM(IEWBIND)  GROUP(CEE)
DEFINE PROGRAM(CDAEEDE)  GROUP(CEE)
DEFINE PROGRAM(IGZXLPKB) GROUP(CEE)
DEFINE PROGRAM(IGZXLPKD) GROUP(CEE)
DEFINE PROGRAM(IGZXLPKE) GROUP(CEE)
DEFINE PROGRAM(IGZXLPKF) GROUP(CEE)
DEFINE PROGRAM(IGZXLPKG) GROUP(CEE)
DEFINE PROGRAM(IGZXPK2) GROUP(CEE)
DEFINE PROGRAM(IGZUOPT) GROUP(CEE)*
DEFINE PROGRAM(IGZXCDA) GROUP(CEE)
```

The IGZ* and CEE* modules are contained in the SCEERUN data set.IEWBNDD is contained in SYS1.SIEAMIGE.

IEWBIND is contained in SYS1.MIGLIB (and possibly LPA).

*The IGZUOPT module is not included in SCEERUN by default. IGZUOPT is an optional module that can be created as needed by using the sample JCL members IGZ1OPT, IGZ2OPT, IGZ3OPT, or IGZ4OPT in SCEESAMP. IGZUOPT is also not included in the SCEESAMP(CEECCSD) sample. If in use, it can be added to SCEESAMP(CEECCSD).

Related tasks
Controlling suppress of OS/VS COBOL warning messages (IGZ2OPT)
Requesting QSAM buffer above the line (IGZ3OPT)
Controlling initiation of QSAM buffer (IGZ4OPT)

Compiler options for programs that run under CICS

Table 43 on page 215 lists the compiler options for Enterprise COBOL programs that run under CICS.

Table 43. Compiler options for programs that run under CICS

Compiler options	Comments

CICS	The CICS compiler option enables the integrated CICS translator capability. The CICS option must be specified if the source program contains CICS statements and has not been processed by the separate CICS translator.
	
	The CICS option requires that the NODYNAM and RENT options also are in effect. Enterprise COBOL forces on these options if DYNAM, or NORENT are specified at the same level as the CICS option.
	
	The CICS translator option COBOL3 is recommended, although COBOL2 is still supported.
	
	Choose the COBOL2 option if you are retranslating old programs that require the use of temporary variables. In particular, note that the use of temporary variables might circumvent errors that would normally occur when an argument value in a program is incorrectly defined. The COBOL2 option provides declarations of temporary variables. Because of this feature, incorrect definitions of argument values might be present, but not noticeable at run time, in programs that were translated with COBOL2. Translating these programs with the COBOL3 option can reveal these errors for the first time.
	
	For example, suppose you coded:
	
	`EXEC CICS LINK PROGRAM('XXXXXXX')`
	`COMMAREA(WS-COMMAREA)`
	`LENGTH('1000')`
	`END-EXEC.`
	
	The length is supposed to be a binary halfword but because it is enclosed in quotation marks, it is a character string. With COBOL3 the character string will be passed directly to CICS on the CALL and will result in an error. With the COBOL2 option the length will be moved to an intermediate variable and COBOL will convert it from character string to binary halfword as part of the move. To assist with migration to the newer releases of CICS, you can use the COBOL2 option to continue to circumvent errors in the programs, rather than correcting them.
	
	If the NOCICS option is in effect, any CICS statements found will be flagged with S-level diagnostics and discarded.

DBCS	The DBCS option is the default for Enterprise COBOL. It might cause problems for CICS programs if you are using the COBOL2 CICS translator option. The fix is to use the COBOL3 translator option.
NODYNAM	NODYNAM is required for programs translated by the CICS translator because the CICS command-level stub cannot be dynamically called. **Note:** Dynamic calls are supported under CICS by the use of the CALL identifier format of the CALL statement, or by the use of the >>CALLINTERFACE DYNAM directive.
RENT	RENT is required for CICS programs. RENT causes the compiler to produce reentrant code and allows you to place the COBOL modules in the LPA (Link PackAarea) or ELPA (Extended Link Pack Area) and thus shared among multiple address spaces under CICS. Also, the modules cannot be overwritten, since the LPA and ELPA are read-only storage.

Table 43. Compiler options for programs that run under CICS (continued)

Compiler options	Comments
TRUNC	Use TRUNC(OPT) for CICS programs that contain EXEC CICS commands, if the program uses binary data items in a way that conforms to the PICTURE and USAGE clause for them. Use TRUNC(BIN) if your program uses binary data items in a way that does not conform to the PICTURE and USAGE clause for them. For example, if a data item is defined as PIC S9(8) BINARY and might receive a value greater than eight digits, use TRUNC(BIN). You can also use TRUNC(OPT) and redefine specific items as COMP-5 to improve runtime performance for the whole program.

For a full list of CICS translator options, see Defining translator options in the *Developing CICS Applications*.

Migrating from the separate CICS translator to the integrated translator

The separate CICS translator has not been updated for newer COBOL language such as floating comment delimiters, JSON GENERATE, and compiler directives. To use the latest features of the COBOL compiler, use the integrated CICS translator.

When you migrate COBOL applications to use the integrated CICS translator:

- Delete the separate translation step from the compile process.
- Change the XOPTS translator option to the CICS compiler option. The suboptions string must be delimited with quotes or apostrophes. For example, a program to be translated by the separate CICS translator might have a CBL statement like this:

```
CBL TEST(NOEJPD), XOPTS(LINKAGE,SEQ,SP)
```

  For the integrated CICS translator it must be changed to this:

```
CBL TEST(NOEJPD), CICS('LINKAGE,SEQ,SP')
```

- Move all CBL/PROCESS statements to the first lines of the source program. The integrated CICS translator does not accept comment lines preceding a CBL/PROCESS statement. The source program must conform to Enterprise COBOL rules.
- Check if you have nested programs that redefine DFHCOMMAREA. The integrated translator will not generate declarations of DFHCOMMAREA or DFHEIBLK in nested programs. DFHCOMMAREA and DFHEIBLK declarations are generated in the outermost program with the GLOBAL attribute specified. COBOL programs that depend on these generated declarations within nested programs require source changes.

Integrated CICS translator

An integrated translator eliminates the separate translation step for COBOL programs that contain CICS statements.

With the integrated translator, the COBOL compiler handles both native COBOL and embedded CICS statements in the source program. When CICS statements are encountered, the compiler interfaces with the integrated CICS translator. The integrated CICS translator takes appropriate actions and then returns to the compiler indicating what native language statements to generate.

Although the separate CICS translator is still supported in Enterprise COBOL, use of the integrated CICS translator is recommended. The integrated CICS translator improves usability and offers the highest level of functionality. The benefits of using the integrated CICS translator include:

- Enhancements in interactive debugging of COBOL applications with Debug Tool. The application can be debugged at the original source level, instead of at the level of the expanded source produced by the CICS translator.
- EXEC CICS or EXEC DLI statements can reside in copybooks, eliminating the need to translate them with an external translator before compilation.
- There is no longer a need for an intermediate data set to hold the translated version (before the program has been compiled) of the source program.
- There is only one output listing instead of two.
- Using nested programs that contain EXEC CICS statements is simplified. DFHCOMMAREA and DFHEIBLK are generated in the outermost program with the GLOBAL attribute specified on the PROCEDURE DIVISION USING of nested programs.
- Nested programs that contain EXEC CICS statements can be held in separate files and included through a COPY statement.
- REPLACE statements can now affect EXEC CICS statements.
- Binary fields in CICS control blocks are generated with USAGE COMP-5 instead of BINARY. Thus, there is no longer a dependency on the setting of the TRUNC compiler option. Any setting of the TRUNC option can be used with CICS applications that use the integrated translator, subject only to the requirements of the user-written logic within the application.

Note: CICS V5.2 and later versions support the EXCI translator option with the integrated CICS translator. In earlier versions than CICS V5.2, the CICS documentation states that the EXCI translator option is not supported for programs compiled with the integrated CICS translator, but CICS has reversed this position. You can also compile with the EXCI translator option and ignore the warning message DFH7006I.

Compiler options for the integrated CICS translator

Table 44 on page 217 lists compiler options for Enterprise COBOL programs that use the integrated CICS translator.

Table 44. Key compiler options for the integrated CICS translator

Compiler option	Comments
CICS	The CICS compiler option enables the integrated CICS translator capability. The CICS option must be specified if the source program contains CICS statements and has not been processed by the integrated CICS translator. The CICS option requires that the NODYNAM, and RENT options also are in effect. Enterprise COBOL forces on these options if DYNAM or NORENT are specified at the same level as the CICS option. If NOCICS option is specified, any CICS statements found in the source program will receive S-level messages and be discarded.
NODYNAM	NODYNAM is required for programs translated by the CICS translator because the CICS command-level stub cannot be dynamically called. **Note:** Dynamic calls are supported under CICS by the use of the CALL identifier format of the CALL statement, or by the use of the >>CALLINTERFACE DYNAM directive.
RENT	RENT is required for CICS programs. RENT causes the compiler to produce reentrant code and allows you to place the COBOL modules in the LPA or ELPA and thus shared among multiple address spaces under CICS. Also, the modules cannot be overwritten, since the LPA and ELPA are read-only storage.

Static calls from COBOL V5 or V6 programs to VS COBOL II programs under CICS

Existing applications with VS COBOL II programs are probably linked with older versions of the pre-Enterprise COBOL library. When a module contains COBOL V5 or V6 programs statically linked with VS COBOL II programs, and if the module is to be run under CICS, the application must be relinked with REPLACE IGZEBST using LE library modules from SCEELKED that have been updated by the PTFs for APAR PI33330.

Chapter 21. DB2 coprocessor conversion considerations

When you upgrade programs that use the DB2 precompiler to instead use the DB2 coprocessor, you need to be aware of differences in language elements and in code-page conversions.

Consider the following topics:

- DB2 coprocessor integration
- Language elements
- Code-page conversion

Starting with DB2 Version 8 you can no longer use the DB2 precompiler for OS/VS COBOL programs. In addition, you cannot mix OS/VS COBOL with Enterprise COBOL. Therefore, if a program needs to be changed, it must be upgraded to Enterprise COBOL.

DB2 coprocessor integration

The integrated SQL coprocessor eliminates the need for precompilation with the DB2 precompiler in COBOL programs containing SQL statements.

The coprocessor uses the COBOL compiler to handle both native COBOL and imbedded SQL statements in the source program. When the SQL statements are encountered, the compiler interfaces with the DB2 coprocessor. The DB2 coprocessor takes appropriate actions and then returns to the compiler typically indicating what native language statements to generate.

The separate precompiler is still supported by DB2 and Enterprise COBOL, however the coprocessor approach is the preferred and recommended solution. The coprocessor approach provides improved usability and the highest level of functionality. In particular, interactive debugging of COBOL applications with Debug Tool is enhanced when the coprocessor solution is used, since the application may be debugged at the original source level, instead of at the level of the expanded source produced by the DB2 precompiler.

The benefits of the coprocessor approach include:

- Compilation of COBOL programs with a single JOB step even if the source contains EXEC SQL (and EXEC CICS) statements.
- The ability to include source code that contains EXEC SQL statements using COPY statements is available.
- Enhancements in interactive debugging of COBOL applications with Debug Tool. The application may be debugged at the original source level, instead of at the level of the expanded source produced by the separate DB2 precompiler.
- There is only one output listing instead of two.
- REPLACE statements can now affect EXEC SQL statements.
- Nested programs that contain EXEC SQL statements can be held in separate files and included through a COPY statement.

The following job stream shows an example of using the DB2 precompiler:

```
//DB2PRE JOB ...,
// NOTIFY=GTAO,MSGCLASS=A,CLASS=A,TIME=(1,0),
// REGION=200M,MSGLEVEL=(1,1)
//PC       EXEC PGM=DSNHPC,
//         PARM='HOST(COB2),QUOTE,APOSTSQL,SOURCE,XREF'
//DBRMLIB DD DSN=GTAO.DBRMLIB.DATA(COBTEST),DISP=SHR
//STEPLIB  DD DSN=DSN910.SDSNLOAD,DISP=SHR
//SYSCIN   DD DSN=&&DSNHOUT,DISP=(MOD,PASS),UNIT=SYSDA,
//            SPACE=(800,(500,500))
//SYSPRINT DD SYSOUT=*
```

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```
//SYSTERM  DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//SYSUT1   DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT2   DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSIN    DD *

        IDENTIFICATION DIVISION.
        PROGRAM-ID.COBTEST.
        ENVIRONMENT DIVISION.
        DATA DIVISION.
        WORKING-STORAGE SECTION.
         01 RES PIC X(10).
         EXEC SQL
           INCLUDE SQLCA
         END-EXEC.
        PROCEDURE DIVISION.
         EXEC SQL
           SELECT COL1 INTO :RES FROM TABLE1
         END-EXEC.
         GOBACK.

//COB EXEC PGM=IGYCRCTL,
//PARM=(NODYNAM,'BUF(12288)',SOURCE,NOXREF)
//STEPLIB DD DSN=IGY.V5R1M0.SIGYCOMP,DISP=SHR
//        DD DSN=CEE.SCEERUN,DISP=SHR
//        DD DSN=CEE.SCEERUN2,DISP=SHR
//SYSIN    DD DSN=&&DSNHOUT,DISP=(OLD,DELETE)
//SYSLIN DD DSN=&&LOADSET,DISP=(MOD,PASS),UNIT=SYSDA,
//SPACE=(800,(500,500))
//SYSPRINT DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//SYSUT1 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT2 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT3 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT4 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT5 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT6 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT7 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT8 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT9 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT10 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT11 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT12 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT13 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT14 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT15 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSMDECK DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
```

The following example shows the integrated SQL coprocessor:

```
//DB2INT JOB (GTAO,F342,090,M49),'Gianni Tao',
//NOTIFY=GTAO,MSGCLASS=A,CLASS=A,TIME=(1,0),
//REGION=200M,MSGLEVEL=(1,1)
//COB EXEC PGM=IGYCRCTL,
//PARM=(NODYNAM,'BUF(12288)',SOURCE,NOXREF,SQL)
//STEPLIB DD DSN=IGY.V5R1M0.SIGYCOMP,DISP=SHR
//        DD DSN=CEE.SCEERUN,DISP=SHR
//        DD DSN=CEE.SCEERUN2,DISP=SHR
//        DD DSN=DSN910.SDSNLOAD,DISP=SHR
//DBRMLIB DD DSN=GTAO.DBRMLIB.DATA(COBTEST),DISP=SHR
//SYSIN DD *

       IDENTIFICATION DIVISION.
       PROGRAM-ID.COBTEST.
       ENVIRONMENT DIVISION.
       DATA DIVISION.
       WORKING-STORAGE SECTION.
        01 RES PIC X(10).
        EXEC SQL
          INCLUDE SQLCA
        END-EXEC.
       PROCEDURE DIVISION.
        EXEC SQL
          SELECT COL1 INTO :RES FROM TABLE1
        END-EXEC.
        GOBACK.

//SYSLIN DD DSN=&&LOADSET,DISP=(MOD,PASS),UNIT=SYSDA,
//SPACE=(800,(500,500))
//SYSPRINT DD SYSOUT=* //SYSUDUMP DD SYSOUT=*
```

```
//SYSUT1 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT2 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT3 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT4 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT5 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT6 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT7 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT8 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT9 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT10 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT11 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT12 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT13 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT14 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSUT15 DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
//SYSMDECK DD UNIT=SYSDA,SPACE=(800,(500,500),,,ROUND)
```

Language elements

There are some differences in the way certain aspects of SQL code are handled between the separate precompiler and the integrated coprocessor. View the following items to take into account these differences when you change to using the coprocessor.

Continuation lines

Precompiler: Requires that an EXEC SQL statement start in columns 12 through 72; continuation lines of the statement can start anywhere in columns 8 through 72.

Coprocessor: Requires that all lines of an EXEC SQL statement be coded in columns 12 through 72, including continuation lines.

Action to migrate to coprocessor: Move any continuation of EXEC SQL statements that start in columns 8 through 11 over to start in columns 12 through 72.

FOR BIT DATA host variables

Precompiler: A COBOL alphanumeric data item can be used as a host variable to hold DB2 character data that has subtype FOR BIT DATA. An explicit EXEC SQL DECLARE VARIABLE statement that declares the host variable in question as FOR BIT DATA is not required with the precompiler.

Coprocessor: A COBOL alphanumeric data item can be used as a host variable to hold DB2 character data having subtype FOR BIT DATA only if:

- You specify the NOSQLCCSID compiler option, or
- An explicit EXEC SQL DECLARE VARIABLE statement for the host variable is specified in the COBOL program. For example:

```
EXEC SQL DECLARE :HV1 VARIABLE FOR BIT DATA END-EXEC
```

If you use the DB2 DCLGEN command to generate COBOL declarations for a table, you can create the EXEC SQL DECLARE statements automatically. To do so, specify the `DCLBIT(YES)` option of the DCLGEN command.

Action to migrate to coprocessor:

- Use DCLGEN to add the explicit EXEC SQL DECLARE VARIABLE FOR BIT DATA statement to the data declarations for any data items that are used as bit data and not just as character data.
- Add the explicit EXEC SQL DECLARE VARIABLE FOR BIT DATA statement to the data declarations manually.
- Use the NOSQLCCSID compiler option.

Multiple definitions of a host variable

Precompiler: Does not require host variable references to be unique.

The first definition that maps to a valid DB2 data type is used.

Coprocessor: Requires that all host variables references be unique.

If a host variable reference is not unique, the coprocessor diagnoses it as a nonunique reference. You must fully qualify the host variable reference to make it unique.

Action to migrate to coprocessor: Fully qualify any host variable references for which there are multiple definitions.

Period at the end of an EXEC SQL INCLUDE statement

Precompiler: A period is not required.

If you do specify a period, the precompiler processes it as part of the statement. If you do not specify a period, the precompiler accepts the statement as if a period were specified.

Coprocessor: A period is required. (The coprocessor treats the EXEC SQL INCLUDE statement like a COPY statement.)

Note: Periods are not required following any other EXEC SQL statements, except for EXEC SQL INCLUDE statements.

Example:

```
IF A = B THEN
    EXEC SQL INCLUDE somecode END-EXEC.
ELSE
    ...
END-IF
```

Note that the period does not terminate the IF statement.

Action to migrate to coprocessor: Add a period after every

```
EXEC SQL INCLUDE somecode END-EXEC
```

statement.

REPLACE and EXEC SQL statements

Precompiler: COBOL REPLACE statements and the REPLACING phrase of COPY statements act on the expanded source created from EXEC SQL statements.

Coprocessor: COBOL REPLACE statements and the REPLACING phrase of COPY statements act on the original source program including EXEC statements, which can result in different behavior in the following examples:

```
REPLACE ==ABC ==By ==XYZ ==.
01 G.
02 ABC PIC X(10).
...
EXEC SQL SELECT *INTO :G.ABC FROM TABLE1 END-EXEC
```

With the precompiler the reference to G.ABC will be displayed as ABC OF G in the expanded source and will be replaced with XYZ OF G. With the coprocessor, replacement will not occur because ABC is not delimited by separators in the original source string G.ABC.

Action to migrate to coprocessor: Change your code to either REPLACE the qualified references (for example G.ABC) as well as the unqualified references:

```
REPLACE ==ABC ==By ==XYZ ==
==G.ABC ==By ==G.XYZ ==.
```

Or change code so that qualification is not required, stop using REPLACE for such data items, or any other means to allow the COBOL programs changed by REPLACE to compile cleanly.

Source code that follows END-EXEC

Precompiler: Ignores any code that follows the END-EXEC on the same line.

Coprocessor: Processes the code that follows the END-EXEC on the same line.

Note: This includes a period that follows END-EXEC, so that using the integrated SQL coprocessor with SQL statements that have periods on the same line as the END-EXEC should be changed. The periods should be removed since they were ignored in the precompiler case.

Action to migrate to coprocessor: add the floating comment indicator *> after the END-EXEC phrase.

SQL-INIT-FLAG

Precompiler: If you pass host variables that might be located at different addresses when the program is called more than once, the called program must reset SQL-INIT-FLAG. Resetting this flag indicates to DB2 that storage must be initialized when the next SQL statement runs. To reset the flag, insert the statement `MOVE ZERO TO SQL-INIT-FLAG` in the PROCEDURE DIVISION of the called program, ahead of any executable SQL statements that use the host variables.

Coprocessor: The called program does not need to reset SQL-INIT-FLAG. An SQL-INIT-FLAG is automatically defined in the program to aid in program portability. However, statements that modify SQL-INIT-FLAG, such as `MOVE ZERO TO SQL-INIT-FLAG`, have no effect on the SQL processing in the program.

Action to migrate to coprocessor: Optionally remove references to SQL-INIT-FLAG, they are not used and not needed.

SYSLIB and COPY versus EXEC SQL INCLUDE

Precompiler: The precompiler has a separate SYSLIB concatenation from the compiler, so that a specific member name, like 'member1', might refer to two different members using EXEC SQL INCLUDE 'member1' during precompilation and COPY 'member1' during compilation.

Coprocessor: There is only one SYSLIB concatenation for both EXEC SQL INCLUDE statements and COPY statements. In this case, you cannot use a single name to refer to two different members.

Action to migrate to coprocessor: Rename the SQL INCLUDE member or the copybook member, and make corresponding source code changes to the SQL INCLUDE or COPY statements involved.

Code-page conversion

There are differences in the way character conversion is handled between the separate precompiler and the integrated coprocessor. View the following items to take into account these differences when you change to using the coprocessor.

Code-page coordination between COBOL and DB2 for SQL statements

Precompiler: There is no coordination. The code page for processing SQL statements is determined from DB2 external mechanisms and defaults

Coprocessor: Code-page coordination between COBOL and DB2 for SQL statements is dependant on the SQLCCSID compile option:

- SQLCCSID:
  - The COBOL CODEPAGE(ccsid) compiler option affects processing of host variables in COBOL statements and SQL statements.
  - CCSID processing is compatible with the SQL coprocessor in Enterprise COBOL V3R4.
  - The ccsid specified in the CODEPAGE compiler option must match the ccsid in DSNHDECP for the database encoding.
- NOSQLCCSID (recommended):
  - The CODEPAGE(ccsid) compiler option only affects processing of COBOL statements, it is not used for processing SQL statements.
  - The code page for processing SQL statements is determined from DB2 external mechanisms such as DSNHDECP and defaults.

For more information about SQLCCSID and NOSQLCCSID, see the *Enterprise COBOL for z/OS Programming Guide* section "COBOL and DB2 CCSID determination".

Chapter 22. Moving IMS programs to Enterprise COBOL V5 or V6

If you use COBOL for IMS exit routines, pay attention to some restrictions with COBOL V5 and V6.

Only IMS exits that are enabled for enhanced services can reside in PDSE data sets. In particular, COBOL users commonly use two types of exits, and they are not enabled to run out of PDSE data sets:

```
DFSME127   The Input Message Segment Edit user exit
DFSME000   The Input Message Field Edit user exit
```

If you have COBOL programs that are used as these types of IMS user exits, the programs cannot be compiled with COBOL V5 or V6. The exception is when the actual exit is an assembler program in a PDS data set that LOADs and calls a COBOL V5 or V6 program in a PDSE. To handle the cases with COBOL V5 or V6 and these users exits, you have the following choices:

- If the exit routine is COBOL, do not recompile with COBOL V5 or V6, but keep using the older COBOL version.
- If the exit routine is COBOL, change to use an assembler program that LOADs COBOL V5 or V6, or an older COBOL program that does a dynamic CALL to COBOL V5 or V6 for exit logic.
- If the exit routine is assembler that loads a COBOL program, recompile the COBOL program with COBOL V5 or V6, bind into a PDSE data set, and add that new data set to the concatenation.

IMS is in the process of enabling user exits for enhanced services, which allows them to be run out of PDSE data sets. See the list of the user exit types that are enabled for the new services in IMS V11:

```
ICQSEVNT(new)          The IMS CQS Event user exit
ICQSSEVT(new)          The IMS CQS Structure Event user exit
INITTERM(new)          The Initialization / Termination user exit
RESTART(new in IMS 10)The Restart user exit
PPUE (DSFSPPUE0)       The Partner Product user exit
```

No additional exits were enabled in IMS 12.

The following user exit types are enabled in IMS 13:

```
BSEX (DFSBSEX0)       The Build Security Environment user exit
LOGEDIT (DFSFLGE0)    The Log Edit user exit
LOGWRT (DFSFLGX0)     The Logger user exit
NDMX (DFSNDMX0)       The Non-Discardable Message user exit
OTMAIOED (DFSYIOE0)   The OTMA Input / Output Exit user exit
OTMARTUX (DFSYRTUX)   The OTMA Resume TPIPE Security user exit
OTMAYPRX (DFSYPRX0)   The OTMA Destination Resolution user exit
RASE (DFSRAS00)       The Resource Access Security user exit
```

Compiling and linking for running under IMS

For best performance in the IMS environment, use the RENT compiler option. It causes COBOL to generate reentrant code. You can then run your application programs in either preloaded mode (the programs are always in storage) or nonpreload mode, without having to recompile with different options.

IMS allows COBOL programs to be preloaded. This preloading can boost performance because subsequent requests for the program can be handled faster when the program is already in storage (rather than being fetched from a library each time it is needed).

You must use the RENT compiler option to compile a program that is to be run preloaded or as both preloaded and nonpreloaded. When you preload a program object that contains COBOL programs, all of the COBOL programs in that program object must be compiled with the RENT option.

In an application with any mixture of Enterprise COBOL, IBM COBOL, and VS COBOL II programs, the following compiler options are recommended:

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Table 45. Recommended compiler options for applications with mixed COBOL programs		
Enterprise COBOL	**IBM COBOL**	**VS COBOL II**
RENT	RENT	RENT and RES

You can place programs compiled with the RENT option in the LPA or ELPA. There they can be shared among the IMS dependent regions.

To run above the 16-MB line, your application program must be compiled with RENT and RMODE(ANY).

With IMS, the data for IMS application programs can reside above the 16-MB line, and you can use DATA(31) and RENT for programs that use IMS services.

The recommended link-edit attributes for proper execution of COBOL programs under IMS are as follows:

- Link as RENT program objects that contain only COBOL programs compiled with the RENT compiler option.
- To link program objects that contain a mixture of COBOL RENT programs and other programs, use the link-edit attributes recommended for the other programs.

LLA-managed load libraries for performance

If you use Library Lookaside (LLA) to manage caching of COBOL load modules (PDS load libraries) and program objects (PDSE load libraries) for performance, COBOL V5 or V6 modules are not cached by LLA in the base versions of z/OS because of the structure of their resulting program objects. IBM has corrected this in the service stream via APAR OA45127. Alternatively, you can get a performance boost by enabling PDSE hyperspace caching, which helps the case of COBOL V5 or V6 program objects in load libraries that are managed by LLA.

One approach for loading large program objects is called page-fault driven loading. The initial load brings in only part of the program object; other parts of the program object might be brought in only when they are referenced, that is, when a page-fault occurs. For libraries that are managed by LLA, in some cases performance can be improved by avoiding page-fault driven loading. If you use the binder option `FETCHOPT=(NOPACK,PRIME)` for a program object, the system does not use page-fault driven loading. The default binder option of `FETCHOPT=(NOPACK,NOPRIME)` allows use of page-fault driven loading.

Note: When a program object resides in a library that is not LLA managed, the default binder option of `FETCHOPT=(NOPACK,NOPRIME)` might provide better performance.

See also the *Enterprise COBOL Version 6 Release 1 Performance Tuning Guide*, under the section "*Other product related factors that affect runtime performance*" for considerations on using LLA when the program object contains RMODE 24 CSECTs.

Appendix A. Commonly asked questions and answers

This section provides answers to some of the most common questions about upgrading to Enterprise COBOL and Language Environment. The questions are grouped into the following categories:

- Compatibility
- Link-editing with Language Environment
- Compiling with Enterprise COBOL
- Language Environment services
- Language Environment runtime options
- Subsystems
- z/OS
- Performance
- Service
- Object-oriented syntax, and Java 6, Java 7 and Java 8 SDKs

Before migration

This topic describes frequently asked questions before migration.

- "What does COBOL migration refer to?" on page 227
- "Is migrating from COBOL V4 and earlier to COBOL V6 different than migrating from COBOL V3 to V4?" on page 228
- "Will support end for my load modules that have been compiled with earlier versions of COBOL?" on page 228
- "Why do I need to migrate?" on page 228
- "Are there any best practices to learn before my migration?" on page 228
- "Are there any tools to speed up migration?" on page 228
- "Do I need to recompile everything for the migration?" on page 229
- "Where can I get an overview of the complete migration process?" on page 229
- "How do I select the top CPU hitters for my first migration target?" on page 229
- "Are there any education packages available so that I can take a deep dive into migration?" on page 229
- "How can I get support if running into migration issues?" on page 229
- "Once I've migrated to V5 or V6, do I have to worry about invalid data?" on page 230
- "If I find that my programs are using invalid data at run time, but my application results are OK, can I avoid correcting the invalid data problems?" on page 230
- "Can I measure the performance gains of a COBOL program on production systems after migration?" on page 230

What does COBOL migration refer to?

From a licensing and system programmer perspective, migration means updating your build compiler to a later version, including required source, option, testing, and environment changes. The current migration target is Enterprise COBOL V6.

From a development perspective, migration means recompiling programs with the newer compiler to get the performance benefits and access to new features of COBOL.

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Is migrating from COBOL V4 and earlier to COBOL V6 different than migrating from COBOL V3 to V4?

Yes. Since the newer generation of COBOL compilers can use different instructions to make your COBOL programs more efficient, they can reveal hidden and underlying issues with invalid data use at run time. The presence of invalid data can lead to different behaviors, so additional testing is needed. Most customers do not have this problem, but you cannot know in advance if you will run into these problems, thus we have a new recommended migration process.

Will support end for my load modules that have been compiled with earlier versions of COBOL?

No. The already compiled modules using z/OS LE will continue to be supported in production as long as you're using a supported z/OS level.

Why do I need to migrate?

The necessity is that EOS (End of Service) is announced for Enterprise COBOL V4 and V5. See IBM Software lifecycle website for more information.

The feasibility lies in the following points:

- Fully exploiting z/Architecture: Enterprise COBOL V6 has advanced optimization and deep hardware exploitation of the latest IBM mainframes to improve performance.
- Modernizing applications: You can leverage new COBOL language and productivity features, such as JSON, Conditional compilation, new intrinsic functions, 64-bit COBOL applications, and others.

Are there any best practices to learn before my migration?

Yes. In order to avoid a failed migration which is possibly caused by a presence of invalid data in COBOL data items at run time, you can go through a 2-compile and 2-test process with migration options, which were added to the compiler to help migration. You can also use IBM DevOps tools (as introduced in the following FAQ) to build and test automatically, which will simplify the migration and further application maintenance and upgrades.

Are there any tools to speed up migration?

Yes. IBM DevOps tools can make management of your applications much easier, including automated testing, which is key to migrating to COBOL V6 from COBOL V4 and earlier compilers.

For improved application build and release, the DevOps tools are as follows:

- IBM UrbanCode® Build
- IBM UrbanCode Deploy
- IBM Dependency Based Build
- IBM UrbanCode Velocity
- IBM UrbanCode Release

For improved editing and debugging, the DevOps tools are as follows:

- IBM Developer for z/OS
- IBM Z® Open Development

For automated testing and testing efficiency, the DevOps tools are as follows:

- IBM Z Open Unit Test
- IBM Rational Test Workbench
- Rational Test Virtualization Server

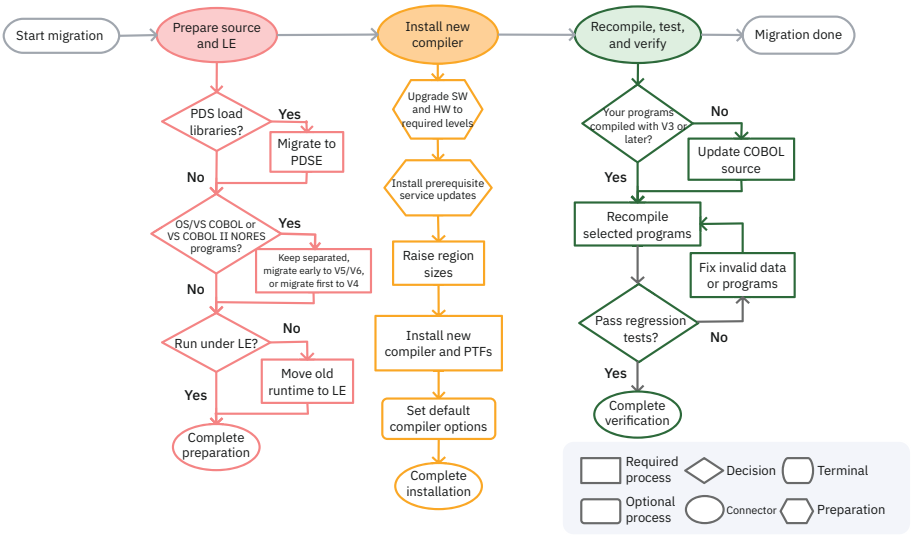
Do I need to recompile everything for the migration?

Although it is recommended, you do not have to recompile all of your programs with the newer build compiler. However, only the recompiled programs have the performance boost of COBOL V6.

Most COBOL users focus their migration effort on applications or programs that are under active development. You can first analyze the development activity on your applications to determine the key candidates for recompilation. Applications or programs that are not regularly updated do not need to be immediately recompiled. If the source of an application or a program is changed, you must recompile the application or program, but if not, you could simply use IBM Automatic Binary Optimizer for z/OS (ABO) to improve the performance.

Where can I get an overview of the complete migration process?

The following migration process diagram illustrates the whole migration process and COBOL Migration Assistant provides guidance to migration.



How do I select the top CPU hitters for my first migration target?

The video "How to Identify Top CPU Consuming COBOL Modules" (https://mediacenter.ibm.com/media/1_ygabnyso) introduces a way to identify the top CPU hitters in four steps, including identifying peak usage, identifying top job-program pairs, identifying top models, and scanning for COBOL CSECTS.

Are there any education packages available so that I can take a deep dive into migration?

The IBM Enterprise COBOL for z/OS V6 Migration Webinar and Performance Tuning Webinar are both available for clients at no charge. The webinars are hosted regularly via webcasts. Check the upcoming ones and register to join from the COBOL Migration & Performance Webinars.

Past migration webinars can be found at Enterprise COBOL Migration Webinars on Box, and past performance webinars can be found Enterprise COBOL Performance Webinars on Box.

How can I get support if running into migration issues?

You can open a case at COBOL compilers support portal to report migration problems.

Once I've migrated to V5 or V6, do I have to worry about invalid data?

If you have corrected all previous invalid data and you have validated the data your program uses, then no. If you still have invalid data, you may see differences in behaviour after a future migration or when you change the ARCH or OPT options.

If I find that my programs are using invalid data at run time, but my application results are OK, can I avoid correcting the invalid data problems?

No. For some customers who migrated successfully to COBOL V6.1 without testing invalid data, when they moved up to COBOL V6.2 and compiled with ARCH(12) for z14 hardware, their programs started abending on the invalid data. Invalid data could be a problem for years and should be corrected.

Can I measure the performance gains of a COBOL program on production systems after migration?

Yes, you can, but it is not recommended because hardware, workloads, and code may all be changed during the migration. The best and most accurate way is to measure COBOL V4 modules and COBOL V6 modules right afterwards on the same machine with the same data. Make sure you either did measurements or kept your load modules around. Otherwise, you cannot get the old numbers when you move forward with your migration.

Compatibility

This topic describes frequently asked questions about compatibility.

- "Can OS/VS COBOL and VS COBOL II programs call Enterprise COBOL programs?" on page 230
- "Can programs compiled with Enterprise COBOL V3 or V4 call programs compiled with Enterprise COBOL V6?" on page 231
- "Can you convert programs selectively to Enterprise COBOL?" on page 231
- "We have had errors when running COBOL programs where an output DD was misspelled and a temporary file was created. This causes problems when it occurs with a file for a one-time program run. Is this still a concern with Enterprise COBOL?" on page 231
- "When should you use the CMPR2 option?" on page 231
- "Is the signature area of Enterprise COBOL programs the same as for OS/VS COBOL and VS COBOL II?" on page 231
- "How is Enterprise COBOL V6 different from previous versions?" on page 231
- "What features are removed from Enterprise COBOL V6?" on page 232

Can OS/VS COBOL and VS COBOL II programs call Enterprise COBOL programs?

Under non-CICS, calls between VS COBOL II NORES programs (that is, programs compiled with the NORES compiler option) and Enterprise COBOL are not supported. Under CICS, VS COBOL II NORES programs cannot run at all.

Under non-CICS and under CICS, any calls between VS COBOL II RES programs and Enterprise COBOL programs are supported. For additional details, see the *Enterprise COBOL Programming Guide*.

For a complete list of calls between COBOL and assembler (including whether they are supported or not when running with Language Environment), see "Runtime support for assembler COBOL calls under CICS" on page 273 .

Can programs compiled with Enterprise COBOL V3 or V4 call programs compiled with Enterprise COBOL V6?

Yes, you can have applications with Enterprise COBOL V3, V4, and V6 programs and they can work well together. Enterprise COBOL V6 programs can call any COBOL programs except for programs compiled with OS/VS COBOL or VS COBOL II when compiled with the NORES option. This means that you can mix and match programs compiled with different COBOL compiler versions. It also means that you can recompile a few programs with Enterprise COBOL V6 in an existing application, while the rest of the programs are still compiled with earlier compilers.

To improve the performance of your COBOL programs without recompiling, you can use IBM Automatic Binary Optimizer for z/OS (ABO) to optimize your old load modules that have been compiled by a COBOL version listed at Eligible compilers in *IBM Automatic Binary Optimizer for z/OS User's Guide*.

Can you convert programs selectively to Enterprise COBOL?

Yes, unless an application contains any OS/VS COBOL programs or VS COBOL II programs compiled with the NORES option. When you convert applications containing OS/VS COBOL programs or VS COBOL II programs compiled with the NORES option, you must convert all of these programs in the run unit to Enterprise COBOL.

We have had errors when running COBOL programs where an output DD was misspelled and a temporary file was created. This causes problems when it occurs with a file for a one-time program run. Is this still a concern with Enterprise COBOL?

Yes, for QSAM you can turn off automatic file creation with the Language Environment CBLQDA(OFF) runtime option.

When should you use the CMPR2 option?

The CMPR2/NOCMPR2 option is not available in Enterprise COBOL. Enterprise COBOL behaves as if NOCMPR2 were in effect at all times. Any programs that were compiled with CMPR2 with a previous compiler must be upgraded to the 85 COBOL standard to compile with Enterprise COBOL.

For more details, see “Migrating from the CMPR2 compiler option to NOCMPR2” on page 104.

Is the signature area of Enterprise COBOL programs the same as for OS/VS COBOL and VS COBOL II?

No, but maps of the signature area can be used to find out what compiler options were used to compile the module, when it was compiled, release level, and so on. For details, see *Reading LIST output* in the *Enterprise COBOL Programming Guide*.

How is Enterprise COBOL V6 different from previous versions?

Enterprise COBOL V6 changes mainly fall into the following categories:

- Prerequisite software level changes
- COBOL source code differences
- Compiler option changes
- Dependence on system MEMLIMIT setting for large programs
- Runtime changes
- Changes that might affect vendor tools

Follow the above links and you can learn more about these changes in the *Enterprise COBOL for z/OS Migration Guide*.

What features are removed from Enterprise COBOL V6?

The removed features are the Millennium Language Extensions and LABEL declaratives. Learn more details at "COBOL source code differences in Enterprise COBOL Version 5 and Version 6" on page 177.

Can you convert programs selectively to Enterprise COBOL?

Yes, unless an application contains any OS/VS COBOL programs. When you convert applications containing OS/VS COBOL programs, you must convert all of the OS/VS COBOL programs in the run unit to Enterprise COBOL.

We have had errors when running COBOL programs where an output DD was misspelled and a temporary file was created. This causes problems when it occurs with a large file for a one-time program run. Is this still a concern with Enterprise COBOL?

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For more details, see "Migrating from the CMPR2 compiler option to NOCMPR2" on page 104.

Is the signature area of Enterprise COBOL programs the same as for OS/VS COBOL and VS COBOL II?

No, but maps of the signature area can be used to find out what compiler options were used to compile the module, when it was compiled, release level, and so on. For details, see *Reading LIST output* in the *Enterprise COBOL Programming Guide*.

Compiling with Enterprise COBOL

This topic describes frequently asked questions about compiling with Enterprise COBOL.

- "Are there any compiler options for finding invalid data or for performance tuning purposes?" on page 232
- "Regarding invalid data, is the testing done at run time?" on page 233
- "Is the 2-step compile exercise a one-time process?" on page 233
- "Can you compile programs written for OS/VS COBOL with Enterprise COBOL using the CMPR2 option?" on page 233
- "Can you compile programs written for VS COBOL II with Enterprise COBOL?" on page 233
- "What utilities or tools can assist in converting OS/VS COBOL or VS COBOL II source to Enterprise COBOL source?" on page 233
- "For Enterprise COBOL V6 only: what should I do if the compiler gives me a message about insufficient memory?" on page 234
- "Does Enterprise COBOL meet the 85 COBOL Standard?" on page 234
- "Does Enterprise COBOL meet the 2002 COBOL Standard?" on page 234
- "How can we compile the programs with parameters to get it executed above the 2 GB bar?" on page 234

Are there any compiler options for finding invalid data or for performance tuning purposes?

For finding invalid data, you can first compile with SSRANGE, NUMCHECK, PARMCHECK, INITCHECK, and OPT(0) for initial code changes and unit tests, and then recompile with NOSSRANGE, NONUMCHECK, NOPARMCHECK, and OPT(2) for quality assurance tests and production (2-step compile process).

- SSRANGE: Use SSRANGE to have the compiler generate code that checks for out-of-range storage references.
- NUMCHECK: Use NUMCHECK to have the compiler generate extra code to validate data items when they are used as sending data items.
- PARMCHECK: Use PARMCHECK to have the compiler generate an extra data item following the last item in WORKING-STORAGE, and then to check whether a called subprogram corrupted data beyond the end of WORKING-STORAGE.
- INITCHECK: Use INITCHECK to have the compiler check for uninitialized data items and issue warning messages when they are used without being initialized.

For performance tuning, Enterprise COBOL V6 offers several new and substantially changed compiler options that can affect performance, and the recommended compiler option set for best performance is OPT(2) and ARCH(x). For more information about performance tuning, see How to tune compiler options to get the most out of V6 in the Enterprise COBOL for z/OS Performance Tuning Guide.

To learn more migration best practices, see Chapter 4, "Migration recommendations to Enterprise COBOL V5 and V6," on page 27.

Regarding invalid data, is the testing done at run time?

Generally speaking, most testing is done at run time. You will find issues at run time because the compiler does not know where the invalid data comes from unless it happens to be within one program.

Is the 2-step compile exercise a one-time process?

As long as you can find and correct all invalid data while migrating, the 2-step compile is a one-time process. If you allow invalid data to persist, future compiler versions or changes in options could result in behavior changes when processing that invalid data.

Can you compile programs written for OS/VS COBOL with Enterprise COBOL using the CMPR2 option?

No, CMPR2 is not available with Enterprise COBOL.

For details, see "Upgrading your source to Enterprise COBOL" on page 14.

Can you compile programs written for VS COBOL II with Enterprise COBOL?

Yes. For details, see "Upgrading your source to Enterprise COBOL" on page 14.

What utilities or tools can assist in converting OS/VS COBOL or VS COBOL II source to Enterprise COBOL source?

The following conversion tools, which you can order through IBM, can assist in converting OS/VS COBOL and VS COBOL II source to Enterprise COBOL source:

1. The COBOL conversion aid (CCCA), which is included with the IBM Debug Tool product, assists in converting OS/VS COBOL and VS COBOL II source to Enterprise COBOL source.
2. The COBOL Report Writer Precompiler 5798-DYR assists in converting OS/VS COBOL Report Writer code, or allows you to continue using it with Enterprise COBOL.
3. The Debug Tool Load Module Analyzer can determine the language translator for each object in your program objects. The Debug Tool Load Module Analyzer is included with the IBM Debug Tool product.
4. The free and open source COBOL Analyzer can provide assistance in taking an inventory of your existing program objects by reporting the compiler, compiler release, and compiler options used.

   Download the free COBOL Analyzer from http://cbttape.org/cbtdowns.htm. It is named as *File # 321 COBOL Analyzer from Roland Schiradin & post processor* on that web page.

5. Rational Asset Analyzer for System z, product number 5655-W57, assists in taking an inventory and analyzing the impact that code changes make upon your enterprise assets.

For Enterprise COBOL V6 only: what should I do if the compiler gives me a message about insufficient memory?

With Enterprise COBOL V6, if you get the message: `IGYCB7145-U Insufficient memory in the compiler to continue compilation`, then you need to either increase the region size available to your compilation job, or increase the MEMLIMIT setting for your system. If you are already using 1 GB or more and it is still not enough, then it might be that your program is so large as to require the "above the BAR" storage. This would mean that the system MEMLIMIT setting must be 2 GB or more. Ask your system programmer what your MEMLIMIT setting is. For very large programs, MEMLIMIT might need to be set to 3 GB or 4 GB or more.

Does Enterprise COBOL meet the 85 COBOL Standard?

Yes, Enterprise COBOL supports all required modules of the 85 COBOL Standard at the highest level defined by the Standard.

Does Enterprise COBOL meet the 2002 COBOL Standard?

Enterprise COBOL supports many parts of the 2002 COBOL Standard. For details, see *2002 COBOL Standard features implemented in Enterprise COBOL Version 3 or later versions* in the *Enterprise COBOL Language Reference*.

How can we compile the programs with parameters to get it executed above the 2 GB bar?

There is no support in z/OS for high-level languages to run above the bar (RMODE 64).

Binding (link-editing) Enterprise COBOL programs

This topic describes frequently asked questions about binding (link-editing) Enterprise COBOL programs.

- "What is the difference between an object module, a load module, and a program object?" on page 234
- "Are PDS and PDSE data sets allowed for object modules with Enterprise COBOL V5 or V6?" on page 234
- "Are there changes in compiler generated symbols between Enterprise COBOL V4 and V5 or V6?" on page 235

What is the difference between an object module, a load module, and a program object?

An object module is the output of the compiler and input to the binder. A load module is a non-GOFF executable that is output from the binder with an Enterprise COBOL V4 or earlier object module. A program object is a new style GOFF executable that is the output from the binder when binding an object module from Enterprise COBOL V5.1 or later versions, or the output from the binder anytime the target data set (SYSLMOD) is a PDSE.

Are PDS and PDSE data sets allowed for object modules with Enterprise COBOL V5 or V6?

Compiler output data sets can be PDS or PDSE, including the object module. The output of the bind step must be a PDSE. When COBOL object modules are bound (link-edited), they become program objects and must be stored in PDSE data sets.

Are there changes in compiler generated symbols between Enterprise COBOL V4 and V5 or V6?

If you use binder statements such as CHANGE to inspect or modify a V4 compiler generated symbol, you should use the AMBLIST utility to understand the symbols generated in COBOL V5 and V6 GOFF executables. For details, see AMBLIST in the *MVS Program Management: User's Guide and Reference*.

The V5 and V6 compilers typically generate new CSECTs such as C_WSA and C_CODE. They also typically generate three related label symbols for each program, for example, Program P will result in label symbols P, P#C, and P#S. If you use a binder statement to modify any one of these symbols, you will need to modify all of them by using similar statements.

Language Environment runtime options

This topic describes frequently asked questions about Language Environment runtime options and their answers.

- "Does Enterprise COBOL use HEAP for WORKING-STORAGE?" on page 235
- "Will lower HEAP storage values for COBOL performance affect the performance of C or C++ programs?" on page 235
- "Will lower HEAP storage values for COBOL performance affect PL/I performance?" on page 235
- "Does Enterprise COBOL use STACK storage?" on page 236
- "What do HEAP(KEEP) or LIBSTACK(KEEP) do? Does the KEEP suboption keep all of the HEAP or LIBSTACK storage or just the increments of extra storage that were obtained?" on page 236
- "How does ERRCOUNT relate to abends? Does ERRCOUNT only count HANDLED conditions?" on page 236

Does Enterprise COBOL use HEAP for WORKING-STORAGE?

It uses HEAP for WORKING-STORAGE when the COBOL program is compiled with the RENT option and is in one of the following cases:

- Compiled with Enterprise COBOL V4.2 or earlier releases
- Compiled with the `DATA(24)` compiler option
- Running in CICS
- A COBOL V5.1.1 or later program in a program object that contains only COBOL programs (except COBOL 5.1.0) and assembler. There are no Language Environment interlanguage calls within the program object and no COBOL V5.1.0 programs.
- A COBOL V5 program in a program object where the main entry point is COBOL V5. In this case, the program object can contain Language Environment interlanguage calls, with COBOL statically linking with C, C++ or PL/I. All COBOL V5 programs within such program objects (even if they are not the main entry point) have their `WORKING-STORAGE` allocated from heap storage.
- A COBOL V6.1 or later program

Will lower HEAP storage values for COBOL performance affect the performance of C or C++ programs?

Yes. If the C programs use a lot of MALLOC statements, then C performance will be worse with lower HEAP storage values.

Will lower HEAP storage values for COBOL performance affect PL/I performance?

In general, the answer is no. However, performance might be slower for applications that have a high use of ALLOCATE and FREE. In this case, tune the HEAP values to improve performance. Also, if the application has many automatic variables, the STACK values should also be tuned to improve performance.

Does Enterprise COBOL use STACK storage?

Enterprise COBOL programs use STACK storage for LOCAL-STORAGE data items. Other COBOL programs do not use STACK storage.

COBOL runtime routines do use STACK storage.

What do HEAP(KEEP) or LIBSTACK(KEEP) do? Does the KEEP suboption keep all of the HEAP or LIBSTACK storage or just the increments of extra storage that were obtained?

The KEEP suboption causes Language Environment to keep **all** of the storage obtained, including the initial and incremental amounts.

How does ERRCOUNT relate to abends? Does ERRCOUNT only count HANDLED conditions?

ERRCOUNT is a count of errors, conditions, abends, and exceptions that are allowed before Language Environment abends with its own abend code. If an error is not HANDLED, the application will terminate so ERRCOUNT will have no effect.

Subsystems

This topic describes frequently asked questions about subsystems and their answers.

- "When running in a CICS region, does EXEC DLI "translate" into interfacing with CEETDLI or CBLTDLI?" on page 236
- "Is CALL 'CEETDLI' supported in a CICS program? What about CALL 'CBLTDLI' in a CICS program running under Language Environment?" on page 236
- "If you have a batch or IMS DC application that has explicit calls to other Language Environment services, or user-coded Language Environment condition handlers, must all IMS interfaces use CEETDLI instead of CBLTDLI?" on page 237
- "Will Language Environment (and its support of mixed COBOL and PL/I programs) still support applications with PL/I and VS COBOL II (or IBM COBOL) where the COBOL programs use CBLTDLI, or must such programs be converted to CEETDLI?" on page 237
- "Do I need to specify the TRAP(OFF) runtime option when using the CBLTDLI interface under IMS?" on page 237
- "Will assembler programs continue to work fine with Enterprise COBOL V6 programs?" on page 237
- "Is Enterprise COBOL V6 less compatible with non-LE-conforming assembler than Enterprise COBOL V4?" on page 237

When running in a CICS region, does EXEC DLI "translate" into interfacing with CEETDLI or CBLTDLI?

EXEC DLI does not "translate" into interfacing with either CEETDLI or CBLIDLI. The CICS translator generates a call to DFHELI. The call to DFHELI must be a static call. (The NODYNAM compiler option is required for programs translated by the CICS translator.)

Is CALL 'CEETDLI' supported in a CICS program? What about CALL 'CBLTDLI' in a CICS program running under Language Environment?

CEETDLI is not supported under a CICS environment. (CICS does not supply a CEETDLI entry point in DFHDLIAL.) CBLTDLI is supported under a CICS environment (CICS does supply a CBLTDLI entry point in DFHDLIAL) under Language Environment.

If you have a batch or IMS DC application that has explicit calls to other Language Environment services, or user-coded Language Environment condition handlers, must all IMS interfaces use CEETDLI instead of CBLTDLI?

No, all calls within a program or run unit are not required to be CEETDLI. The exception is if you have any current application using the AIBTDLI interface. AIBTDLI should be changed to CEETDLI as it improves ESTAE processing and does not require a logic change, only a change to the call from AIBTDLI to CEETDLI.

Will Language Environment (and its support of mixed COBOL and PL/I programs) still support applications with PL/I and VS COBOL II (or IBM COBOL) where the COBOL programs use CBLTDLI, or must such programs be converted to CEETDLI?

There is no problem with a mixed environment from an IMS standpoint and the programs do not need to be modified. Consider CBLTDLI and CEETDLI equivalent for conversion purposes.

Under Language Environment, your COBOL programs can still use the CBLTDLI interface. Remember that the programs must be VS COBOL II or Enterprise COBOL because mixed OS/VS COBOL and PL/I is not allowed under Language Environment. Either CBLTDLI or CEETDLI can be used, except that CEETDLI is not supported under a CICS environment.

Under CICS, mixed VS COBOL II and PL/I is not allowed.

Do I need to specify the TRAP(OFF) runtime option when using the CBLTDLI interface under IMS?

No, TRAP(OFF) is not supported for COBOL programs. There are some instances when you cannot use Language Environment condition handling when using CBLTDLI under IMS. However, if you specify ABTERMENC(ABEND), database rollback will be performed automatically for severe-error conditions. For details, see the *Language Environment Programming Guide*.

Will assembler programs continue to work fine with Enterprise COBOL V6 programs?

Assembler programs that currently interoperate with Enterprise COBOL V4 and earlier programs will continue to work fine with Enterprise COBOL V6 programs. They do not need to be LE-conforming.

Is Enterprise COBOL V6 less compatible with non-LE-conforming assembler than Enterprise COBOL V4?

It depends on what your assembler programs do. If your assembler programs look into COBOL executables for information (depending on the COBOL program layout), or if your assembler programs are not LE-enabled (running well with LE), then problems may occur. If you have a lot of assemblers, investigate what problems you may get into. Assembler programs do not need to be LE-conforming (that are using CEEENTRY and CEETERM macros), but they do need to be LE-enabled.

z/OS

Does COBOL run in 64-bit z/OS?

Yes. Though COBOL does not yet support 64-bit addressing in COBOL programs, you will get some of the benefits of 64-bit z/OS just by moving to it. With a 64-bit addressable real memory backing your virtual memory, there will be less paging and swapping and therefore better system performance, and you don't have to change your programs at all! In addition, DB2 can exploit 64-bit addressing for SQL statements in COBOL programs without any changes to the COBOL programs.

Even when your z/OS system is running in 64-bit mode, you can still run existing AMODE 24 and AMODE 31 applications without having to relink or recompile them. You can get improved system performance without any changes to your applications.

Performance

This topic describes frequently asked questions about performance and their answers.

- "Is there a performance improvement when one converts from OS/VS COBOL to Enterprise COBOL?" on page 238
- "How do I know the performance gains after recompiling with Enterprise COBOL V6?" on page 238
- "What is the best way to measure the performance of a COBOL program before and after the migration?" on page 238

Is there a performance improvement when one converts from OS/VS COBOL to Enterprise COBOL?

Yes. Enterprise COBOL V5 and V6 can give you a significant performance improvement when compared to all older COBOL compilers. It is especially true for programs with a lot of arithmetic.

For details about the key performance benefits and tuning considerations when using Enterprise COBOL, see the *Enterprise COBOL Version 6 Release 1 Performance Tuning Guide*.

How do I know the performance gains after recompiling with Enterprise COBOL V6?

The only way to know the performance gains is to measure the performance before and after the migration. So if you want to find out what your performance improvement is, it is recommended that you back up your current Enterprise COBOL V4 modules before migrating your build compiler. When the migration, required recompilation, or optimization by IBM Automatic Binary Optimizer for z/OS (ABO) is done, set up a test environment, prepare the real representative workload, and measure the performance between the Enterprise COBOL V4 modules that you backed up and your new COBOL V6 or ABO-optimized modules.

What is the best way to measure the performance of a COBOL program before and after the migration?

It depends on your application and workload:

- If it's a transactional application, you'll look at throughput for how many transactions it can process in a given amount of time, for example, transactions per second.
- If it's a batch application, measure the CPU or elapsed time of the batch job.

To measure the performance of a COBOL program before and after the migration, use a profiling tool like IBM Omegamon, IBM Application Performance Analyzer for z/OS, and other tools from IBM and other vendors. You could also use IBM RMF to measure job resource usage through the use of SMF records. For details on how to use RMF and other tools, see the white paper: COBOL Applications: Techniques to make them more Efficient. In performance tuning, you should find the hotspot and the particular modules that take the most amount of CPU time. It's not best practice to compare COBOL V4 performance before migration with COBOL V6 performance after migration because hardware, workloads, and code may all be changed during the migration. The comparison should be made on the same machine at the same time of day with the same data as input.

Service

Do I need to recompile all of my programs to get IBM service support for my applications?

If your programs are running with a supported run time, you do not need to recompile your programs to continue to have IBM service support. For additional details, see “Service support for OS/VS COBOL and VS COBOL II programs” on page 20.

Object-oriented syntax, and Java 6, Java 7 and Java 8 SDKs

How do I run existing COBOL applications with Java 6, Java 7 and Java 8?

Earlier versions of Enterprise COBOL applications that use object-oriented syntax for Java interoperability were supported with Java SDK 1.4.2 and Java 5.

To run these applications with Java 6, Java 7, or Java 8, do these steps:

1. Recompile and relink the applications using Enterprise COBOL V5.2 or later.
2. Recompile the generated Java class that is associated with each object-oriented COBOL class using the `javac` command from Java 6, Java 7, or Java 8.

Appendix B. COBOL reserved word comparison

The following table shows differences in reserved words between OS/VS COBOL, VS COBOL II, IBM COBOL, and Enterprise COBOL.

Information about source language comparison can be found in:

- Chapter 6, “Upgrading OS/VS COBOL source programs,” on page 45
- Chapter 8, “Upgrading VS COBOL II source programs,” on page 89
- Chapter 10, “Upgrading IBM COBOL source programs,” on page 99
- Chapter 12, “Upgrading programs from Enterprise COBOL Version 3,” on page 143
- Chapter 14, “Upgrading from Enterprise COBOL Version 4,” on page 155

Key:

X
The word is reserved in the product.

-
The word is *not* reserved in the product. (This includes obsolete reserved words that are no longer flagged.)

CDW
The word is an Enterprise COBOL compiler directing statement. If used as a user-defined word, it is flagged with a severe message.

RFD
The word is reserved for future development. If used, it is flagged with an informational message.

UNS
The word is a 85 COBOL Standard reserved word for a feature not supported by this compiler. For some of these words, the feature is supported by the Report Writer Precompiler. If used in a program, it is recognized as a reserved word and flagged with a severe message.

Table 46. Reserved word comparison

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
ACCEPT	X	X	X	X
ACCESS	X	X	X	X
ACTIVE-CLASS	RFD	-	-	-
ACTUAL	-	-	-	X
ADD	X	X	X	X
ADDRESS	X	X	X	X
ADVANCING	X	X	X	X
AFTER	X	X	X	X
ALIGNED	RFD	-	-	-
ALL	X	X	X	X

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Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
ALLOCATE[1]	X Reserved only in Enterprise COBOL V6.1 or later	-	-	-
ALPHABET	X	X	X	-
ALPHABETIC	X	X	X	X
ALPHABETIC-LOWER	X	X	X	-
ALPHABETIC-UPPER	X	X	X	-
ALPHANUMERIC	X	X	X	-
ALPHANUMERIC-EDITED	X	X	X	-
ALSO	X	X	X	X
ALTER	X	X	X	X
ALTERNATE	X	X	X	X
AND	X	X	X	X
ANY	X	X	X	-
ANYCASE	RFD	-	-	-
APPLY	X	X	X	X
ARE	X	X	X	X
AREA	X	X	X	X
AREAS	X	X	X	X
ASCENDING	X	X	X	X
ASSIGN	X	X	X	X
AT	X	X	X	X
AUTHOR	X	X	X	X
AUTOMATIC	RFD	-	-	-
B-AND	RFD	RFD	RFD	-
B-NOT	RFD	RFD	RFD	-
B-OR	RFD	RFD	RFD	-
B-XOR	RFD	-	-	-
BASED	RFD	-	-	-
BASIS	CDW	CDW	CDW	X
BEFORE	X	X	X	X
BEGINNING	X	X	X	X

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
BINARY	X	X	X	-
BINARY-CHAR	RFD	-	-	-
BINARY-DOUBLE	RFD	-	-	-
BINARY-LONG	RFD	-	-	-
BINARY-SHORT	RFD	-	-	-
BIT	RFD	RFD	RFD	-
BLANK	X	X	X	X
BLOCK	X	X	X	X
BOOLEAN	RFD	RFD	RFD	-
BOTTOM	X	X	X	X
BY	X	X	X	X
CALL	X	X	X	X
CANCEL	X	X	X	X
CBL	CDW	CDW	CDW	X
CD	UNS	UNS	UNS	X
CF	UNS	UNS	UNS	X
CH	UNS	UNS	UNS	X
CHANGED	-	-	-	X
CHARACTER	X	X	X	X
CHARACTERS	X	X	X	X
CLASS	X	X	X	-
CLASS-ID	X	X	-	-
CLOCK-UNITS	UNS	UNS	UNS	-
CLOSE	X	X	X	X
COBOL	X	X	X	-
CODE	X	X	X	X
CODE-SET	X	X	X	X
COL	RFD	-	-	-
COLLATING	X	X	X	X
COLS	RFD	-	-	-
COLUMN	UNS	UNS	UNS	X
COLUMNS	RFD	-	-	-
COM-REG	X	X	X	-
COMMA	X	X	X	X

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
COMMON	X	X	X	-
COMMUNICATION	UNS	UNS	UNS	X
COMP	X	X	X	X
COMP-1	X	X	X	X
COMP-2	X	X	X	X
COMP-3	X	X	X	X
COMP-4	X	X	X	X
COMP-5	X	X Reserved only in COBOL for OS/390 & VM, V2.2 or later	RFD	-
COMPUTATIONAL	X	X	X	X
COMPUTATIONAL-1	X	X	X	X
COMPUTATIONAL-2	X	X	X	X
COMPUTATIONAL-3	X	X	X	X
COMPUTATIONAL-4	X	X	X	X
COMPUTATIONAL-5	X	X Reserved only in COBOL for OS/390 & VM, V2.2 or later	RFD	-
COMPUTE	X	X	X	X
CONDITION	RFD	-	-	-
CONFIGURATION	X	X	X	X
CONSOLE	-	-	-	X
CONSTANT	RFD	-	-	-
CONTAINS	X	X	X	X
CONTENT	X	X	X	-
CONTINUE	X	X	X	-

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
CONTROL	UNS	UNS	UNS	X
CONTROLS	UNS	UNS	UNS	X
CONVERTING	X	X	X	-
COPY	CDW	CDW	CDW	X
CORR	X	X	X	X
CORRESPONDING	X	X	X	X
COUNT	X	X	X	X
CRT	RFD	-	-	-
CSP	-	-	-	X
CURRENCY	X	X	X	X
CURRENT-DATE	-	-	-	X
CURSOR	RFD	-	-	-
C01	-	-	-	X
C02	-	-	-	X
C03	-	-	-	X
C04	-	-	-	X
C05	-	-	-	X
C06	-	-	-	X
C07	-	-	-	X
C08	-	-	-	X
C09	-	-	-	X
C10	-	-	-	X
C11	-	-	-	X
C12	-	-	-	X
DATA	X	X	X	X
DATA-POINTER	RFD	-	-	-
DATE	X	X	X	X
DATE-COMPILED	X	X	X	X
DATE-WRITTEN	X	X	X	X
DAY	X	X	X	X
DAY-OF-WEEK	X	X	X	-
DBCS	X	X	X	-
DE	UNS	UNS	UNS	X
DEBUG	-	-	-	X

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
DEBUG-CONTENTS	X	X	X	X
DEBUG-ITEM	X	X	X	X
DEBUG-LINE	X	X	X	X
DEBUG-NAME	X	X	X	X
DEBUG-SUB-1	X	X	X	X
DEBUG-SUB-2	X	X	X	X
DEBUG-SUB-3	X	X	X	X
DEBUGGING	X	X	X	X
DECIMAL-POINT	X	X	X	X
DECLARATIVES	X	X	X	X
DEFAULT[1]	X Reserved only in Enterprise COBOL V6.1 or later	RFD	RFD	-
DELETE	X	X	X	X
DELIMITED	X	X	X	X
DELIMITER	X	X	X	X
DEPENDING	X	X	X	X
DESCENDING	X	X	X	X
DESTINATION	UNS	UNS	UNS	X
DETAIL	UNS	UNS	UNS	X
DISABLE	UNS	UNS	UNS	X
DISP	-	-	-	X
DISPLAY	X	X	X	X
DISPLAY-ST	-	-	-	X
DISPLAY-1	X	X	X	-
DIVIDE	X	X	X	X
DIVISION	X	X	X	X
DOWN	X	X	X	X
DUPLICATES	X	X	X	X
DYNAMIC	X	X	X	X
EC	RFD	-	-	-
EGCS	X	X	X	-

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
EGI	UNS	UNS	UNS	X
EJECT	CDW	CDW	CDW	X
ELSE	X	X	X	X
EMI	UNS	UNS	UNS	X
ENABLE	UNS	UNS	UNS	X
END	X	X	X	X
END-ACCEPT	RFD	-	-	-
END-ADD	X	X	X	-
END-CALL	X	X	X	-
END-COMPUTE	X	X	X	-
END-DELETE	X	X	X	-
END-DISPLAY	RFD	-	-	-
END-DIVIDE	X	X	X	-
END-EVALUATE	X	X	X	-
END-EXEC	X	X Reserved only in COBOL for OS/390 & VM, V2.2 or later	-	-
END-IF	X	X	X	-
END-INVOKE	X	X	-	-
END-JSON[1]	X Reserved only in Enterprise COBOL V6.1 or later	-	-	-
END-MULTIPLY	X	X	X	-
END-OF-PAGE	X	X	X	X
END-PERFORM	X	X	X	-
END-READ	X	X	X	-
END-RECEIVE	UNS	UNS	UNS	-
END-RETURN	X	X	X	-
END-REWRITE	X	X	X	-

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
END-SEARCH	X	X	X	-
END-START	X	X	X	-
END-STRING	X	X	X	-
END-SUBTRACT	X	X	X	-
END-UNSTRING	X	X	X	-
END-WRITE	X	X	X	-
END-XML[1]	X	-	-	-
ENDING	X	X	X	X
ENTER	X	X	X	X
ENTRY	X	X	X	X
ENVIRONMENT	X	X	X	X
EO	RFD	-	-	-
EOP	X	X	X	X
EQUAL	X	X	X	X
ERROR	X	X	X	X
ESI	UNS	UNS	UNS	X
EVALUATE	X	X	X	-
EVERY	X	X	X	X
EXAMINE	-	-	-	X
EXCEPTION	X	X	X	X
EXCEPTION-OBJECT	RFD	-	-	-
EXEC	X	X Reserved only in COBOL for OS/390 & VM, V2.2 or later	-	-

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
EXECUTE	X	X Reserved only in COBOL for OS/390 & VM, V2.2 or later	-	-
EXHIBIT	-	-	-	X
EXIT	X	X	X	X
EXTEND	X	X	X	X
EXTERNAL	X	X	X	-
FACTORY	X	X Reserved only in COBOL for OS/390 & VM, V2.2 or later	-	-
FALSE	X	X	X	-
FD	X	X	X	X
FILE	X	X	X	X
FILE-CONTROL	X	X	X	X
FILE-LIMIT	-	-	-	X
FILE-LIMITS	-	-	-	X
FILLER	X	X	X	X
FINAL	UNS	UNS	UNS	X
FIRST	X	X	X	X
FLOAT-EXTENDED	RFD	-	-	-
FLOAT-LONG	RFD	-	-	-
FLOAT-SHORT	RFD	-	-	-
FOOTING	X	X	X	X
FOR	X	X	X	X
FORMAT	RFD	RFD	RFD	-

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
FREE[1]	X Reserved only in Enterprise COBOL V6.1 or later	RFD	RFD	-
FROM	X	X	X	X
FUNCTION	X	X	-	-
FUNCTION-ID	RFD	-	-	-
FUNCTION-POINTER[1]	X	-	-	-
GENERATE	UNS	UNS	UNS	X
GET	RFD	RFD	RFD	-
GIVING	X	X	X	X
GLOBAL	X	X	X	-
GO	X	X	X	X
GOBACK	X	X	X	X
GREATER	X	X	X	X
GROUP	UNS	UNS	UNS	X
GROUP-USAGE[1]	X	-	-	-
HEADING	UNS	UNS	UNS	X
HIGH-VALUE	X	X	X	X
HIGH-VALUES	X	X	X	X
I-O	X	X	X	X
I-O-CONTROL	X	X	X	X
ID	X	X	X	X
IDENTIFICATION	X	X	X	X
IF	X	X	X	X
IN	X	X	X	X
INDEX	X	X	X	X
INDEXED	X	X	X	X
INDICATE	UNS	UNS	UNS	X
INHERITS	X	X	-	-
INITIAL	X	X	X	X
INITIALIZE	X	X	X	-
INITIATE	UNS	UNS	UNS	X

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
INPUT	X	X	X	X
INPUT-OUTPUT	X	X	X	X
INSERT	CDW	CDW	CDW	X
INSPECT	X	X	X	X
INSTALLATION	X	X	X	X
INTERFACE	RFD	-	-	-
INTERFACE-ID	RFD	-	-	-
INTO	X	X	X	X
INVALID	X	X	X	X
INVOKE	X	X	-	-
IS	X	X	X	X
JNIENVPTR[1]	X	-	-	-
JSON[1]	X Reserved only in Enterprise COBOL V6.1 or later	-	-	-
JSON-CODE[1]	X Reserved only in Enterprise COBOL V6.1 or later	-	-	-
JUST	X	X	X	X
JUSTIFIED	X	X	X	X
KANJI	X	X	X	-
KEY	X	X	X	X
LABEL	X	X	X	X
LAST	UNS	UNS	UNS	X
LEADING	X	X	X	X
LEAVE	-	-	-	X
LEFT	X	X	X	X
LENGTH	X	X	X	X
LESS	X	X	X	X
LIMITS	UNS	UNS	UNS	X
LINAGE	X	X	X	X

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
LINAGE-COUNTER	X	X	X	-
LINE	X	X	X	X
LINE-COUNTER	UNS	UNS	UNS	X
LINES	X	X	X	X
LINKAGE	X	X	X	X
LOCAL-STORAGE	X	X	-	-
LOCALE	RFD	-	-	-
LOCK	X	X	X	X
LOW-VALUE	X	X	X	X
LOW-VALUES	X	X	X	X
MEMORY	X	X	X	X
MERGE	X	X	X	X
MESSAGE	UNS	UNS	UNS	X
METACLASS	-	X	-	-
METHOD	X	X	-	-
METHOD-ID	X	X	-	-
MINUS	RFD	-	-	-
MODE	X	X	X	X
MODULES	X	X	X	X
MORE-LABELS	X	X	X	X
MOVE	X	X	X	X
MULTIPLE	X	X	X	X
MULTIPLY	X	X	X	X
NAMED	-	-	-	X
NATIONAL[1]	X	-	-	-
NATIONAL-EDITED[1]	X	-	-	-
NATIVE	X	X	X	X
NEGATIVE	X	X	X	X
NESTED	RFD	-	-	-
NEXT	X	X	X	X
NO	X	X	X	X
NOMINAL	-	-	-	X
NOT	X	X	X	X
NOTE	-	-	-	X

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
NULL	X	X	X	-
NULLS	X	X	X	-
NUMBER	UNS	UNS	UNS	X
NUMERIC	X	X	X	X
NUMERIC-EDITED	X	X	X	-
OBJECT	X	X	-	-
OBJECT-COMPUTER	X	X	X	X
OBJECT-REFERENCE	RFD	-	-	-
OCCURS	X	X	X	X
OF	X	X	X	X
OFF	X	X	X	X
OMITTED	X	X	X	X
ON	X	X	X	X
OPEN	X	X	X	X
OPTIONAL	X	X	X	X
OPTIONS	RFD	-	-	-
OR	X	X	X	X
ORDER	X	X	X	-
ORGANIZATION	X	X	X	X
OTHER	X	X	X	-
OTHERWISE	-	-	-	X
OUTPUT	X	X	X	X
OVERFLOW	X	X	X	X
OVERRIDE	X	X	-	-
PACKED-DECIMAL	X	X	X	-
PADDING	X	X	X	-
PAGE	X	X	X	X
PAGE-COUNTER	UNS	UNS	UNS	X
PASSWORD	X	X	X	X
PERFORM	X	X	X	X
PF	UNS	UNS	UNS	X
PH	UNS	UNS	UNS	X
PIC	X	X	X	X
PICTURE	X	X	X	X

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
PLUS	UNS	UNS	UNS	X
POINTER	X	X	X	X
POINTER-24	RFD	-	-	-
POINTER-31	RFD	-	-	-
POINTER-64	RFD	-	-	-
POSITION	X	X	X	X
POSITIONING	-	-	-	X
POSITIVE	X	X	X	X
PRESENT	RFD	RFD	RFD	-
PREVIOUS	RFD	RFD	-	-
PRINT-SWITCH	-	-	-	X
PRINTING	UNS	UNS	UNS	-
PROCEDURE	X	X	X	X
PROCEDURE-POINTER	X	X	-	-
PROCEDURES	X	X	X	X
PROCEED	X	X	X	X
PROCESSING	X	X	X	X
PROGRAM	X	X	X	X
PROGRAM-ID	X	X	X	X
PROGRAM-POINTER	RFD	-	-	-
PROPERTY	RFD	-	-	-
PROTOTYPE	RFD	-	-	-
PURGE	UNS	UNS	UNS	-
QUEUE	UNS	UNS	UNS	X
QUOTE	X	X	X	X
QUOTES	X	X	X	X
RAISE	RFD	-	-	-
RAISING	RFD	-	-	-
RANDOM	X	X	X	X
RD	UNS	UNS	UNS	X
READ	X	X	X	X
READY	X	X	X	X
RECEIVE	UNS	UNS	UNS	X
RECORD	X	X	X	X

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
RECORD-OVERFLOW	-	-	-	X
RECORDING	X	X	X	X
RECORDS	X	X	X	X
RECURSIVE	X	X	-	-
REDEFINES	X	X	X	X
REEL	X	X	X	X
REFERENCE	X	X	X	-
REFERENCES	X	X	X	X
RELATIVE	X	X	X	X
RELEASE	X	X	X	X
RELOAD	X	X	X	X
REMAINDER	X	X	X	X
REMARKS	-	-	-	X
REMOVAL	X	X	X	X
RENAMES	X	X	X	X
REORG-CRITERIA	-	-	-	X
REPLACE	X	X	X	-
REPLACING	X	X	X	X
REPORT	UNS	UNS	UNS	X
REPORTING	UNS	UNS	UNS	X
REPORTS	UNS	UNS	UNS	X
REPOSITORY	X	X	-	-
REREAD	-	-	-	X
RERUN	X	X	X	X
RESERVE	X	X	X	X
RESET	X	X	X	X
RESUME	RFD	-	-	-
RETRY	RFD	-	-	-
RETURN	X	X	X	X
RETURN-CODE	X	X	X	X
RETURNING	X	X	-	-
REVERSED	X	X	X	X
REWIND	X	X	X	X
REWRITE	X	X	X	X

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
RF	UNS	UNS	UNS	X
RH	UNS	UNS	UNS	X
RIGHT	X	X	X	X
ROUNDED	X	X	X	X
RUN	X	X	X	X
SAME	X	X	X	X
SCREEN	RFD	-	-	-
SD	X	X	X	X
SEARCH	X	X	X	X
SECTION	X	X	X	X
SECURITY	X	X	X	X
SEEK	-	-	-	X
SEGMENT	UNS	UNS	UNS	X
SEGMENT-LIMIT	X	X	X	X
SELECT	X	X	X	X
SELECTIVE	-	-	-	X
SELF	X	X	-	-
SEND	UNS	UNS	UNS	X
SENTENCE	X	X	X	X
SEPARATE	X	X	X	X
SEQUENCE	X	X	X	X
SEQUENTIAL	X	X	X	X
SERVICE	X	X	X	X
SET	X	X	X	X
SHARING	RFD	-	-	-
SHIFT-IN	X	X	X	-
SHIFT-OUT	X	X	X	-
SIGN	X	X	X	X
SIZE	X	X	X	X
SKIP1	CDW	CDW	CDW	X
SKIP2	CDW	CDW	CDW	X
SKIP3	CDW	CDW	CDW	X
SORT	X	X	X	X
SORT-CONTROL	X	X	X	-

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
SORT-CORE-SIZE	X	X	X	X
SORT-FILE-SIZE	X	X	X	X
SORT-MERGE	X	X	X	X
SORT-MESSAGE	X	X	X	X
SORT-MODE-SIZE	X	X	X	X
SORT-RETURN	X	X	X	X
SOURCE	UNS	UNS	UNS	X
SOURCE-COMPUTER	X	X	X	X
SOURCES	RFD	-	-	-
SPACE	X	X	X	X
SPACES	X	X	X	X
SPECIAL-NAMES	X	X	X	X
SQL	X	X Reserved only in COBOL for OS/390 & VM, V2.2 or later	-	-
STANDARD	X	X	X	X
STANDARD-1	X	X	X	X
STANDARD-2	X	X	X	-
START	X	X	X	X
STATUS	X	X	X	X
STOP	X	X	X	X
STRING	X	X	X	X
SUB-QUEUE-1	UNS	UNS	UNS	X
SUB-QUEUE-2	UNS	UNS	UNS	X
SUB-QUEUE-3	UNS	UNS	UNS	X
SUB-SCHEMA	RFD	RFD	RFD	-
SUBTRACT	X	X	X	X
SUM	UNS	UNS	UNS	X
SUPER	X	X	-	-
SUPPRESS	X	X	X	X

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
SYMBOLIC	X	X	X	X
SYNC	X	X	X	X
SYNCHRONIZED	X	X	X	X
SYSIN	-	-	-	X
SYSLIST	-	-	-	X
SYSOUT	-	-	-	X
SYSPUNCH	X	X	X	X
SYSTEM-DEFAULT	RFD	-	-	-
S01	-	-	-	X
S02	-	-	-	X
TABLE	UNS	UNS	UNS	X
TALLY	X	X	X	X
TALLYING	X	X	X	X
TAPE	X	X	X	X
TERMINAL	UNS	UNS	UNS	X
TERMINATE	UNS	UNS	UNS	X
TEST	X	X	X	-
TEXT	UNS	UNS	UNS	X
THAN	X	X	X	X
THEN	X	X	X	X
THROUGH	X	X	X	X
THRU	X	X	X	X
TIME	X	X	X	X
TIME-OF-DAY	-	-	-	X
TIMES	X	X	X	X
TITLE	CDW	CDW	CDW	-
TO	X	X	X	X
TOP	X	X	X	X
TOTALED	-	-	-	X
TOTALING	-	-	-	X
TRACE	X	X	X	X
TRACK-AREA	-	-	-	X
TRACK-LIMIT	-	-	-	X
TRACKS	-	-	-	X

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
TRAILING	X	X	X	X
TRANSFORM	-	-	-	X
TRUE	X	X	X	-
TYPE	X	X Reserved only in COBOL for OS/390 & VM, V2.2 or later	-	-
TYPEDEF	RFD	-	-	-
UNIT	X	X	X	X
UNIVERSAL	RFD	-	-	-
UNLOCK	RFD	-	-	-
UNSTRING	X	X	X	X
UNTIL	X	X	X	X
UP	X	X	X	X
UPDATE	RFD	RFD	RFD	-
UPON	X	X	X	X
UPSI-0	-	-	-	X
UPSI-1	-	-	-	X
UPSI-2	-	-	-	X
UPSI-3	-	-	-	X
UPSI-4	-	-	-	X
UPSI-5	-	-	-	X
UPSI-6	-	-	-	X
UPSI-7	-	-	-	X
USAGE	X	X	X	X
USE	X	X	X	X
USER-DEFAULT	RFD	-	-	-
USING	X	X	X	X
VAL-STATUS	RFD	-	-	-
VALID	RFD	RFD	RFD	-
VALIDATE	RFD	RFD	RFD	-

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
VALIDATE-STATUS	RFD	-	-	-
VALUE	X	X	X	X
VALUES	X	X	X	X
VARYING	X	X	X	X
VOLATILE[1]	X Reserved only in Enterprise COBOL V5.2 or later	-	-	-
WHEN	X	X	X	X
WHEN-COMPILED	X	X	X	X
WITH	X	X	X	X
WORDS	X	X	X	X
WORKING-STORAGE	X	X	X	X
WRITE	X	X	X	X
WRITE-ONLY	X	X	X	X
XML[1]	X	-	-	-
XML-CODE[1]	X	-	-	-
XML-EVENT[1]	X	-	-	-
XML-INFORMATION[1]	X Reserved only in Enterprise COBOL V4.2 or later	-	-	-
XML-NAMESPACE[1]	X Reserved only in Enterprise COBOL V4.1 or later	-	-	-
XML-NAMESPACE-PREFIX[1]	X Reserved only in Enterprise COBOL V4.1 or later	-	-	-

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
XML-NNAMESPACE[1]	X Reserved only in Enterprise COBOL V4.1 or later	-	-	-
XML-NNAMESPACE-PREFIX[1]	X Reserved only in Enterprise COBOL V4.1 or later	-	-	-
XML-NTEXT[1]	X	-	-	-
XML-SCHEMA[1]	X Reserved only in Enterprise COBOL V4.2 or later	-	-	-
XML-TEXT[1]	X	-	-	-
ZERO	X	X	X	X
ZEROES	X	X	X	X
ZEROS	X	X	X	X
_	X Reserved only in Enterprise COBOL V4.2 or later	-	-	-
<	X	X	X	X
<>	RFD			
<=	X	X	X	-
+	X	X	X	X
*	X	X	X	X
**	X	X	X	X
-	X	X	X	X
/	X	X	X	X
>	X	X	X	X
>=	X	X	X	-
=	X	X	X	X

Table 46. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
*>[1]	X Reserved only in Enterprise COBOL V5.1 or later	-	-	-
::	RFD	-	-	-

Note:

1. This is a new reserved word that has been added since IBM COBOL.

Appendix C. Conversion tools for source programs

A number of conversion tools are available to help you upgrade OS/VS COBOL, VS COBOL II, or IBM COBOL source programs to Enterprise COBOL.

This appendix describes the conversion tools available for your assistance during the conversion. These tools are:

- MIGR compiler option (OS/VS COBOL)
- FLAGMIG compiler option (VS COBOL II, COBOL for MVS & VM, COBOL for OS/390 & VM)
- Other programs that aid conversion

This appendix helps you to determine which, if any, of the tools to use, and understand how to use them and how to analyze their output to assess the extent of the remaining conversion effort.

MIGR compiler option

You can use the OS/VS COBOL MIGR compiler option when you are planning to convert an OS/VS COBOL program to Enterprise COBOL. This option helps you understand the magnitude of the conversion effort.

MIGR can also ease any planned future conversion by helping you avoid using OS/VS COBOL source language not supported by Enterprise COBOL. By compiling your programs using MIGR, you can determine ahead of time which language elements must be converted.

There are incompatibilities in the following areas:

- New reserved words that are introduced because of COBOL functions that have been added (previously valid user words might now be illegal)
- Language function that is supported in a different manner
- Language function that is not supported

You can set the MIGR compiler option either as an installation default, or when compiling an OS/VS COBOL program. When you set MIGR on, the compiler flags most statements that are changed in or not supported by Enterprise COBOL.

Language differences

The following language differences exist between Enterprise COBOL and OS/VS COBOL.

- Changes to ALPHABETIC class
- B symbol in PICTURE clause
- Changes to CALL statement
- Changes to CBL compiler directing statement
- Changes to Combined abbreviated relation condition
- DIVIDE ID1 BY ID2 [GIVING ID3] ON SIZE ERROR . . .
- DIVIDE ID1 INTO ID2 [GIVING ID3] ON SIZE ERROR . . .
- EXIT PROGRAM (or STOP RUN) missing at program end
- FILE STATUS clause
- ID1 IS [NOT] ALPHABETIC

  (class test on IF, PERFORM, and SEARCH)
- Changes to IF . . . OTHERWISE statement
- MOVE A TO B

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where B is defined as a variable-length data item containing its own ODO object

- MULTIPLY ID1 BY ID2 [GIVING ID3] ON SIZE ERROR . . .
- Changes to OCCURS DEPENDING ON clause
- Changes in intermediate results for ON SIZE ERROR option
- PERFORM P1 [THRU P2] VARYING ID2 FROM ID3 BY ID4 UNTIL COND-1 AFTER ID5 FROM ID6 BY ID7 UNTIL COND-2 AFTER ID8 FROM ID9 BY ID10 UNTIL COND-3

  1. Where ID6 is (potentially) dependent on ID-2
  2. Where ID9 is (potentially) dependent on ID-5
  3. Where ID4 is (potentially) dependent on ID-5
  4. Where ID7 is (potentially) dependent on ID-8

  Dependencies occur when the first identifier or index name (IDx) is identical to, subscripted with, or qualified with the second identifier. Dependencies might also occur with a partial or full redefinition of the second identifier.
- Changes to PROGRAM COLLATING SEQUENCE clause
- READ filename RECORD INTO B

  where B is defined variable-length data containing the object of the ODO phrase
- RECORD CONTAINS integer-4 CHARACTERS in the FD section
- Changes to RERUN clause
- Changes to RESERVE clause
- Changes to Reserved word list
- SPECIAL-NAMES: alphabet-name IS xxxxx
- Changes in evaluation for subscripts out of range
- UNSTRING A INTO B . . .

  where B is defined variable-length data containing the object of the ODO phrase
- UNSTRING ID1 DELIMITED BY ID2 INTO ID4 DELIMITER IN ID5 COUNT IN ID6 WITH POINTER ID7
- UPSI switches and UPSI mnemonic names references
- VALUE clause condition names
- WHEN-COMPILED special register
- WRITE BEFORE/AFTER ADVANCING PAGE statement
- WRITE AFTER POSITIONING

Statements supported with enhanced accuracy

Via the link below, you can see OS/VS COBOL statements supported with enhanced accuracy in Enterprise COBOL and flagged by a message indicating that more accurate results might be provided in Enterprise COBOL.

Arithmetic statements

- Definitions of floating-point data items
- Usage of floating-point literals
- Usage of exponentiation

LANGLVL(1) statements not supported

The following OS/VS COBOL statements, applicable only to the LANGLVL(1) compiler option, are not supported in Enterprise COBOL and are flagged when the MIGR compiler option is specified.

- COPY language—1968
- JUSTIFIED|JUST clause with VALUE
- Changes in scaling for MOVE statement and comparison
- NOT in an abbreviated combined relation condition
- PERFORM statement in independent segments
- RESERVE integer AREAS
- SELECT OPTIONAL clause—1968 standard interpretation
- SPECIAL-NAMES paragraph: use of L, /, and =
- UNSTRING with DELIMITED BY ALL

LANGLVL(1) and LANGLVL(2) statements not supported

The following OS/VS COBOL statements, applicable to both the LANGLVL(1) and LANGLVL(2) compiler options, are not supported in Enterprise COBOL and are flagged when the MIGR compiler option is specified.

Communications

- COMMUNICATION SECTION
- ACCEPT MESSAGE
- SEND, RECEIVE, ENABLE, and DISABLE statements. (Note that RECEIVE ...MESSAGE is LANGLVL sensitive, but is flagged only under Communications.)

Report Writer

- INITIATE, GENERATE, and TERMINATE statements
- LINE-COUNTER, PAGE-COUNTER, and PRINT-SWITCH special registers
- Nonnumeric literal IS mnemonic-name in SPECIAL NAMES
- REPORT clause of FD
- REPORT SECTION header
- USE BEFORE REPORTING declarative

The Report Writer Precompiler can convert these statements for you. See “COBOL Report Writer Precompiler” on page 269.

ISAM

- APPLY REORG-CRITERIA (ISAM)
- APPLY CORE-INDEX (ISAM)
- I/O statements—all that reference ISAM files
- ISAM file declarations
- NOMINAL KEY clause
- Organization parameter "I"
- TRACK-AREA clause
- USING KEY clause on START statement

BDAM

- ACTUAL KEY clause
- APPLY RECORD-OVERFLOW (BDAM)
- BDAM file declarations

- I/O statements—all that reference BDAM files
- Organization parameters “D”, “R”, and "W"
- SEEK statement
- TRACK-LIMIT clause

Use for debugging

- USE FOR DEBUGGING ON [ALL REFERENCES OF] identifiers, file-names, cd-names

Other statements

- APPLY RECORD-OVERFLOW
- Assignment-name organization parameter "C" indicating ASCII
- ASSIGN . . . OR
- ASSIGN TO integer system-name
- ASSIGN . . . FOR MULTIPLE REEL/UNIT
- CLOSE . . . WITH POSITIONING/DISP
- CURRENT-DATE and TIME-OF-DAY special registers
- Debug packets
- EXAMINE statement
- EXHIBIT statement
- FILE-LIMITS
- LABEL RECORDS Clause with TOTALING/TOTALED AREA options
- NOTE statement
- ON statement
- OPEN . . . LEAVE/REREAD/DISP
- Qualified index-names

  (Using this unsupported format results in a severe (RC = 12) level message.)
- READY TRACE and RESET TRACE statements
- REMARKS paragraph
- RESERVE NO/ALTERNATE AREAS
- SEARCH . . . WHEN condition using KEY item as object, not subject
- SERVICE RELOAD statement
- START . . . USING key statement
- THEN as a statement connector
- TIME-OF-DAY special register
- TRANSFORM statement
- USE AFTER STANDARD ERROR . . . GIVING
- USE BEFORE STANDARD LABEL
- USING procedure-name or file-name on CALL statement

Other programs that aid conversion

The following sections describe several conversion tools that offer you help in your conversion tasks. These programs are:

- The Debug Tool Load Module Analyzer can determine the language translator for each object in your program objects.

The Debug Tool Load Module Analyzer is included in Debug Tool.

- COBOL and CICS/VS Command Level Conversion Aid (CCCA)

  The COBOL and CICS/VS Command Level Conversion Aid is included in Debug Tool
- CICS application migration aid
- COBOL Report Writer Precompiler

IBM Application Discovery and Delivery Intelligence

IBM Application Discovery and Delivery Intelligence provides tools that generate an inventory of enterprise assets and return an index of the relative effort required to make code changes.

For details, see IBM Application Discovery and Delivery Intelligence at https://www.ibm.com/products/app-discovery-and-delivery-intelligence.

COBOL and CICS/VS Command Level Conversion Aid (CCCA)

The COBOL and CICS/VS Command Level Conversion Aid (CCCA), included with the IBM Debug Tool product, converts CICS and non-CICS source code into source code that can be compiled with Enterprise COBOL.

CCCA is updated for reserved word conversions for Enterprise COBOL V5.1 by the PTF for APAR PM86253. For V5.2, CCCA is updated for reserved word conversions by the PTF for APAR PI32750. For V6.1, CCCA is updated for reserved word conversions by the PTF for APAR PI55980.

CCCA is designed to automate identifying incompatible source code and converting it to Enterprise COBOL source. Using CCCA should significantly reduce your conversion effort.

CCCA requires that you have an Enterprise COBOL, IBM COBOL, VS COBOL II, or OS/VS COBOL compiler available when converting CICS programs.

The key CCCA facilities:

- Conversion of most syntax differences between OS/VS COBOL or VS COBOL II programs and Enterprise COBOL programs
- Elimination of conflicts between OS/VS COBOL, VS COBOL II, and IBM COBOL user-defined names and Enterprise COBOL reserved words
- Flagging of language elements that cannot be directly converted
- Statement-by-statement diagnostic listing
- Conversion management information, including where-used reports for COPY books and files
- Conversion of EXEC CICS commands
- Removal or conversion of the BLL (Base Locator for Linkage) section mechanism and references

CCCA is designed so that you can tailor it to fit the needs of your shop. CCCA LCPs (Language Conversion Programs), which determine the conversions to be performed, are written in a COBOL-like language. You can modify the supplied LCPs or add your own.

For more details, see the *COBOL and CICS/VS Command Level Conversion Aid* manual.

When to use CCCA

If you plan to convert your applications from OS/VS COBOL, VS COBOL II or IBM COBOL to Enterprise COBOL, evaluate the usefulness of the CCCA to your conversion project. While the number of changes required to any individual program might be small, the CCCA will identify those changes, and in the majority of cases, convert them automatically in a standard fashion. The CCCA converts both CICS and non-CICS programs. The CCCA converts SERVICE RELOAD statements and the complicated logic of BLL cell addressing to statements valid for Enterprise COBOL.

CCCA also handles non-CICS syntax.

CCCA processing of CICS statements

If the CICS option is ON, the BLL definitions and SERVICE RELOAD statements are removed. If the entire BLL structure is redefined, the redefined structure is removed. If the BLLs are not defined with a length of 4 bytes, the CICS conversion cannot be performed.

If needed by the conversion of statements involving the primary BLLs, the following code is generated in the WORKING-STORAGE SECTION for use with the POINTER facility:

```
    77  LCP-WS-ADDR-COMP PIC S9(8) COMP.
    77  LCP-WS-ADDR-PNTR REDEFINES LCP-WS-ADDR-COMP USAGE POINTER.
```

EXEC CICS processing

The primary BLLs used with SET options are replaced by corresponding ADDRESS OF special register. For example:

```
    EXEC CICS READ ... SET(BLL1) ...
```

is replaced by:

```
    EXEC CICS READ ... SET(ADDRESS OF REC1) ...
```

The statements involved are:

- CONVERSE
- GETMAIN
- ISSUE RECEIVE
- LOAD
- POST
- READ
- READNEXT
- READPREV
- READQ
- RECEIVE
- RETRIEVE
- SEND CONTROL
- SEND PAGE
- SEND TEXT

The primary BLLs used with CICS ADDRESS statements are replaced by the corresponding Enterprise COBOL ADDRESS OF special register.

For example:

```
    EXEC CICS TWA(BLL).
```

is replaced by:

```
    EXEC CICS TWA(ADDRESS OF TWA).
```

The options involved are: CSA, CWA, EIB, TCTUA, and TWA.

Statements dealing with the primary BLLs

The statements dealing with the primary BLLs are shown in Table 47 on page 269.

Statements dealing with the secondary BLLs are replaced by CONTINUE.

Table 47. COBOL statements dealing with primary BLLs

Original source	Source after conversion
MOVE BLL1 TO BLL2	SET ADDRESS OF REC2 TO ADDRESS OF REC1
MOVE ID TO BLL	MOVE ID TO LCP-WS-ADDR-COMP SET ADDRESS OF REC1 TO LCP-WS-ADDR-PNTR
MOVE BLL TO ID	SET LCP-WS-ADDR-PNTR TO ADDRESS OF REC MOVE LCP-WS-ADDR-COMP TO ID
ADD ID1, .. TO BLL	SET LCP-WS-ADDR-PNTR TO ADDRESS OF REC ADD ID1, TO LCP-WS-ADDR-COMP SET ADDRESS OF REC TO LCP-WS-ADDR-PNTR
ADD BLL TO ID1, ID2	SET LCP-WS-ADDR-PNTR TO ADDRESS OF REC ADD LCP-WS-ADDR-COMP TO ID1, ID2
ADD ID1, ID2 GIVING BLL	ADD ID1, ID2 GIVING LCP-WS-ADDR-COMP SET ADDRESS OF REC TO LCP-WS-ADDR-PNTR
ADD ID, BLL1 GIVING BLL2 BLL3	SET LCP-WS-ADDR-PNTR TO ADDRESS OF REC ADD ID, LCP-WS-ADDR-COMP GIVING LCP-WS-ADDR-COMP SET ADDRESS OF REC2 TO LCP-WS-ADDR-PNTR SET ADDRESS OF REC3 TO LCP-WS-ADDR-PNTR
ADD ID1, BLL1 GIVING ID2 ID3	SET LCP-WS-ADDR-PNTR TO ADDRESS OF REC ADD ID1, LCP-WS-ADDR-COMP GIVING ID2 ID3
SUBTRACT statements	The conversion is performed in the same way as ADD.
COMPUTE BLL = exp (BLL)	SET LCP-WS-ADDR-PNTR TO ADDRESS OF REC COMPUTE LCP-WS-ADDR-COMP = exp (LCP-WS-ADDR-COMP)
COMPUTE ID = exp (BLL)	SET LCP-WS-ADDR-PNTR TO ADDRESS OF REC COMPUTE ID = exp (LCP-WS-ADDR-COMP)
COMPUTE BLL = exp ...	COMPUTE LCP-WS-ADDR-COMP = exp ...

COBOL Report Writer Precompiler

You can use the COBOL Report Writer Precompiler to compile applications that contain Report Writer statements, or to permanently convert Report Writer statements to valid Enterprise COBOL statements.

IBM has licensed COBOL Report Writer Precompiler from SPC Systems and sells it under the following program numbers:

- 5798-DYR: COBOL Report Writer Precompiler and Libraries
- 5798-DZX: COBOL Report Writer Library only

Note: Starting with Enterprise COBOL V5.1, COBOL Report Writer Precompiler V1.6.01 or later is required due to changes to the compiler architecture. Updates to the COBOL Report Writer must be obtained from SPC Systems subject to an SPC Systems support contract. For program services and technical support (including Q&A), contact SPC Systems at https://www.spc-systems.com.

The Report Writer Precompiler offers the following features:

- Extended Report Writer language capabilities
- Integration with the target COBOL compiler—as though Report Writer statements in the source program are being processed by the COBOL compiler itself
- Single consolidated source listing merges information from the precompiler listing and the COBOL compiler listings
- COPY library members can contain Report Writer statements
- Supports the Enterprise COBOL nested COPY feature
- Performs a diagnostic check of the input Report Writer source statements
- Can be run in stand-alone mode to convert Report Writer statements in your COBOL programs into non-Report Writer COBOL source statements acceptable to the Enterprise COBOL compiler

For details, see *COBOL Report Writer Precompiler Programmer's Manual* and *COBOL Report Writer Precompiler Installation and Operation*.

Debug Tool Load Module Analyzer

The Debug Tool Load Module Analyzer analyzes program objects to determine the language translator (compiler or assembler) that was used to generate the object for each CSECT.

This program can process all or selected program objects in a concatenation of PDS or PDSE data sets. Load Module Analyzer is included with the IBM Debug Tool product.

Free and open source COBOL Analyzer

The free and open source COBOL Analyzer helps you inventory your existing program objects by reporting the compiler, compiler release, and compiler options used.

Download the free COBOL Analyzer from http://cbttape.org/cbtdowns.htm. It is named as *File # 321 COBOL Analyzer from Roland Schiradin & post processor* on that web page.

Appendix D. Applications with COBOL and assembler

If your applications contain mixed COBOL and assembler programs, you might have to make some modifications to the applications.

Do the following tasks as needed:

- Determining requirements for calling and called assembler programs
- Determining which assembler/COBOL calls are supported under non-CICS
- Determining which assembler/COBOL calls are supported under CICS
- Converting programs that change the program mask
- Upgrading applications that use an assembler driver
- Modifying applications in which assembler loads, calls, or deletes COBOL programs
- Saving and restoring the high halves of General Purpose Registers (GPRs) in assembler programs that will call or be called by Enterprise COBOL V5

Some information about applications that contain both assembler and COBOL programs is included in other sections of this documentation. For example, you can find information about assembler programs that pass procedure names in "Language elements that changed from OS/VS COBOL" on page 69

Called assembler programs

A called assembler program must save the registers and store other information in the save area passed to it by the COBOL program. In particular, the COBOL save area must be properly back chained from the save area of an assembler program. The assembler program must also contain a return routine that:

- Loads the address of the COBOL save area back into R13
- Restores the contents of the other registers
- Optionally sets a return code in R15
- Branches to the address in R14
- Returns to the COBOL caller in the same AMODE that was in use when it was called

SVC LINK and COBOL run-unit boundary

If the target of SVC LINK is a non-Language Environment-conforming assembler program, and the assembler program later calls a COBOL program, the Language Environment enclave and COBOL run-unit boundary will be at the COBOL program, not at the assembler program. The main program of the enclave (and run unit) is the COBOL program.

If the target of SVC LINK is a Language Environment-conforming assembler program, the Language Environment enclave boundary will be at the assembler program. The assembler program is the main program of the enclave (provided MAIN=YES is specified in the CEEENTRY macro). If the assembler program calls a COBOL program at a later time, the COBOL program is a subprogram.

Runtime support for assembler COBOL calls under non-CICS

The combinations of calls involving COBOL programs and assembler programs and whether the calls are supported when running under Language Environment under non-CICS are listed in the following table.

For the calls that are *not* supported, Table 48 on page 272 also lists the symptom (message or abend code) that is returned in most cases. In some cases, depending on the application environment, the symptom might not occur. You could receive a different failure, or the application might appear to run successfully.

The term, *IBM COBOL* refers to COBOL/370, COBOL for MVS &VM and COBOL for OS/390 & VM.

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Table 48. Language Environment supported calls between COBOL programs and assembler programs under non-CICS; Yes indicates that a call is supported.

Calls from		**Issued to**						
Call type	**Program issuing**	**Enterprise COBOL**	**IBM COBOL**	**VS COBOL II**	**OS/VS COBOL**	**LanEnv[1] Asm[2] main**	**LanEnv[1] Asm subrtn**	**Non-LanEnv Asm**
Static	Enterprise COBOL	Yes	Yes	Yes	No	No[3]	Yes	Yes
	IBM COBOL	Yes	Yes	Yes	Yes	No[3]	Yes	Yes
	VS COBOL II with RES	Yes	Yes	Yes	Yes	No[3]	Yes[4]	Yes
	VS COBOL II with NORES	No	Yes	Yes	Yes	No[3]	Yes[4]	Yes
	OS/VS COBOL	No	Yes	Yes	Yes	No[3]	Yes[4]	Yes
Dynamic	Enterprise COBOL	Yes	Yes	Yes	No	No[3]	Yes	Yes
	IBM COBOL	Yes	Yes	Yes	Yes	No[3]	Yes	Yes
	VS COBOL II with RES	Yes	Yes	Yes	Yes	No[3]	Yes	Yes
	VS COBOL II with NORES	No	Yes	Yes	Yes	No[3]	Yes	Yes
	OS/VS COBOL	No	Yes	Yes	Yes	No[3]	Yes	Yes
VCON	Asm (LanEnv)	Yes	Yes	Yes	Yes	No[3]	Yes	Yes
	Asm (non-LanEnv)	Yes	Yes	Yes	Yes	Yes[5]	No[6]	Yes
LOAD	Asm (LanEnv)	Yes	Yes	Yes	Yes	No[3]	Yes	Yes
BALR	Asm (non-LanEnv)	Yes	Yes	Yes	Yes	Yes[5]	No[6]	Yes
LINK	Asm (LanEnv)	Yes	Yes	Yes	Yes[7]	Yes	No[6]	Yes
	Asm (non-LanEnv)	Yes	Yes	Yes	Yes[7]	Yes	No[6]	Yes

Table 48. Language Environment supported calls between COBOL programs and assembler programs under non-CICS; Yes indicates that a call is supported. (continued)

Calls from		Issued to						
Call type	**Program issuing**	**Enterprise COBOL**	**IBM COBOL**	**VS COBOL II**	**OS/VS COBOL**	**LanEnv[1] Asm[2] main**	**LanEnv[1] Asm subrtn**	**Non-LanEnv Asm**

The failure symptoms described in these notes are as they would occur when the Language Environment TRAP(ON) and ABTERMENC(ABEND) runtime options are in effect.

1. (LanEnv stands for Language Environment.) CEEENTRY macro with MAIN=YES creates a Language Environment assembler main. If you specify MAIN=NO on the CEEENTRY macro, a Language Environment assembler subroutine is created. The default is MAIN=YES.
2. (Asm stands for assembler.)
3. Invoking a Language Environment assembler main program from an established Language Environment enclave is not recommended (unless through the use of SVC LINK). For this reason, the table entries associated with this footnote are marked No. A nested enclave is not created and, therefore, the program runs as a subprogram in the invoking enclave. If you follow this recommendation, you might avoid the need for reprogramming in the future.
4. You must specify NAB=NO and MAIN=NO on the CEEENTRY macro. Otherwise, you will receive failure symptom 0C1, 0C4, or 0C5 abend.
5. If the non-Language Environment assembler caller is running within an established Language Environment enclave, see note 3.
6. Failure symptom of 0C1, 0C4, or 0C5 abend.
7. Except when OS/VS COBOL programs exist in another established Language Environment enclave. For detail, see Failure symptom of: message IGZ0005S.

Runtime support for assembler COBOL calls under CICS

The combinations of calls involving COBOL programs and assembler programs and whether the calls are supported when running under Language Environment under CICS are listed in the following table.

For the calls that are *not* supported, Table 49 on page 273 also lists the symptom (message or abend code) that will be returned in most cases. In some cases, depending on the application environment, the symptom might not occur; you could receive a different failure, or the application might appear to run successfully.

The term *IBM COBOL* refers to COBOL/370, COBOL for MVS & VM, and COBOL for OS/390 & VM.

Table 49. Language Environment supported calls between COBOL programs and assembler programs that run under CICS; Yes indicates that a call is supported.

Calls from		Issued to					
Call type	**Program issuing**	**Enterprise COBOL**	**IBM COBOL**	**VS COBOL II**	**LanEnv[1] Asm[2] main**	**LanEnv[1] Asm subrtn**	**Non-LanEnv Asm**
Static	Enterprise COBOL	Yes	Yes	Yes	No[3]	Yes	Yes
	IBM COBOL	Yes	Yes	Yes	No[3]	No[4]	Yes
	VS COBOL II	Yes	Yes	Yes	No[3]	No[4]	Yes
Dynamic	Enterprise COBOL	Yes	Yes	Yes	No[3]	Yes	Yes
	IBM COBOL	Yes	Yes	Yes	No[3]	Yes	Yes
	VS COBOL II	Yes	Yes	Yes	No[3]	Yes	Yes

Table 49. Language Environment supported calls between COBOL programs and assembler programs that run under CICS; Yes indicates that a call is supported. (continued)

Calls from		Issued to					
Call type	**Program issuing**	**Enterprise COBOL**	**IBM COBOL**	**VS COBOL II**	**LanEnv[1] Asm[2] main**	**LanEnv[1] Asm subrtn**	**Non-LanEnv Asm**
EXEC CICS LINK	Enterprise COBOL	Yes	Yes	Yes	No[3]	No[4]	Yes
	IBM COBOL	Yes	Yes	Yes	No[3]	No[4]	Yes
	VS COBOL II	Yes	Yes	Yes	No[3]	No[4]	Yes
VCON	Asm (LanEnv)	Yes	Yes	No[4]	No[3]	Yes	Yes
	Asm (non-LanEnv)	No[4]	No[4]	No[4]	No[3]	No[4]	Yes
EXEC CICS LINK	Asm (non-LanEnv)	Yes	Yes	Yes	No[3]	No[4]	Yes
	Asm (non-LanEnv)	Yes	Yes	Yes	No[3]	No[4]	Yes

The failure symptoms described in these notes are as they would occur when the Language Environment TRAP(ON) and ABTERMENC(ABEND) runtime options are in effect.

1. (LanEnv stands for Language Environment.) CEEENTRY macro with MAIN=YES creates a Language Environment assembler main. If you specify MAIN=NO on the CEEENTRY macro, a Language Environment assembler subroutine is created. The default is MAIN=YES.
2. (Asm stands for assembler.)
3. There is no support for Language Environment-conforming assembler main programs under CICS at a level earlier than CICS TS Version 3. Failure symptom: Unpredictable. The applications might appear to run successfully.
4. Failure symptom of: ASRA abend (caused by type 1 or 5 program check).

Converting programs that change the program mask

When a VS COBOL II program calls an assembler program that changes the program mask (for example, uses an SPM instruction), the program mask is restored after the call to the assembler program.

With Enterprise COBOL, the program mask is not restored. Thus, if you change the program mask in your assembler program, you must restore it before returning to the COBOL program. Failure to restore the program mask could result in undetected data errors, such as fixed-point overflow, decimal overflow, exponent underflow, and significance exceptions.

Upgrading applications that use an assembler driver

There are three methods for upgrading applications that use an assembler driver to call COBOL subroutines:

- Convert the assembler driver to a Language Environment-conforming assembler driver.
- Modify the assembler driver to set up the Language Environment.
- Use the RTEREUS runtime option if the assembler driver cannot be modified.

These methods are described in the sections below. In all cases, you upgrade the COBOL subroutines in the same way as described in the other COBOL conversion scenarios.

Convert the assembler driver

To upgrade an application that has an assembler driver, you can change the assembler driver to be a Language Environment-conforming assembler main program. For details about how to make your existing assembler programs Language Environment-conforming, see the *Language Environment Programming Guide*.

Modify the assembler driver

If the assembler driver uses either IGZERRE or ILBOSTP0, it must be modified.

Replace the OS/VS COBOL ILBOSTP0 or IGZERRE routine with the Language Environment CEEPIPI INIT_SUB, CEEPIPI INIT_ MAIN, and CEEPIPI TERM functions. These Language Environment routines have a convenient complementary termination function that was not available with OS/VS COBOL.

Use an unmodified assembler driver

If you cannot (or do not want to) modify the non-COBOL driver, you can use the unmodified driver while specifying the Language Environment RTEREUS runtime option. (RTEREUS initializes the runtime environment for reusability when the first COBOL program is invoked.)

Note: RTEREUS is not recommended for all applications; in some instances, it exhibits undesirable behavior. Before using RTEREUS, thoroughly explore the possible side effects and understand the impact on your application.

Note: For IMS, you can start an IMS MPR with `JVMOPMAS=DFSJVMMS` and `ENVIRON=DFSJVMEV` or specify `//STDENV DD` in the MPR's startup JCL. This action pre-initializes the Language Environment and enables Java in the dependent region. The region can be used to run transactions with Enterprise COBOL programs and other LE conforming languages that need a pre-initialized LE. VS COBOL II is not supported in this environment.

Assembler programs that load and BALR to MAIN COBOL programs

Previous to Enterprise COBOL V5, you could LOAD and BALR, then BALR again to OS/VS COBOL main programs from assembler. But it is not supported to LOAD and BALR then BALR again to a main program that was compiled with Enterprise COBOL (or any newer compiler) with the NORENT option. If you recompile an OS/VS COBOL program (in the above case of BALR again) with Enterprise COBOL and use the NORENT compiler option, the program will abend with message IGZ0044S. There are several possible solutions:

- Compile with RENT.
- Change the assembler code to DELETE and LOAD again before a subsequent BALR to NORENT COBOL.
- Change the assembler program to be Language Environment-conforming.

Assembler programs that load and delete COBOL programs

Under Language Environment, assembler programs can SVC load and SVC delete load modules that contain any of the following programs:

- VS COBOL II programs compiled with the NORENT option
- IBM COBOL programs compiled with the NORENT option
- Enterprise COBOL programs compiled with the NORENT option

Restriction: Debug Tool does not support COBOL programs that are in load modules that are deleted by assembler using SVC delete.

Under Language Environment, assembler programs can SVC load but *cannot* SVC delete load modules that contain any of the following programs:

- VS COBOL II programs compiled with the RENT option
- IBM COBOL programs compiled with the RENT option
- Enterprise COBOL programs compiled with the RENT option

If assembler programs SVC delete load modules that contain these kinds of programs, unpredictable results can occur.

For assembler programs that need to load and delete load modules that contain a COBOL RENT program, perform one of the following tasks:

- Have the assembler program statically call a COBOL program that performs the dynamic call and performs the CANCEL.
- Use the Language Environment-provided CEEFETCH and CEERELES macros.

Assembler programs must use CEEFETCH instead of CEELOAD to load COBOL V5 or V6 programs, because COBOL V5 and V6 programs are program objects.

Saving and restoring the high halves of General Purpose Registers in assembler programs

In this topic, you can find information about how to save and restore the high halves of General Purpose Registers (GPRs) in assembler programs that will call or be called by Enterprise COBOL V5 or V6.

Do not use the F5SA or F8SA save area formats as described in the *MVS Programming: Assembler Services Guide*.

You can save the high halves of GPRs to and restore from anywhere in your user storage, but you might want to choose the model used by COBOL when HGPR(PRESERVE) is in effect. In this case, the COBOL V5 or V6 compiler always uses a block of storage in the same relative location as is used to save the lower halves of the registers. Here is an example of what COBOL V5 does to save and restore the high halves of GPRs:

1. On entry:
   a. Reserve 72 bytes in DSA, currently at about offset +136
   b. Specify STMH R1,R15,136(,R13)
2. On exit, specify LMH R1,R15,136(,R13)

Finding the program name and compile time stamp in Enterprise COBOL V5 or V6 programs

You can find the program name (and PPA1) for COBOL V5 or V6 programs at run time.

1. From the current Register 13, follow the backchain pointer (R13 + 4).
2. The Entry Point address (EP@) is in the backchain, in the R15 slot (backchain address + 16).
3. At the EP@, look at the word in EP@+12. An integer is there, which is the offset from the entry point to the PPA1 in this program.
4. Add this integer to the EP@. This is the PPA1 address.
5. The program name is in the PPA1. (The first byte in PPA1 times 2 (byte *2) gives the offset of the program name in PPA1.)
6. The first 2 bytes of the program name are the length of the name, followed by the name.

Finding the name of the program that called the current COBOL V5 or V6 program

You can find the name of the calling programs from a COBOL V5 or V6 program at run time by using the LE service CEETBCK. For more information, see the *z/OS Language Environment Vendor Interfaces*.

Appendix E. Option comparison

The following table describes the Enterprise COBOL V5 and V6 compiler options and installation options, and explains how the options compare with those in OS/VS COBOL, VS COBOL II, IBM COBOL, and Enterprise COBOL V3 and V4.

For complete descriptions of the Enterprise COBOL V5 and V6 options, see *Compiler options* in the *Enterprise COBOL Programming Guide*.

Key:

X
The compiler option is available.

-
The compiler option is *not* available.

Table 50. Option comparison

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
ADATA	-	-	X	X	X	X	Produces associated data file at compilation. NOADATA is the default. The Enterprise COBOL ADATA option replaces the COBOL/370 EVENTS option.
ADV	X	X	X	X	X	X	Adds print control byte at beginning of records. ADV is the default.
AFP	-	-	-	-	X	X	Controls the compiler usage of the Additional Floating Point (AFP) registers that are provided by z/Architecture processors. AFP(VOLATILE) is the default.
ANALYZE	-	-	X Available only in COBOL for OS/390 & VM V2.1, or later	-	-	-	Causes the compiler to check the syntax of embedded SQL and CICS statements in addition to native COBOL statements.
ALOWCBL	-	X	X	X	X	X	Allows PROCESS or CBL statements in source programs. You can only specify this option at installation time. ALOWCBL is the default.

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Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
APOST/QUOTE	X	X	X	X	X	X	Specifies apostrophe (') as delimiter for literals. QUOTE is the default. In Enterprise COBOL, literals can be delimited with either quotation marks or apostrophes regardless of whether APOST or QUOTE is in effect. If APOST is used, the figurative constant QUOTE/QUOTES represents one or more apostrophe (') characters.
ARCH	-	-	-	-	X	X	Specifies the machine architecture for which the executable program instructions are to be generated. ARCH(8) is the default.
ARITH	-	-	X	X	X	X	Sets the maximum number of digits that you can specify for decimal data and affects the precision of intermediate results. ARITH(COMPAT) is the default. With ARITH(COMPAT) you can specify 18 digits in the PICTURE clause, fixed-point numeric literals, and arguments to NUMVAL, NUMVAL-C and NUMVAL-F, and 28 digits in arguments to FACTORIAL. With ARITH(EXTEND) you can specify 31 digits in the PICTURE clause, fixed-point numeric literals, and arguments to NUMVAL, NUMVAL-C and NUMVAL-F, and 29 digits in arguments to FACTORIAL.
AWO	-	X	X	X	X	X	Activates APPLY WRITE-ONLY processing for physical sequential files with VB format. NOAWO is the default.
BLOCK0	-	-	-	X	X	X	Activates BLOCK CONTAINS 0 clause for all physical sequential files in the program that specify neither BLOCK CONTAINS nor RECORDING MODE U in the file description.
BUF	X	-	-	-	-	-	Allocates buffer storage for compiler work data sets. In Enterprise COBOL, the BUFSIZE option replaces the OS/VS COBOL BUF option.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
BUFSIZE	-	X	X	X	X	X	Allocates buffer storage for compiler work data sets. Three suboptions are available: BUFSIZE(nnnnn), BUFSIZE(nnnK), and BUFSIZE(4096). BUFSIZE(4096) is the default. BUFSIZE replaces the OS/VS COBOL BUF option.
CICS	-	-	X	X	X	X	Enables the integrated CICS translator capability and specifies CICS options. NOCICS is the default.
CLIST	X	-	-	-	-	-	Produces a condensed PROCEDURE DIVISION listing plus tables and program statistics. NOCLIST is the default. The VS COBOL II, IBM COBOL, and Enterprise COBOL OFFSET option replaces the OS/VS COBOL CLIST option.
CMPR2	-	X	X	-	-	-	Specified generation of IBM COBOL source code compatible with VS COBOL II Release 2 or other VS COBOL II CMPR2 behavior. NOCMPR2 is the default behavior which cannot be changed. NOCMPR2 specifies the full use of all IBM COBOL language features (including language extensions for object-oriented COBOL and improved interoperability with C programs). The CMPR2 option is obsolete in Enterprise COBOL V4, but was tolerated with informational or warning messages to ease migration from V3 or prior versions. With Enterprise COBOL V5 and V6, CMPR2 option is no longer tolerated, and specifying it will result in an error message.
CODEPAGE	-	-	-	X	X	X	Specifies the code page used for encoding contents of alphanumeric and DBCS data items at run time as well as alphanumeric, national, and DBCS literals in a COBOL source program. CODEPAGE(1140) is the default.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
COMPILE	-	X	X	X	X	X	Requests an unconditional full compilation. Other options are NOCOMPILE and NOCOMPILE(W|E|S). The default is NOCOMPILE(S). NOCOMPILE specifies unconditional syntax checking. NOCOMPILE(W|E|S) specify conditional syntax checking based on the severity of the error. COMPILE is equivalent to the OS/VS COBOL NOSYNTAX and NOCSYNTAX options. NOCOMPILE is equivalent to the OS/VS COBOL SYNTAX options. NOCOMPILE(W|E|S) is equivalent to the OS/VS COBOL CSYNTAX and SUPMAP options.
COPYLOC	-	-	-	-	-	X Available only in Enterprise COBOL V6.1 with service applied, or later	Use the COPYLOC compiler option to add either a PDSE (or PDS) dataset or z/OS UNIX directory as an additional location to be searched for copy members during the library phase.
COPYRIGHT	-	-	-	-	X	X	Use COPYRIGHT to place a string in the object module if the object module is generated. If the object is linked into a program object, the string is loaded into memory with that program object.
COUNT	X	-	-	-	-	-	Produces statement execution summaries at the end of program execution. Each statement is identified by procedure-name and by statement number, and the number of times it was used is indicated. A similar function is provided with Debug Tool.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
CURRENCY	-	-	X	X	X	X	Defines the default currency symbol. When both the CURRENCY option and the CURRENCY SIGN clause are used in a program, the symbol specified in the CURRENCY SIGN clause is considered the currency symbol in a PICTURE clause when that symbol is used. NOCURRENCY is the default and indicates that no alternate default currency sign is provided by the CURRENCY option.
DATA	-	X	X	X	X	X	Specifies whether reentrant program data areas are acquired above or below the 16-MB line. With DATA(24), reentrant programs data is acquired below the 16-MB line. With DATA(31), reentrant programs data is acquired above the 16-MB line. DATA(31) is the default.
DATEPROC	-	-	X	X	-	-	Enables the millennium language extensions of the COBOL compiler. Options consist of DATEPROC(FLAG), DATEPROC(NOFLAG), DATEPROC(TRIG), DATEPROC(NOTRIG) and NODATEPROC.
DBCS	-	X	X	X	X	X	Tells the compiler to recognize DBCS shift-in and shift-out codes. DBCS is the default.
DBCSXREF	-	X	X	X	X	X	Specifies that an ordering program is to be used for cross-references to DBCS characters, where code sets parameters giving information about the DBCS Ordering Support Program. You can only specify DBCSXREF at installation time. DBCSXREF=NO is the default.
DECK	X	X	X	X	X	X	Generates object code as 80-character card images and places it in SYSPUNCH file. NODECK is the default.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
DEFINE	-	-	-	-	-	X Available only in Enterprise COBOL V6.1 with service applied, or later	Assigns a literal value to a compilation variable that is defined in the program by using the DEFINE directive with the PARAMETER phrase.
DIAGTRUNC	-	-	X	X	X	X	Causes the compiler to issue a severity-4 (warning) diagnostic message for MOVE statements with numeric receivers when the receiving data has fewer integer positions than the sending data item or literal. NODIAGTRUNC is the default.
DISPSIGN	-	-	-	-	X	X	Controls output formatting for DISPLAY of signed numeric items. DISPSIGN(COMPAT) is the default.
DLL	-	-	X	X	X	X	Enables the compiler to generate an object module that is enabled for DLL (Dynamic Link Library) support. NODLL is the default.
DMAP	X	-	-	-	-	-	Produces a listing of the DATA DIVISION and implicitly declared items. NODMAP is the default. The VS COBOL II, IBM COBOL, and Enterprise COBOL MAP option replaces the OS/VS COBOL DMAP option.
DUMP	X	X	X	X	X	X	Specifies that a system dump be produced at end of compilation. NODUMP is the default.
DYNAM	X	X	X	X	X	X	Changes the behavior of CALL literal statements to load subprograms dynamically at run time. NODYNAM is the default. With NODYNAM, CALL literal statements cause subprograms to be statically link-edited in the program object.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
EXIT	-	X	X	X	X	X	Allows the compiler to accept user-supplied modules. (Each *string* is an optional user-supplied input string to the exit module, and each *mod* names a user-supplied exit module.) The ADEXIT suboption is only available with COBOL for MVS & VM and later compilers. The MSGEXIT suboption is only available with Enterprise COBOL V4.2 and later compilers. NOEXIT is the default.
EXPORTALL	-	-	X	X	X	X	Instructs the compiler to automatically export certain symbols when the object deck is link-edited to form a DLL. NOEXPORTALL is the default.
FASTSRT	-	X	X	X	X	X	Specifies fast sorting by the IBM DFSORT licensed program. NOFASTSRT is the default, and specifies that Enterprise COBOL will do SORT or MERGE input/output.
FLAG	X	X	X	X	X	X	Specifies that syntax messages are produced at the level indicated. For OS/VS COBOL the FLAG options are: FLAGW and FLAGE. For Enterprise COBOL, the FLAG options are: FLAG(I) FLAG(W) FLAG(E) FLAG(S) FLAG(U) FLAG(I|W|E|S|U,I|W|E|S|U) For VS COBOL II and IBM COBOL FLAG(I) is the default. For Enterprise COBOL, FLAG(I,I) is the default.
FLAGMIG	-	X	X	X	-	-	Specifies NOCMPR2 flagging for possible semantic changes from VS COBOL II Release 2 or other programs with CMPR2 behavior.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
FLAGMIG4	-	-	-	X Available only in Enterprise COBOL V4.2 with service applied	-	-	APAR PM93450 for Enterprise COBOL Version 4 Release 2 adds option FLAGMIG4 to identify language elements in Enterprise COBOL Version 4 programs that are not supported, or that are supported differently in Enterprise COBOL Version 5 or Version 6. The compiler will generate a warning diagnostic messages for all such language elements. It is also recommended that you install PTFs for APARs PI12240, PI26838, and PI58762 as these contain updates to the FLAGMIG4 option. **Note:** The source code changes for COBOL V5 and V6 are rarely used COBOL language features and do not affect 99% of COBOL users.
FLAGSTD	-	X	X	X	X	X	Specifies 85 COBOL Standard flagging. For COBOL for OS/390 & VM and COBOL for MVS & VM, FLAGSTD also flags language syntax for object-oriented COBOL, improved C interoperability, and use of the PGMNAME(LONGMIXED) compiler option. NOFLAGSTD is the default.
FDUMP	-	X	-	-	-	-	Produces a dump with debugging information when an application ends with an abend. NOFDUMP is the default. The Enterprise COBOL TEST option replaces the VS COBOL II FDUMP option.
HGPR	-	-	-	-	X	X	Controls the compiler usage of the 64-bit registers provided by z/Architecture processors. HGPR(PRESERVE) is the default.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
INITCHECK	-	-	-	-	-	X Available only in Enterprise COBOL V6.1 with service applied, or later	Controls whether to check for uninitialized data items and issue warning messages when they are used without being initialized.
INLINE	-	-	-	-	-	X Available only in Enterprise COBOL V6.1 with service applied, or later	Controls the compiler usage of inlining procedures (paragraphs or sections) referenced by PERFORM statements in the source program. Specifying NOINLINE prevents the compiler from inlining procedures referenced by PERFORM statements.
IDLGEN	-	-	X	-	-	-	In addition to the normal compile of the COBOL source file, IDLGEN generates IDL definitions for defined classes. NOIDLGEN is the default.
INTDATE	-	-	X	X	X	X	Determines the starting date for integer format dates when used with date intrinsic functions. INTDATE(ANSI) uses 85 COBOL Standard starting date, where Day 1 = January 1, 1601. INTDATE(LILIAN) uses the Language Environment Lilian starting date, where Day 1 = October 15, 1582. INTDATE(ANSI) is the default.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
LANGUAGE	-	X	X	X	X	X	LANGUAGE(AAa...a) specifies language in which compiler messages are issued, where AAa . . . a is: **UE or UENGLISH** Uppercase English **EN or ENGLISH** Mixed-case English **JA, JP, or JAPANESE** Japanese, using the KANJI character set LANGUAGE=(EN) is the default.
LIB	X	X	X	X	-	-	Specifies that the program uses the COPY library.
LINECNT	X	-	-	-	-	-	Specifies the number of lines per page on the output listing. For VS COBOL II, IBM COBOL, and Enterprise COBOL, the LINECOUNT compiler option replaces the OS/VS COBOL LINECNT option.
LINECOUNT	-	X	X	X	X	X	Specifies the number of lines per page on the output listing. The two formats for LINECOUNT are: LINECOUNT(60) and LINECOUNT(nn). LINECOUNT(60) is the default. LINECOUNT replaces the OS/VS COBOL LINECNT option.
LIST	-	X	X	X	X	X	Produces a listing of assembler language expansion of source code. NOLIST is the default. LIST replaces the OS/VS COBOL PMAP option.
LOAD	X	-	-	-	-	-	Stores object code on disk or tape for input to linkage-editor. NOLOAD is default. The VS COBOL II, IBM COBOL, and Enterprise COBOL OBJECT option replaces the OS/VS COBOL LOAD option.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
MAP	-	X	X	X	X	X	Produces a listing of the DATA DIVISION and implicitly declared items. NOMAP is the default. MAP replaces the OS/VS COBOL DMAP option. In Enterprise COBOL V5.1 with the latest service installed, and Enterprise COBOL V5.2 and V6, new suboptions HEX and DEC are added to control whether hexadecimal or decimal offsets are shown for MAP output in the compiler listing. Enterprise COBOL V5.1 at base level always produced MAP output with decimal offsets, while earlier compilers all produced MAP output with hexadecimal offsets. If MAP is specified with no suboption, it will be accepted as MAP(HEX). This will give you the same behavior in Enterprise COBOL V5 and V6 as in earlier COBOL compilers.
MAXPCF	-	-	-	-	X	X	Instructs the compiler not to optimize code if the program contains a complexity factor greater than *n*. The default is MAXPCF(100000).
MDECK	-	-	-	X	X	X	Causes output from the library processing (the expansion of COPY, BASIS, REPLACE, and EXEC SQL INCLUDE statements) to be written to a file. NOMDECK is the default.
NAME	X	X	X	X	X	X	Indicates that a linkage-editor NAME statement is appended to each object module created. For VS COBOL II, IBM COBOL, and Enterprise COBOL, NAME has the suboptions (ALIAS|NOALIAS). If ALIAS is specified, an ALIAS statement is also generated for each ENTRY statement NONAME is the default.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
NSYMBOL	-	-	-	X	X	X	Controls the interpretation of the "N" symbol used in literals and picture clauses, indicating whether national or DBCS processing is assumed. NSYMBOL(NATIONAL) is the default.
NUM	X	-	-	-	-	-	Prints line numbers in error messages and listings. NONUM is the default. The VS COBOL II, IBM COBOL, and Enterprise COBOL NUMBER option replaces the OS/VS COBOL NUM option.
NUMBER	-	X	X	X	X	X	Prints line numbers in error messages and listings. NONUMBER is the default. The NUMBER option replaces the OS/VS COBOL NUM option.
NUMCHECK	-	-	-	-	-	X Available only in Enterprise COBOL V6.1 with service applied, or later	Controls whether to generate implicit numeric class tests for zoned decimal and packed decimal data items that are used as sending data items, and whether to generate SIZE ERROR checking for binary data items. NUMCHECK is introduced in Enterprise COBOL V6.1 with the service PTFs. For details, see *NUMCHECK* in the *Enterprise COBOL Programming Guide*.
NUMCLS	-	X	X	X	X	X	Determines, together with the NUMPROC option, valid sign configurations for numeric items in the NUMERIC class test. NUMCLS has two suboptions: (PRIM/ALT). NUMCLS(PRIM) is the default. You can specify NUMCLS only at installation time. For more information, see the *Enterprise COBOL Customization Guide*.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
NUMPROC	-	X	X	X	X	X	Handles packed/zoned decimal signs as follows: **NUMPROC(PFD)** Decimal fields assumed to have standard S/390® signs **NUMPROC(NOPFD)** The compiler does any necessary sign conversion of nonpreferred but valid signs. **NUMPROC(MIG)** Enterprise COBOL processes sign conversion in a manner very similar to OS/VS COBOL. This suboption is not supported in Enterprise COBOL V5 and V6. To migrate your programs compiled with NUMPROC(MIG) to Enterprise COBOL V6, consider using the NUMCHECK compiler option to help you migrate to NUMPROC(PFD): 1. Compile your programs with NUMCHECK(ZON,PAC) and NUMPROC(PFD). 2. Run a thorough regression test with a good breadth of input data. If your applications get no NUMCHECK messages or NUMCHECK abends, you can safely compile with NUMPROC(PFD) and NONUMCHECK for production. This will not only solve the invalid data problem, but NUMPROC(PFD) is the most efficient setting for the NUMPROC compiler option. NUMCHECK is introduced in Enterprise COBOL V6.1 with the service PTFs. For details, see *NUMCHECK* in the *Enterprise COBOL Programming Guide*. NUMPROC(NOPFD) is the default.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
OBJECT	-	X	X	X	X	X	Stores object code on disk or tape for input to linkage-editor. OBJECT is the default. OBJECT replaces the OS/VS COBOL LOAD option.
OFFSET	-	X	X	X	X	X	Produces a condensed PROCEDURE DIVISION listing plus tables and program statistics. NOOFFSET is the default. OFFSET replaces the OS/VS COBOL CLIST option.
OPTFILE	-	-	-	X	X	X	Specifies that compiler options should be read from a separate data set or file specified by a SYSOPTF DD statement. OPTFILE is not in effect by default.
OPTIMIZE	X	X	X	X	X	X	Optimizes the object program. With IBM COBOL and Enterprise COBOL prior to V5, OPTIMIZE had the suboptions of (STD/FULL). The default was NOOPTIMIZE. In Enterprise COBOL V5 and V6, OPTIMIZE has the suboptions of (*0* | *1* | *2*). The OPTIMIZE option specifies increasing levels of optimization to improve application runtime performance. `OPTIMIZE(`*`0`*`)` is the default.
OUTDD	-	X	X	X	X	X	Routes DISPLAY output to SYSOUT or to a specified data set. OUTDD(SYSOUT) is the default. OUTDD replaces the OS/VS COBOL SYSx option.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
PARMCHECK	-	-	-	-	-	X Available only in Enterprise COBOL V6.1 with service applied, or later	Tells the compiler to generate an extra data item following the last item in WORKING-STORAGE. This buffer data item is then used at run time to check whether a called subprogram corrupted data beyond the end of WORKING-STORAGE. NOPARMCHECK is the default.
PGMNAME	-	-	X	X	X	X	Controls the handling of program names in relation to length and case. **PGMNAME(LONGMIXED)** Program names are used at their full length, without truncation and without folding or translating by the compiler. **PGMNAME(LONGUPPER)** Program names are used at their full length, without truncation. **PGMNAME(COMPAT)** Program names are handled in a manner compatible with older versions of COBOL compilers. PGMNAME(COMPAT) is the default.
PMAP	X	-	-	-	-	-	Produces a listing of assembler language expansion of source code. The VS COBOL II, IBM COBOL, and Enterprise COBOL LIST compiler option replaces the OS/VS COBOL PMAP option.
QUALIFY	-	-	-	-	X	X	QUALIFY affects qualification rules and controls whether to extend qualification rules so that some data items that cannot be referenced under COBOL Standard rules can be referenced.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
QUOTE	X	X	X	X	X	X	Specifies a quotation mark (") as the delimiter for literals. QUOTE is the default. In Enterprise COBOL, literals can be delimited with either quotation marks or apostrophes regardless of whether APOST or QUOTE is in effect. If QUOTE is used, the figurative constant QUOTE/QUOTES represents one or more quotation marks (") characters.
RES	X	X	-	-	-	-	Causes most library routines to be loaded dynamically, instead of being link-edited with the COBOL program. RES is the default behavior and is not changeable.
RENT	-	X	X	X	X	X	Specifies reentrant code in object program. RENT is the default.
RMODE	-	-	X	X	X	X	Establishes the residency mode for the generated object program. Programs compiled with NORENT will have RMODE(24). Programs compiled with RENT will have RMODE(ANY). RMODE(AUTO) is the default.
RULES	-	-	-	-	X Available only in Enterprise COBOL V5.1 with service applied, or later	X	Requests information about your program from the compiler to improve the program by flagging certain types of source code at compile time.
SEQ	X	-	-	-	-	-	Checks ascending sequencing of source statement line numbers. The VS COBOL II, IBM COBOL, and Enterprise COBOL SEQUENCE option replaces the OS/VS COBOL SEQ option.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
SEQUENCE	-	X	X	X	X	X	Checks ascending sequencing of source statement line numbers. SEQUENCE is the default. SEQUENCE replaces the OS/VS COBOL SEQ option.
SERVICE	-	-	-	-	X	X	Use SERVICE to place a string in the object module if the object module is generated. If the object module is linked into a program object, the string is loaded into memory with this program object. If the Language Environment dump includes a traceback, this string is included in that traceback.
SIZE	-	X	X	X	X		Specifies virtual storage to be used for compilation. SIZE(MAX) is not supported in Enterprise COBOL V5.1. The SIZE option is not supported in Enterprise COBOL V5.2.
SOURCE	X	X	X	X	X	X	Produces a listing of the source program and embedded messages. SOURCE is the default.
SPACE	X	X	X	X	X	X	Produces a single, double, or triple spaced listing. The syntax of the SPACE option in OS/VS COBOL is: SPACE1, SPACE2, SPACE3. The syntax of SPACE in VS COBOL II and Enterprise COBOL is: SPACE(1), SPACE(2), SPACE(3). SPACE(1) is the default.
SQL	-	-	X	X	X	X	Enables the Db2 coprocessor capability and specifies Db2 suboptions. NOSQL is the default.
SQLCCSID	-	-	-	X	X	X	Determines whether the CODEPAGE compiler option influences the processing of SQL statements in COBOL programs. Has an effect only when the integrated Db2 coprocessor (SQL compiler option) is used. SQLCCSID is the default.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
SQLIMS	-	-	-	-	X	X	Enables the IMS SQL coprocessor capability and specifies IMS suboptions. NOSQLIMS is the default.
SSRANGE	-	X	X	X	X	X	At run time, checks validity of subscript, index, and reference modification references. In Enterprise COBOL V6.1 with the PTF for APAR PI74933 installed, new suboptions MSG and ABD are added to control the runtime behavior of the COBOL program when a range check fails. In Enterprise COBOL V6.1, new suboptions ZLEN and NOZLEN are added to control how the compiler checks reference modification lengths. NOSSRANGE is the default.
STGOPT	-	-	-	-	X	X	Controls storage optimization. NOSTGOPT is the default.
SUPPRESS	-	-	-	-	-	X	Controls whether to ignore the SUPPRESS phrase of COPY statements.
SYSx	X	-	-	-	-	-	Routes DISPLAY output to SYSOUT or to a specified data set. The VS COBOL II, IBM COBOL, and Enterprise COBOL OUTDD option replaces the OS/VS COBOL SYSx option.
STATE	X	-	-	-	-	-	Produces a dump with debugging information when an application ends with an abend. The IBM Enterprise COBOL TEST option replaces the OS/VS COBOL STATE option.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
SUPMAP SYNTAX CSYNTAX	X	-	-	-	-	-	Specifies the extent of compilation. SYNTAX specifies unconditional syntax checking. CSYNTAX and CSUPMAP specify conditional syntax checking. NOSYNTAX and NOCSYNTAX specify an unconditional full compile. The VS COBOL II, IBM COBOL, and Enterprise COBOL COMPILE option replaces the OS/VS COBOL SYNTAX, CSYNTAX, and CSUPMAP options.
SYMDMP	X	-	-	-	-	-	Produces a symbolic dump. ABEND dumps and dynamic dumps are available through Language Environment services. Symbolic dumps are available by using the TEST compiler option.
SXREF	X	-	-	-	-	-	Produces sorted cross-reference listing of data names and procedure names used in program. The VS COBOL II, IBM COBOL, and Enterprise COBOL XREF option replaces the OS/VS COBOL SXREF option.
TERM	X	-	-	-	-	-	Sends progress messages to the SYSTERM data set. The VS COBOL II, IBM COBOL, and Enterprise COBOL TERMINAL option replaces the OS/VS COBOL TERM option.
TERMINAL	-	X	X	X	X	X	Sends progress messages to the SYSTERM data set. NOTERMINAL is the default. TERMINAL replaces the OS/VS COBOL TERM option.
TEST	X	X	X	X	X	X	Produces object code usable by Debug Tool for the product. NOTEST(NODWARF, NOSOURCE, NOSEPARATE) is the default. For details, see TEST in the *Enterprise COBOL Programming Guide*.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
THREAD	-	-	-	X	X	X	Enables a COBOL program for execution in a run unit with multiple POSIX threads or PL/I tasks. NOTHREAD is the default.
TRUNC	X	X	X	X	X	X	Truncates final intermediate results. OS/VS COBOL has the TRUNC and NOTRUNC options (NOTRUNC is the default). VS COBOL II, IBM COBOL, and Enterprise COBOL have the TRUNC(STD|OPT|BIN) option. **TRUNC(STD)** Truncates numeric fields according to PICTURE specification of the binary receiving field **TRUNC(OPT)** Truncates numeric fields in the most optimal way **TRUNC(BIN)** Truncates binary fields based on the storage they occupy TRUNC(STD) is the default. For a complete description, see the *Enterprise COBOL Programming Guide*.
TYPECHK	-	-	X	-	-	-	Enforces the rules for OO type conformance and issues diagnostics for any violations. NOTYPECHK is the default.
VBREF	-	X	X	X	X	X	Produces a cross-reference listing of all statement types used in program. NOVBREF is the default.
VBSUM	X	-	-	-	-	-	Produces a cross-reference listing of all verb types used in program.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
VLR	-	-	-	-	X Available only in Enterprise COBOL V5.1 with service applied, or later	X	Affects the file status returned from READ statements for variable-length records when the length of record returned is inconsistent with the record descriptions.
VSAMOPENFS	-	-	-	-	X Available only in Enterprise COBOL V5.2 with service applied, or later	X	Affects the user file status reported from successful VSAM OPEN statements that require verified file integrity check.
WORD	-	X	X	X	X	X	Tells the compiler which reserved word table to use. To use an installation-specific reserved word table, specify WORD(table-name). To use the default reserved word table, specify NOWORD. NOWORD is the default.
XMLPARSE	-	-	-	X Available only in Enterprise COBOL V4.1, or later	X Available only in Enterprise COBOL V5.1 with service applied, or later	X	For Enterprise COBOL Version 4 and later only (available in Enterprise COBOL Version 5.1 via service). Selects which XML parser is to be used, either the z/OS XML System Services parser (XMLSS) or the COBOL high-speed parser that was used in Enterprise COBOL Version 3. The default is XMLPARSE(XMLSS).
XREF	-	X	X	X	X	X	Produces a sorted cross-reference listing of data names and procedure names used in program. The default is XREF. XREF replaces the OS/VS COBOL SXREF option.

Table 50. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL V3 and V4	Enterprise COBOL V5	Enterprise COBOL V6	Usage notes
YEARWINDOW	-	-	X	X	-	-	Specifies the first year of the 100-year window (the century window) to be applied to windowed date field processing by the COBOL compiler. YEARWINDOW(1900) is the default.
ZONECHECK	-	-	-	-	X Available only in Enterprise COBOL V5.1 with service applied, or later	X	Tells the compiler to generate IF NUMERIC class tests for zoned decimal data items that are used as sending data items. From Enterprise COBOL V6.1 with the service PTFs, ZONECHECK is deprecated but is tolerated for compatibility. Consider using NUMCHECK(ZON) instead. For details, see *NUMCHECK* in the *Enterprise COBOL Programming Guide*.
ZONEDATA	-	-	-	-	X Available only in Enterprise COBOL V5.1 with service applied, or later	X	Tells the compiler whether data in USAGE DISPLAY and PACKED-DECIMAL data items is valid, and if not, what the behavior of the compiler should be.
ZWB	X	X	X	X	X	X	Removes the sign from a signed numeric DISPLAY field when comparing it with an alphanumeric field. ZWB is the default.

Appendix F. Compiler limit comparison

The following table lists the compiler limits for Enterprise COBOL V5 and V6, other Enterprise COBOL versions, IBM COBOL, VS COBOL II, and OS/VS COBOL programs.

These are guidelines to the limits in the table:

- Interpret a limit stated in megabytes (MB) as: x megabytes minus 1-B.
- Interpret a limit stated in kilobytes (KB) as: x kilobytes minus 1-B.
- Interpret a limit stated in gigabytes (GB) as: x gigabytes minus 1-B.
- B stands for bytes.
- N/L stands for no limit.
- Footnotes are at the end of the table.

Language element	Enterprise COBOL V5 and V6	Other Enterprise COBOL versions	IBM COBOL and VS COBOL II	OS/VS COBOL
Size of program	999,999 lines	999,999 lines	999,999 lines	999,999 lines
Number of literals	4,194,303-B[1]	4,194,303-B[1]	4,194,303-B[1]	16,384-B
Total length of literals	4,194,303-B[1]	4,194,303-B[1]	4,194,303-B[1]	32,767-B after OPT
Reserved word table entries	1536	1536	1536	N/L
COPY REPLACING . . . BY . . . (items per COPY statement)	N/L	N/L	N/L	150
Number of COPY libraries	N/L	N/L	N/L	N/L
Block size of COPY library	32,760-B	32,767-B	32,767-B	16,384-B
IDENTIFICATION DIVISION				
ENVIRONMENT DIVISION				
CONFIGURATION SECTION				
SPECIAL-NAMES paragraph				
mnemonic-name IS	18	18	18	18
UPSI-*n* . . . (switches)	0-7	0-7	0-7	0-7
alphabet-name IS . . .	N/L	N/L	N/L	N/L
literal THRU . . . or ALSO . . .	256	256	256	256
INPUT-OUPUT SECTION				
FILE-CONTROL paragraph				
SELECT *file-name* . . .	A maximum of 65,535 file names can be assigned external names	A maximum of 65,535 file names can be assigned external names	A maximum of 65,535 file names can be assigned external names	A maximum of 65,535 file names can be assigned external names

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Language element	Enterprise COBOL V5 and V6	Other Enterprise COBOL versions	IBM COBOL and VS COBOL II	OS/VS COBOL
ASSIGN *system-name* . . .	N/L	N/L	N/L	N/L
ALTERNATE RECORD KEY *data-name* . . .	253	253	253	253
RECORD KEY length	N/L[2]	N/L[2]	N/L[2]	255
RESERVE *integer* (buffers)	255[3]	255[3]	255[3]	255[3]
I-O-CONTROL paragraph				
RERUN ON *system-name* . . .	32,767	32,767	32,767	32,767
RERUN *integer* RECORDS	16,777,215	16,777,215	16,777,215	16,777,215
SAME RECORD AREA	255	255	255	255
SAME RECORD AREA FOR *file-name* . . .	255	255	255	255
SAME SORT/MERGE AREA	N/L[4]	N/L[4]	N/L[4]	N/L[4]
MULTIPLE FILE *file-name* . . .	N/L[4]	N/L[4]	N/L[4]	N/L[4]
DATA DIVISION				
77 data item size	999,999,999	134,217,727	16,777,215	1,048,576
Total 01 + 77 (data items)	N/L	N/L	N/L	255
88 condition-names . . .	N/L	N/L	N/L	N/L
66 RENAMES . . .	N/L	N/L	N/L	N/L
PICTURE clause, number of characters in *character-string*	50	50	30	30
PICTURE clause, numeric item digit positions	With ARITH(COMPAT): 18 With ARITH(EXTEND): 31	18 (or 31)[6]	For IBM COBOL: 18 (or 31)[6] For VS COBOL II: 18	18
PICTURE clause, numeric-edited character positions	249	249	249	127
PICTURE symbol replication ( )	999,999,999	134,217,727	16,777,215	99,999
PICTURE symbol replication ( ), class DBCS items	499,999,999	67,108,863	8,388,607	N/A
PICTURE symbol replication ( ), class national items	499,999,999	67,108,863	N/A	N/A
PICTURE symbol replication (editing)	32,767	32,767	32,767	99,999
Elementary item size	134,217,727	134,217,727	16,777,215	32,767
OCCURS integer	999,999,999	134,217,727	4,194,303	65,535

Language element	Enterprise COBOL V5 and V6	Other Enterprise COBOL versions	IBM COBOL and VS COBOL II	OS/VS COBOL
Table size	999,999,999	134,217,727	8,388,607	32,767
ASC or DES KEY . . . (per OCCURS clause)	12	12	12	12
Total length of keys (per OCCURS clause)	256B	256B	256B	256B
INDEXED BY . . . (index names by OCCURS clause)	12	12	12	12
Total number of indexes (index names) per class or program	65,535	65,535	65,535	65,535
Size of relative index	32,765	32,765	32,765	32,765
FILE SECTION				
FD record description entry	1,048,575	1,048,575	1,048,575	1,048,575
FD *file-name* . . .	65,535	65,535	65,535	65,535
LABEL *data-name* . . . (if no optional clauses)	255	255	255	185
Label record length	80-B	80-B	80-B	80-B
DATA RECORD *data-name* . . .	N/L[4]	N/L[4]	N/L[4]	N/L[4]
BLOCK CONTAINS *integer*	2,147,483,647[9]	2,147,483,647[9]	For IBM COBOL: 2,147,483,647 For VS COBOL II: 1,048,575[5]	32,760
RECORD CONTAINS *integer*	1,048,575[5]	1,048,575[5]	1,048,575[5]	32760
SD *file-name* . . .	65,535	65,535	65,535	65,535
DATA RECORD *data-name* . . .	N/L[4]	N/L[4]	N/L[4]	N/L[4]
WORKING-STORAGE SECTION				
Total size of items without the EXTERNAL attribute	2,147,483,646-B	134,217,727-B	134,217,727-B	1,048,576
Total size of items with the EXTERNAL attribute	2,147,483,646-B	134,217,727-B	134,217,727-B	N/A
LINKAGE SECTION				
Total size	N/L	134,213,631-B	134,217,727-B	1,048,576
PROCEDURE DIVISION				
Procedure and constant area	4,194,303[1]	4,194,303[1]	4,194,303[1]	1M+32-KB
PROCEDURE DIVISION USING *identifier* . . .	32,767	32,767	32,767	N/L
Procedure-names	1,048,575[1]	1,048,575[1]	1,048,575[1]	64-KB[1]

Language element	Enterprise COBOL V5 and V6	Other Enterprise COBOL versions	IBM COBOL and VS COBOL II	OS/VS COBOL
Statements per line (FDUMP/TEST)	7	7	7	7
Subscripted data-names per statement	32,767	32,767	32,767	511
ADD *identifier* . . .	N/L	N/L	N/L	N/L
ALTER *procedure-name 1* TO *procedure-name 2* . . .	4,194,303[1]	4,194,303[1]	4,194,303[1]	64-KB[1]
CALL . . . BY CONTENT *identifier*	2,147,483,647	2,147,483,647	2,147,483,647	N/A
CALL *literal* . . .	4,194,303[1]	4,194,303[1]	4,194,303[1]	N/L
CALL *identifier* or *literal* USING *identifier* or *literal* . . .	16,380	16,380	16,380	N/L
Active programs in run unit	32,767	32,767	32,767	32,767
Number of names called (DYN option)	N/L	N/L	N/L	64-K
CANCEL *identifier* or *literal* . . .	N/L	N/L	N/L	N/L
CLOSE *file-name* . . .	N/L	N/L	N/L	N/L
COMPUTE *identifier* . . .	N/L	N/L	N/L	N/L
DISPLAY *identifier* or *literal* . . .	N/L	N/L	N/L	N/L
DIVIDE *identifier* . . .	N/L	N/L	N/L	N/L
ENTRY USING *identifier* or *literal* . . .	N/L	N/L	N/L	N/L
EVALUATE . . . subjects	64	64	64	N/L
EVALUATE . . . WHEN clauses	256	256	256	N/L
GO *procedure-name* . . . DEPENDING	255	255	255	2031
INSPECT TALLYING and REPLACING clauses	N/L	N/L	N/L	15
MERGE *file-name* ASC or DES KEY . . .	N/L	N/L	N/L	12
Total merge key length	4092-B[7]	4092-B[7]	4092-B[7]	256-B
MERGE USING *file-name* . . .	16[8]	16[8]	16[8]	16[8]
MOVE *identifier* or *literal* TO *literal* . . .	N/L	N/L	N/L	N/L
MULTIPLY *identifier* . . .	N/L	N/L	N/L	N/L
OPEN *file-name* . . .	N/L	N/L	N/L	N/L
PERFORM	4,194,303	4,194,303	4,194,303	64-K
SEARCH . . . WHEN . . .	N/L	N/L	N/L	N/L
SET *index* or *identifier* . . . TO	N/L	N/L	N/L	N/L
SET *index* . . . UP or DOWN	N/L	N/L	N/L	N/L
SORT *file-name* ASC or DES KEY	N/L	N/L	N/L	12

Language element	Enterprise COBOL V5 and V6	Other Enterprise COBOL versions	IBM COBOL and VS COBOL II	OS/VS COBOL
Total sort key length	4092-B[7]	4092-B[7]	4092-B[7]	256-B
SORT USING *file-name* . . .	16[8]	16[8]	16[8]	16[8]
STRING *identifier* . . .	N/L	N/L	N/L	N/L
STRING DELIMITED *identifier* or *literal* . . .	N/L	N/L	N/L	N/L
UNSTRING DELIMITED *identifier* or *literal* . . .	N/L	255	255	15
UNSTRING INTO *identifier* or *literal* . . .	N/L	N/L	N/L	N/L
USE . . . ON *file-name* . . .	N/L	N/L	N/L	N/L

1. Items included in limit for procedure plus constant area.
2. No compiler limit, but VSAM limits it to 255 bytes.
3. QSAM limit.
4. Syntax checked, but has no effect on the execution of the program; there is no limit.
5. The compiler limit is shown, but QSAM limits it to 32,767 bytes.
6. For COBOL for OS/390 & VM V2R2 and later versions, 18 if ARITH(COMPAT) is in effect, or 31 if ARITH(EXTEND) is in effect.
7. For QSAM and VSAM, the limit is 4088 bytes if EQUALS is coded on the OPTION control statement.
8. SORT limit for QSAM and VSAM.
9. Requires large block interface (LBI) support provided by OS/390 DFSMS Version 2 Release 10.0 or later. On OS/390 systems with earlier releases of DFSMS, the limit is 32,767 bytes. For more information about using large block sizes, see the *Enterprise COBOL Programming Guide*.

Appendix G. Preventing file status 39 for QSAM files

To prevent file-status 39 for a QSAM file, ensure that there are no mismatches between the description of the file in your program and the attributes defined for the data set.

Processing existing files

When your program processes an existing file, code the description of the file in your COBOL program to be consistent with the file attributes of the data set, for example:

File format	Requirement
Format-V files or Format-S files	The maximum record length specified in your program must be exactly 4 bytes smaller than the length attribute of the data set.
Format-F files	The record length specified in your program must exactly match the length attribute of the data set.
Format-U files	The maximum record length specified in your program must exactly match the length attribute of the data set.

Remember: Information in the JCL overrides information in the data set label.

For details about how record lengths are determined from the FD entry and record descriptions in your program, see the *Enterprise COBOL Programming Guide*.

Defining variable-length records

The easiest way to define variable-length records in your program is to use RECORD IS VARYING FROM integer-1 TO integer-2 in the FD entry and specify an appropriate value for integer-2. For example, assume that you have determined the length attribute of the data set to be 104 (LRECL=104). Keeping in mind that the maximum record length is determined from the RECORD IS VARYING clause (in which values are specified) and not from the level-01 record descriptions, you could define a format-V file in your program with this code:

```
FILE SECTION.
FD  COMMUTER-FILE-MST
    RECORDING MODE IS V
    RECORD IS VARYING FROM 4 TO 100 CHARACTERS.
01  COMMUTER-RECORD-A           PIC X(4).
01  COMMUTER-RECORD-B           PIC X(75).
```

Assume that the existing file in the previous example was format-U instead of format-V. If the 104 bytes are all user data, you could define the file in your program with this code:

```
FILE SECTION.
FD  COMMUTER-FILE-MST
    RECORDING MODE IS U
    RECORD IS VARYING FROM 4 TO 104 CHARACTERS.
01  COMMUTER-RECORD-A           PIC X(4).
01  COMMUTER-RECORD-B           PIC X(75).
```

Defining fixed-length records

To define fixed-length records in your program, use either the RECORD CONTAINS integer clause, or omit this clause and specify all level-01 record descriptions to be the same fixed size. In either case, use a value that equals the value of the length attribute of the data set. When you intend to use the same program to process different files at execution and the files have differing fixed-length record lengths, the recommended way to avoid record-length conflicts is to code RECORD CONTAINS 0.

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If the existing file is an ASCII data set (DCB=(OPTCD=Q)), you must specify the CODE-SET clause in the program's FD entry for the file.

Converting existing files that do not match the COBOL record

You can re-allocate a new file with the matching LRECL, copy the data from an existing file to the new file, then use the new file as input.

Processing new files

If your COBOL program will write records to a new file which is made available before the program is run, ensure that the file attributes you specify in the DD statement or the allocation do not conflict with the attributes you have specified in your program. In most cases, you only need to specify a minimum of parameters when predefining your files, as illustrated in the following example of a DD statement related to the FILE-CONTROL and FD entries in your program:

```
JCL DD Statement:

 1
//OUTFILE  DD  DSNAME=OUT171,UNIT=SYSDA,SPACE=(TRK,(50,5)),
//             DCB=(BLKSIZE=400)


/*

Enterprise COBOL Program Code:

ENVIRONMENT DIVISION.
  INPUT-OUTPUT SECTION.
    FILE-CONTROL.
      SELECT CARPOOL  2
          ASSIGN TO OUTFILE  1
          ORGANIZATION IS SEQUENTIAL
          ACCESS IS SEQUENTIAL.
    .
    .
    .
DATA DIVISION.
  FILE SECTION.
    FD CARPOOL  2
      LABEL RECORD STANDARD
      BLOCK CONTAINS 0 CHARACTERS
      RECORD CONTAINS 80 CHARACTERS
```

Figure 6. Example of JCL, FILE-CONTROL entry, and FD entry

Where:

1

The *ddname* in the DD statement corresponds to the *assignment-name* in the ASSIGN clause:

```
//OUTFILE  DD  DSNAME=OUT171 …
```

This *assignment-name* points to the *ddname* of OUTFILE in the DD statement.

```
ASSIGN TO OUTFILE
```

2

When you specify a file in your COBOL FILE-CONTROL entry, the file must be described in an FD entry for *file-name*.

```
SELECT CARPOOL

FD CARPOOL
```

If you do need to explicitly specify a length attribute for the data set (for example, you are using an ISPF allocation panel or if your DD statement is for a batch job in which the program uses RECORD CONTAINS 0), use the following rules:

- For format-V and format-S files, specify a length attribute that is 4 bytes larger than what is defined in the program.
- For format-F and format-U files, specify a length attribute that is the same as what is defined in the program.
- If you open your file as OUTPUT and write it to a printer, the compiler might add one byte to the record length to account for the carriage control character, depending on the ADV compiler option and the COBOL language used in your program. In such a case, take the added byte into account when specifying the LRECL.

For example, if your program contains the following code for a file with variable-length records:

```
FILE SECTION.
  FD  COMMUTER-FILE-MST
      RECORDING MODE IS V
      RECORD VARYING 10 TO 50 CHARACTERS.
  01  COMMUTER-RECORD-A           PIC X(10).
  01  COMMUTER-RECORD-B           PIC X(50).
```

The LRECL in your DD statement or allocation should be 54.

Processing files dynamically created by COBOL

Note: This topic is for QSAM files only.

Enterprise COBOL dynamically allocates a file when all of the following conditions exist:

- The CBLQDA(ON) runtime option is in effect.
- A ddname for the file is not explicitly allocated.
- An environment variable of the same name is not set.
- The COBOL program opens the file to write to it.

When the file is opened, the attributes specified in your program will be used.

If CBLQDA(OFF) is in effect, an error will be generated.

Appendix H. Overriding binder (linkage-editor) defaults

AMODE and RMODE

You might need to override the Enterprise COBOL default settings for AMODE and RMODE depending on the settings of the RENT and RMODE compiler options.

Do not override AMODE or RMODE assigned by the compiler, in particular:

- Do not change the RMODE of Enterprise COBOL Version 5 and Version 6 NORENT programs to RMODE ANY.
- Do not change the AMODE of Enterprise COBOL Version 5.1.0 programs to AMODE 24. You can change the AMODE of Enterprise COBOL Version 5.1.1 and later programs to AMODE 24.

If a program object gets assigned AMODE 24 after binding, then it must also have RMODE 24. You cannot specify the binder option RMODE(ANY).

RENT

If you compile with the RENT compiler option, you must tell the binder that a module is RENT with REUS=RENT or the alternative RENT option (RENT includes REUS, so REUS is not necessary). The attribute RENT is not set in the program object by the compiler, unlike AMODE and RMODE.

How to override the defaults

To override the defaults, specify AMODE or RMODE using one of the mechanisms as described in this topic.

- EXEC statement of your link-edit job step, where *programname* refers to the program binder (linkage-editor), such as IEWBLINK, IEWL or HEWL:

```
//LKED     EXEC     PGM=programname,
//          PARM='AMODE=xx,RMODE=yy'
```

- The linkage-editor MODE control statements:

```
MODE AMODE(xx),RMODE(yy)
```

- One of the following TSO commands LINK or LOADGO:

```
LINK(dsn-list)
AMODE(xx) RMODE(yy)
LOADGO(dsn-list) AMODE(xx) RMODE(yy)
```

For more information about allowable *xx* and *yy* and binder MODE control statements, see your *MVS Program Management: User's Guide and Reference*.

The loader that uses information set by the binder uses a program's AMODE attribute to determine whether a program invoked using ATTACH, LINK, XCTL, or LOAD/BASSM is to receive control in 24-bit or 31-bit addressing mode. The loader uses the RMODE attribute to determine whether a program must be loaded into virtual storage below 16 MB, or can reside anywhere in virtual storage (above or below 16 MB).

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Appendix I. TSO considerations

This appendix describes conversion considerations for programs running on TSO. It includes information about using REXX execs.

Using REXX execs

When you run a COBOL program from a REXX exec, you need to be aware of the differences in the parameter list formats for using the different "address" options. When you use 'Address TSO' (the default) or 'Address ATTCHMVS', both program parameters and Language Environment runtime options are processed. When using 'Address LINKMVS', runtime options are not processed, but they are passed as program parameters to the COBOL program.

Due to the differences in parameter list formats and save area conventions, 'Address LINK', 'Address ATTACH', 'Address LINKPGM', and 'Address ATTCHPGM' are not supported.

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Appendix J. Migrating from XMLPARSE(COMPAT) to XMLPARSE(XMLSS)

You can migrate your programs to use XMLPARSE(XMLSS) after you understand the differences between XMLPARSE settings: XMLSS and COMPAT. Some of these differences are described in terms of new, changed, unchanged, and discontinued events when XMLPARSE(XMLSS) is in effect.

- **ATTRIBUTE-CHARACTER event (discontinued)**
  - **XMLSS:** The ATTRIBUTE-CHARACTER event no longer occurs. All entity references, including predefined ones, are now included in the ATTRIBUTE-CHARACTERS event, unless there is an unresolved entity reference, in which case an EXCEPTION event is signaled.
  - **COMPAT:** The ATTRIBUTE-CHARACTER event occurs for predefined entity references only. The five predefined entity references are shown in Table 51 on page 319. XML-TEXT or XML-NTEXT contains the single character that corresponds with the predefined entity reference in the attribute value. Character references are signaled as ATTRIBUTE-NATIONAL-CHARACTER events.
  - **To migrate to XMLPARSE(XMLSS):** Remove references to the ATTRIBUTE-CHARACTER event and integrate any actions for this event into your ATTRIBUTE-CHARACTERS event handling.
- **ATTRIBUTE-CHARACTERS event (changed)**
  - **XMLSS:** XML-TEXT or XML-NTEXT could have a substring of the value for the ATTRIBUTE-CHARACTERS event. XML-TEXT or XML-NTEXT could also contain a complete string of the value even if the value contains a character reference or an entity reference.
  - **COMPAT:** XML-TEXT or XML-NTEXT has only a substring of the value for the ATTRIBUTE-CHARACTERS event when the value contains a character reference or an entity reference.
  - **To migrate to XMLPARSE(XMLSS):** You might have to modify your code that handles the ATTRIBUTE-CHARACTERS event to handle more than one event even if your attribute values do not contain character or entity references. You might also have to change your code to process ATTRIBUTE-CHARACTERS as a single event where your code was handling ATTRIBUTE-CHARACTERS as multiple events.
- **ATTRIBUTE-NAME event (changed)**
  - **XMLSS:** For attribute names that are not in a namespace, XML-TEXT or XML-NTEXT contains the attribute name, and the namespace special registers are all empty and have length zero. Attributes with names in a namespace are always prefixed and have the form:

    ```
    prefix:local-part = AttValue
    ```

    XML-TEXT or XML-NTEXT contains the local-part, XML-NAMESPACE or XML-NNAMESPACE contains the namespace and XML-NAMESPACE-PREFIX or XML-NNAMESPACE-PREFIX contains the prefix.
  - **COMPAT:** For all attribute names, XML-TEXT or XML-NTEXT contains the complete attribute name, even if the name is prefixed (indicating that the name belongs to a namespace).
  - **To migrate to XMLPARSE(XMLSS):** Either change your code to process the separate parts of the namespace, or change your code to reconstruct the complete attribute name from the separate parts in XML-TEXT, XML-NAMESPACE-PREFIX, and XML-NAMESPACE, or XML-NTEXT, XML-NNAMESPACE-PREFIX, and XML-NNAMESPACE.
- **ATTRIBUTE-NATIONAL-CHARACTER event (changed)**
  - **XMLSS:** Character references that can be represented in the EBCDIC encoding of the XML document are resolved and included in the ATTRIBUTE-CHARACTERS event.

    Unrepresentable character references are expressed as ATTRIBUTE-NATIONAL-CHARACTER events, as for COMPAT.

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  - **COMPAT:** Regardless of the type of the XML document specified by identifier-1 in the XML PARSE statement, XML-TEXT is empty and XML-NTEXT contains the single national character corresponding with the (numeric) character reference.
  - **To migrate to XMLPARSE(XMLSS):** Possibly no change will be required, but be aware that with COMPAT, the national character might have an EBCDIC equivalent, whereas with XMLSS, the national character is known to have no representation in the EBCDIC encoding of the document.
- **COMMENT event (changed)**
  - **XMLSS:** XML-TEXT or XML-NTEXT could have a substring of the value for the COMMENT event.
  - **COMPAT:** XML-TEXT or XML-NTEXT always has the complete string of the value for the COMMENT event.
  - **To migrate to XMLPARSE(XMLSS):** You might have to modify your code that handles the COMMENT event to handle more than one event if you get a substring of the COMMENT value in XML-TEXT or XML-NTEXT. If that is the case, you get two or more COMMENT events in succession and you would concatenate strings together to re-create the complete string of the value. You cannot distinguish a comment that is split in this way from a sequence of distinct comments.
- **CONTENT-CHARACTER event (discontinued)**
  - **XMLSS:** The CONTENT-CHARACTER event no longer occurs. All entity references, including predefined ones, are now included in the CONTENT-CHARACTERS event unless there is an unresolved entity reference, in which case an UNRESOLVED-REFERENCE event or an EXCEPTION event is signaled.
  - **COMPAT:** The CONTENT-CHARACTER event occurs for predefined entity references only. The five predefined entity references are shown in Table 51 on page 319. XML-TEXT or XML-NTEXT contains the single character that corresponds with the predefined entity reference in the attribute value. Character references are signaled as CONTENT-NATIONAL-CHARACTER events.
  - **To migrate to XMLPARSE(XMLSS):** Remove references to the CONTENT-CHARACTER event and integrate any actions for this event into your CONTENT-CHARACTERS event handling.
- **CONTENT-CHARACTERS event (changed)**
  - **XMLSS:** XML-TEXT or XML-NTEXT could have a substring of the content for the CONTENT-CHARACTERS event. XML-TEXT or XML-NTEXT could also contain a complete string of the content even if the content contains a character reference or an entity reference.
  - **COMPAT:** XML-TEXT or XML-NTEXT has only a substring of the content for the CONTENT-CHARACTERS event when the content contains a character reference or an entity reference.
  - **To migrate to XMLPARSE(XMLSS):** You might have to modify your code that handles the CONTENT-CHARACTERS event to handle more than one event even if your attribute values do not contain character or entity references. You might also have to change your code to process CONTENT-CHARACTERS as a single event where your code was handling CONTENT-CHARACTERS as multiple events.
- **CONTENT-NATIONAL-CHARACTER event (changed)**
  - **XMLSS:** Character references that can be represented in the EBCDIC encoding of the XML document are resolved and included in the CONTENT-CHARACTERS event.

    Unrepresentable character references are expressed as CONTENT-NATIONAL-CHARACTER events, as for COMPAT.
  - **COMPAT:** Regardless of the type of the XML document specified by identifier-1 in the XML PARSE statement, XML-TEXT is empty, and XML-NTEXT contains the single national character corresponding with the (numeric) character reference.
  - **To migrate to XMLPARSE(XMLSS):** Possibly no change will be required, but be aware that with COMPAT, the national character might have an EBCDIC equivalent, whereas with XMLSS, the national character is known to have no representation in the EBCDIC encoding of the document.

Note: The XML System Services parser transforms the following characters or character combinations to x'15' when parsing EBCDIC documents:

x'0D' CR
x'15' NL
x'25' LF
x'0D15' (these two bytes together)
x'0D25' (these two bytes together)

Some of these characters might be produced when an in-memory image of an ASCII document is translated to EBCDIC. The COMPAT parser does none of these transforms. An application which depends on them not being done will need appropriate changes when using XMLPARSE(XMLSS).

- **DOCUMENT-TYPE-DECLARATION event (changed)**
  - **XMLSS:** XML-TEXT or XML-NTEXT contains the name of the root element, as specified in the document type declaration. The parser processes entity declarations and default attribute values in the internal DTD subset, and ignores the rest of the text in the document type declaration.
  - **COMPAT:** XML-TEXT or XML-NTEXT contains the entire document type declaration.
  - **To migrate to XMLPARSE(XMLSS):** If having the whole document type declaration is important, you might have to modify your code that handles the DOCUMENT-TYPE-DECLARATION event to acquire the information directly from your XML document.
- **ENCODING-DECLARATION event (changed)**
  - **XMLSS:** XML-TEXT or XML-NTEXT contains the encoding name. The encoding declaration is not used by the parser, so you might get incorrect characters passed through that would cause the parser to signal an EXCEPTION event from which you can't recover.
  - **COMPAT:** XML-TEXT or XML-NTEXT contains the encoding name. If there are errors in the encoding of the document, you would get an EXCEPTION event from which you might be able to recover and continue.
  - **To migrate to XMLPARSE(XMLSS):** Check your document before parsing or specify your encoding using the CODEPAGE compiler option or by using the WITH ENCODING phrase on the XML PARSE statement.
- **END-OF-CDATA-SECTION event (changed)**
  - **XMLSS:** All XML special registers except XML-EVENT, XML-CODE and XML-INFORMATION are empty with length zero.
  - **COMPAT:** XML-TEXT or XML-NTEXT always contains the string "]]>".
  - **To migrate to XMLPARSE(XMLSS):** If the string "]]>" is acquired from the END-OF-CDATA-SECTION event, change your code to manually return it using a literal, or data item initialized with the value "]]>".
- **END-OF-DOCUMENT event (no change)**
  - The 2 parsers have the same behavior for the END-OF-DOCUMENT event.
  - **To migrate to XMLPARSE(XMLSS):** No change required.
- **END-OF-ELEMENT event (changed)**
  - **XMLSS:** XML-TEXT or XML-NTEXT contains the local part of the end element tag or empty element tag name. If the element name is in a namespace, XML-NAMESPACE or XML-NNAMESPACE contains the namespace, otherwise these special registers are empty with length zero. If the element name is in a namespace and is prefixed (of the form "prefix:local-part"), XML-NAMESPACE-PREFIX or XML-NNAMESPACE-PREFIX contains the prefix, otherwise these special registers are empty with length zero.
  - **COMPAT:** XML-TEXT or XML-NTEXT contains the complete element tag name, including any prefix. If the element name is not in a namespace, there is no difference between COMPAT and XMLSS for END-OF-ELEMENT.

  - **To migrate to XMLPARSE(XMLSS):** If the element name is not in a namespace, then no change is required. If the element name is in a namespace, change your code to not use the complete element name, or reconstruct the complete element name from the separate parts in the XML text and namespace special registers.

- **END-OF-INPUT event (new)**
  - **XMLSS:** The END-OF-INPUT event indicates the end of a segment of an XML document.
  - **COMPAT:** The END-OF-INPUT event does not occur.
  - **To migrate to XMLPARSE(XMLSS):** With COMPAT, your document is in one segment, so no change is required to change to XMLSS.
- **EXCEPTION event (changed)**
  - **XMLSS:** XML-CODE contains the unique return code and reason code identifying the exception. See the following section "Other differences" for a description of XML-CODE differences. XML-TEXT or XML-NTEXT contains the document fragment up to the point of the error or anomaly that caused the EXCEPTION event. All other XML special registers except XML-EVENT and XML-INFORMATION are empty with length zero. It is not possible to continue from any EXCEPTION event.
  - **COMPAT:** XML-TEXT or XML-NTEXT contains the entire document that has been parsed up to the point of the EXCEPTION event. It is possible to continue from some EXCEPTION events.
  - **To migrate to XMLPARSE(XMLSS):** You might have to change your code or documents if they depend on being able to recover from EXCEPTION events.
- **NAMESPACE-DECLARATION event (new)**
  - **XMLSS:** XML-TEXT and XML-NTEXT are both empty with length zero. XML-NAMESPACE or XML-NNAMESPACE contains the declared namespace. If the namespace is "undeclared" by specifying the empty string, XML-NAMESPACE and XML-NNAMESPACE are empty with length zero. XML-NAMESPACE-PREFIX or XML-NNAMESPACE-PREFIX contains the prefix if the attribute name for the namespace declaration is of the form "xmlns:prefix", otherwise, if the declaration is for the default namespace and the attribute name is "xmlns", XML-NAMESPACE-PREFIX and XML-NNAMESPACE-PREFIX are both empty with length zero.
  - **COMPAT:** The NAMESPACE-DECLARATION event does not occur.
  - **To migrate to XMLPARSE(XMLSS):** If you get the NAMESPACE-DECLARATION event after migrating to XMLSS, see the descriptions in this table of ATTRIBUTE-NAME, END-OF-ELEMENT and START-OF-ELEMENT event changes.
- **PROCESSING-INSTRUCTION-DATA event (changed)**
  - **XMLSS:** XML-TEXT or XML-NTEXT could have a substring of the value for the PROCESSING-INSTRUCTION-DATA event.
  - **COMPAT:** XML-TEXT or XML-NTEXT always has the complete string of the value for the PROCESSING-INSTRUCTION-DATA event.
  - **To migrate to XMLPARSE(XMLSS):** You might have to modify your code that handles the PROCESSING-INSTRUCTION-DATA event to handle more than one event if you get a substring of the PROCESSING-INSTRUCTION-DATA value in XML-TEXT or XML-NTEXT. If that is the case, you get two or more PROCESSING-INSTRUCTION-DATA events, each one preceded by its matching PROCESSING-INSTRUCTION-TARGET event. You would then concatenate the PROCESSING-INSTRUCTION-DATA substrings together to reconstitute the complete data string.
- **PROCESSING-INSTRUCTION-TARGET event (changed)**
  - **XMLSS:** If the processing instruction data is split into substrings, the PROCESSING-INSTRUCTION-TARGET event is repeated before each instance of the PROCESSING-INSTRUCTION-DATA event for a given processing instruction.
  - **COMPAT:** The PROCESSING-INSTRUCTION-TARGET event occurs only once for a given processing instruction.

- **To migrate to XMLPARSE(XMLSS):** You might have to modify your code to accommodate multiple occurrences of the PROCESSING-INSTRUCTION-TARGET event while accumulating processing instruction data.

- **STANDALONE-DECLARATION event (no change)**
  - XMLSS and COMPAT have the same behavior for the STANDALONE-DECLARATION event.
  - **To migrate to XMLPARSE(XMLSS):** No change required.
- **START-OF-CDATA-SECTION event (changed)**
  - **XMLSS:** All XML special registers except XML-EVENT, XML-CODE and XML-INFORMATION are empty with length zero.
  - **COMPAT:** XML-TEXT or XML-NTEXT always contains the string "![CDATA[".
  - **To migrate to XMLPARSE(XMLSS):** If the string "![CDATA[" is acquired from the START-OF-CDATA-SECTION event, change your code to manually return it using a literal, or data item initialized with the value "![CDATA[".
- **START-OF-DOCUMENT event (changed)**
  - **XMLSS:** All XML special registers except XML-EVENT, XML-CODE and XML-INFORMATION are empty with length zero.
  - **COMPAT:** XML-TEXT or XML-NTEXT contains the entire document.
  - **To migrate to XMLPARSE(XMLSS):** Change your code to not require the entire document for START-OF-DOCUMENT.
- **START-OF-ELEMENT event (changed)**
  - **XMLSS:** XML-TEXT or XML-NTEXT contains the local part of the start element name or empty element name. If the element name is in a namespace, XML-NAMESPACE or XML-NNAMESPACE contains the namespace, otherwise these special registers are empty with length zero. If the element name is in a namespace and is prefixed (of the form "prefix:local-part"), XML-NAMESPACE-PREFIX or XML-NNAMESPACE-PREFIX contains the prefix, otherwise these special registers are empty with length zero.
  - **COMPAT:** XML-TEXT or XML-NTEXT contains the complete start element name, including any prefix. If the element name is not in a namespace, there is no difference between COMPAT and XMLSS for START-OF-ELEMENT.
  - **To migrate to XMLPARSE(XMLSS):** If the element name is not in a namespace, then no change is required. If the element name is in a namespace, change your code to not use the complete element name, or reconstruct the complete element name from the separate parts in the XML text and namespace special registers.
- **UNKNOWN-REFERENCE-IN-ATTRIBUTE event (discontinued)**
  - **XMLSS:** Does not occur. The parser always signals an EXCEPTION event if, while processing an attribute value, it encounters a reference to an entity that has not been defined.
  - **COMPAT:** XML-TEXT or XML-NTEXT contains the entity reference name, not including the "&" and ";" delimiters.
  - **To migrate to XMLPARSE(XMLSS):** Ensure that your XML documents do not contain any undefined entity references in attribute values.
- **UNKNOWN-REFERENCE-IN-CONTENT event (discontinued)**
  - **XMLSS:** Does not occur. Instead, an UNRESOLVED-REFERENCE or EXCEPTION event occurs.
  - **COMPAT:** XML-TEXT or XML-NTEXT contains the entity reference name, not including the "&" and ";" delimiters.
  - **To migrate to XMLPARSE(XMLSS):** Change your code that processes UNKNOWN-REFERENCE-IN-CONTENT to process UNRESOLVED-REFERENCE instead.

    The UNRESOLVED-REFERENCE event is signaled only if all of the following conditions are true:

    - The unresolved reference is within element content, not an attribute value.

- The XML document starts with an XML declaration that specifies standalone="no".
- The XML document contains a document type declaration, for example:

```
<!DOCTYPE rootElementName>
```

- If the VALIDATING phrase is specified on the XML PARSE statement, the document type declaration must also specify an external DTD subset, for example:

```
<!DOCTYPE rootElementName SYSTEM "extSub.dtd">
```

If these conditions are not met, the parser signals an EXCEPTION event instead of UNRESOLVED-REFERENCE.

- **UNRESOLVED-REFERENCE event (new)**
  - **XMLSS:** XML-TEXT or XML-NTEXT contains the entity reference name, not including the "&" and ";" delimiters.
  - **COMPAT:** The event does not occur. Instead an UNKNOWN-REFERENCE-IN-CONTENT event would occur.
  - **To migrate to XMLPARSE(XMLSS):** See UNKNOWN-REFERENCE-IN-CONTENT.
- **VERSION-INFORMATION event (no change)**
  - both parsers have the same behavior for the VERSION-INFORMATION event.
  - **To migrate to XMLPARSE(XMLSS):** No change required.

More differences between XMLPARSE(XMLSS) and XMLPARSE(COMPAT):

- **XML-CODE**
  - **XMLSS:** When XML-CODE is set by the parser for an EXCEPTION event, the first halfword is the return code and the last halfword is the reason code. Convert the value to hexadecimal. You can find common return code and reason code in the *z/OS XML System Services User's Guide and Reference*. You can also find COBOL specific return code and reason code in the *Enterprise COBOL Programming Guide*
  - **COMPAT:** XML-CODE values are described in decimal in the *Enterprise COBOL Programming Guide, Version 4 Release 2*.
  - **To migrate to XMLPARSE(XMLSS):** If your program tests for specific XML-CODE values for EXCEPTION events, you might have to change those values in your source program.
- **Condition handling, RESUME, and XML PARSE statements**
  - **XMLSS:** If a condition handling routine, registered by CEEHDLR or runtime option USERHDLR, gets control while executing a processing procedure due to an exception in the processing procedure and the resume cursor is moved by CEEMRCE to a point in the program before an XML PARSE statement, and RESUME is requested from the condition manager, the second XML PARSE would result in the following severity 3 runtime error message:

```
IGZ0228S There was an invalid attempt to start an XML PARSE statement.
```

  - **COMPAT:** If a condition handling routine (registered by CEEHDLR or runtime option USERHDLR) gets control while executing a processing procedure due to an exception in the processing procedure, and the resume cursor is moved by CEEMRCE to a point in the program before an XML PARSE statement, and RESUME is requested from the condition manage, the second XML PARSE would start sucessfully.
  - **To migrate to XMLPARSE(XMLSS):** Move the call to CEE3SRP to be within the processing procedure. Then at the resumption point, if the condition handling routine is unable to recover from the exception, terminate parsing by moving -1 to XML-CODE. If the condition handling routine is able to make an effective recovery, you might be able to continue parsing by leaving XML-CODE unchanged.

Alternatively, you can use CEEMRCR instead of CEEMRCE so that when execution is resumed, it is in the program that called the program that had the XML PARSE statement that got the exception in the processing procedure.

Either of these methods properly addresses the exception.

The following table shows the predefined entity references.

Table 51. The predefined entity references

Predefined entity	**Character**
<	<
>	>
&	&
'	'
"	"

Appendix K. Controlling initialization of QSAM buffer (IGZ4OPT)

The first character in a QSAM file can be used as a control character (CC) for printer spacing control. In some cases, a blank record with just the control character is outputted, depending on semantic requirements of the LINAGE clause or WRITE AFTER...LINE(S) statement.

The bytes after the CC are called the slack bytes. In Enterprise COBOL V5.1 and earlier versions, the value of these slack bytes is undefined. It might be either EBCDIC SPACE or BINARY ZERO, but no explicit initialization is done during the COBOL processing routine. These slack bytes are technically irrelevant because the printer would have moved to a different line when processing the CC. However, some printers might misbehave with a certain value.

To control what the QSAM buffer is initialized with during COBOL processing and ensure that the value of slack bytes is consistent, apply the COBOL runtime LE PTF for APAR PH25917 and take the following steps:

1. In the Language Environment sample data set .SCEESAMP, copy and customize the sample JCL IGZ4OPT. Specify the QSAMBUFFINITCHAR option as needed. Change the JOB card and load library name, and run this JCL to generate IGZUOPT.
2. Put this module in a data set in the STEPLIB concatenation when running the application.

When using the sample JCL IGZ4OPT to create IGZUOPT, JOB STEP1 of the JCL assembles an assembler program that invokes a MACRO called IGZXOPT. This macro is used to specify special COBOL runtime options. Specify the QSAMBUFFINITCHAR option with the following syntax:

```
IGZXOPT QSAMBUFFINITCHAR=DEFAULT | SPACE | BINZERO
```

The setting of QSAMBUFFINITCHAR can be DEFAULT, SPACE, or BINZERO, and the default value is DEFAULT. The QSAM buffer is initialized based on the value that you specify:

- If DEFAULT is specified, the QSAM buffer used for the LINAGE clause or WRITE AFTER...LINE(S) statement is using the same behavior as in Enterprise COBOL V5.1 or earlier versions.
- If SPACE is specified, the QSAM buffer used for the LINAGE clause WRITE AFTER...LINE(S) statement is initialized with EBCDIC SPACE (X'40').
- If BINZERO is specified, the QSAM buffer used for the LINAGE clause or WRITE AFTER...LINE(S) statement is initialized with BINARY ZERO (X'00').

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Appendix L. Accessibility features for Enterprise COBOL for z/OS

Accessibility features assist users who have a disability, such as restricted mobility or limited vision, to use information technology content successfully. The accessibility features in z/OS provide accessibility for Enterprise COBOL for z/OS.

Accessibility features

z/OS includes the following major accessibility features:

- Interfaces that are commonly used by screen readers and screen-magnifier software
- Keyboard-only navigation
- Ability to customize display attributes such as color, contrast, and font size

z/OS uses the latest W3C Standard, WAI-ARIA 1.0 (http://www.w3.org/TR/wai-aria/), to ensure compliance to US Section 508 (https://www.access-board.gov/ict/) and Web Content Accessibility Guidelines (WCAG) 2.0 (http://www.w3.org/TR/WCAG20/). To take advantage of accessibility features, use the latest release of your screen reader in combination with the latest web browser that is supported by this product.

The Enterprise COBOL for z/OS online product documentation in IBM Knowledge Center is enabled for accessibility. The accessibility features of IBM Knowledge Center are described at http://www.ibm.com/support/knowledgecenter/en/about/releasenotes.html.

Keyboard navigation

Users can access z/OS user interfaces by using TSO/E or ISPF.

Users can also access z/OS services by using IBM Developer for z/OS.

For information about accessing these interfaces, see the following publications:

- *z/OS TSO/E Primer*
- *z/OS TSO/E User's Guide*
- *z/OS ISPF User's Guide Volume I*
- IBM Developer for z/OS Knowledge Center (http://www.ibm.com/support/knowledgecenter/SSQ2R2/rdz_welcome.html?lang=en)

These guides describe how to use TSO/E and ISPF, including the use of keyboard shortcuts or function keys (PF keys). Each guide includes the default settings for the PF keys and explains how to modify their functions.

Interface information

The Enterprise COBOL for z/OS online product documentation is available in IBM Knowledge Center, which is viewable from a standard web browser.

PDF files have limited accessibility support. With PDF documentation, you can use optional font enlargement, high-contrast display settings, and can navigate by keyboard alone.

To enable your screen reader to accurately read syntax diagrams, source code examples, and text that contains period or comma PICTURE symbols, you must set the screen reader to speak all punctuation.

Assistive technology products work with the user interfaces that are found in z/OS. For specific guidance information, see the documentation for the assistive technology product that you use to access z/OS interfaces.

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Related accessibility information

In addition to standard IBM help desk and support websites, IBM has established a TTY telephone service for use by deaf or hard of hearing customers to access sales and support services:

TTY service 800-IBM-3383 (800-426-3383) (within North America)

IBM and accessibility

For more information about the commitment that IBM has to accessibility, see IBM Accessibility (www.ibm.com/able).

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Programming interface information

This information is intended to help you write programs using IBM Enterprise COBOL for z/OS. This Migration Guide documents General-Use Programming Interface and Associated Guidance Information provided for IBM Enterprise COBOL for z/OS. General-Use programming interfaces allow the customer to write programs that obtain the services of IBM Enterprise COBOL for z/OS.

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Glossary

The terms in this glossary are defined in accordance with their meaning in COBOL. These terms might or might not have the same meaning in other languages.

This glossary includes terms and definitions from the following publications:

- *ANSI INCITS 23-1985, Programming Languages - COBOL* as amended by:
  - *ANSI INCITS 23a-1989, Programming Languages - Intrinsic Function Module for COBOL,*
  - *ANSI INCITS 23b-1993, Programming Language - Correction Amendment for COBOL*
- *ANSI INCITS 172-2002 American National Standard Dictionary of Information Technology*.

American National Standard definitions are preceded by an asterisk (*).

A

*** abbreviated combined relation condition**
The combined condition that results from the explicit omission of a common subject or a common subject and common relational operator in a consecutive sequence of relation conditions.

abend
Abnormal termination of a program.

above the 16-MB line
Storage above the so-called 16-MB line (or boundary) but below the 2-GB bar. This storage is addressable only in 31-bit mode (AMODE 31). Before IBM introduced the MVS/XA architecture in the 1980s, the virtual storage for a program was limited to 16 MB. Programs that have been compiled with 24-bit mode (AMODE 24) can address only 16 MB of space, as though they were kept under an imaginary storage line. Since VS COBOL II, a program that has AMODE 31 can address data above the 16-MB line.

*** access mode**
The manner in which records are to be operated upon within a file.

*** actual decimal point**
The physical representation, using the decimal point characters period (.) or comma (,), of the decimal point position in a data item.

*** alphabet-name**
A user-defined word, in the SPECIAL-NAMES paragraph of the ENVIRONMENT DIVISION, that assigns a name to a specific character set or collating sequence.

*** alphabetic character**
A letter or a space character.

*** alphanumeric character**
Any character in the computer's single-byte character set.

alphanumeric data item
A general reference to a data item that is described implicitly or explicitly as `USAGE DISPLAY`, and that has category alphanumeric, alphanumeric-edited, or numeric-edited.

alphanumeric-edited data item
A data item that is described by a `PICTURE` character string that contains at least one instance of the symbol `A` or `X` and at least one of the simple insertion symbols `B`, `0`, or `/`. An alphanumeric-edited data item has `USAGE DISPLAY`.

*** alphanumeric function**
A function whose value is composed of a string of one or more characters from the computer's character set.

*** alternate record key**
A key, other than the prime record key, whose contents identify a record within an indexed file.

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AMODE
Provided by the linkage-editor, the attribute of a program object that indicates the addressing mode in which the program object should be entered.

application
A collection of one or more routines cooperating to achieve particular objectives.

ANSI (American National Standards Institute)
An organization consisting of producers, consumers, and general interest groups, that establishes the procedures by which accredited organizations create and maintain voluntary industry standards in the United States.

*** argument**
(1) An expression used at the point of a call to specify a data item or aggregate to be passed to the called routine. (2) The data passed to a called routine at the point of call or the data received by a called routine.

*** arithmetic expression**
An identifier of a numeric elementary item, a numeric literal, such identifiers and literals separated by arithmetic operators, two arithmetic expressions separated by an arithmetic operator, or an arithmetic expression enclosed in parentheses.

*** arithmetic operation**
The process caused by the execution of an arithmetic statement, or the evaluation of an arithmetic expression, that results in a mathematically correct solution to the arguments presented.

*** arithmetic operator**
A single character, or a fixed two-character combination that belongs to the following set:

Character	Meaning
+	addition
-	subtraction
*	multiplication
/	division
**	exponentiation

*** arithmetic statement**
A statement that causes an arithmetic operation to be executed. The arithmetic statements are the ADD, COMPUTE, DIVIDE, MULTIPLY, and SUBTRACT statements.

array
In Language Environment, an aggregate consisting of data objects, each of which may be uniquely referenced by subscripting. Roughly analogous to a COBOL table.

*** ascending key**
A key upon the values of which data is ordered, starting with the lowest value of the key up to the highest value of the key, in accordance with the rules for comparing data items.

ASCII
American National Standard Code for Information Interchange. The standard code, using a coded character set consisting of 7-bit coded characters (8 bits including parity check), used for information interchange between data processing systems, data communication systems, and associated equipment. The ASCII set consists of control characters and graphic characters.

Extension: IBM has defined an extension to ASCII code (characters 128-255).

assignment-name
A name that identifies the organization of a COBOL file and the name by which it is known to the system.

*** assumed decimal point**
A decimal point position that does not involve the existence of an actual character in a data item. The assumed decimal point has logical meaning with no physical representation.

*** AT END condition**
A condition caused by one of the following operations:

1. A READ statement for a sequentially accessed file, when one of the following conditions is encountered:
   - No next logical record exists in the file.
   - The number of significant digits in the relative record number is larger than the size of the relative key data item.
   - An optional input file is not present.
2. A RETURN statement, when no next logical record exists for the associated sort or merge file.
3. A SEARCH statement, when the search operation terminates without satisfying the condition specified in any of the associated WHEN phrases.

B

basic document encoding
For an XML document, one of the following encoding categories that the XML parser determines by examining the first few bytes of the document:

- ASCII
- EBCDIC
- Unicode UTF-16, either big-endian or little-endian
- Other unsupported encoding
- No recognizable encoding

big-endian
The default format that the mainframe and the AIX® workstation use to store binary data and UTF-16 characters. In this format, the least significant byte of a binary data item is at the highest address and the least significant byte of a UTF-16 character is at the highest address. Compare with *little-endian*.

binary item
A numeric data item represented in binary notation (on the base 2 numbering system). Binary items have a decimal equivalent consisting of the decimal digits 0 through 9, plus an operational sign. The leftmost bit of the item is the operational sign.

binary search
A dichotomizing search in which, at each step of the search, the set of data elements is divided by two; some appropriate action is taken in the case of an odd number.

*** block**
A physical unit of data that is normally composed of one or more logical records. For mass storage files, a block may contain a portion of a logical record. The size of a block has no direct relationship to the size of the file within which the block is contained or to the size of the logical record(s) that are either contained within the block or that overlap the block. The term is synonymous with physical record.

breakpoint
A place in a program, usually specified by a command or condition, where execution may be interrupted and control given to the workstation user or to a specified debug program.

Btrieve
A key-indexed record management system that allows applications to manage records by key value, sequential access method, or random access method. Enterprise COBOL supports COBOL sequential and indexed file I-O language through Btrieve.

buffer
An area of storage into which data is read or from which it is written. Typically, buffers are used only for temporary storage.

built-in function
See "intrinsic function".

byte
The basic unit of storage addressability. It has a length of 8 bits.

C

C language
A high-level language used to develop software applications in compact, efficient code that can be run on different types of computers with minimal change.

C++ language
An object-oriented high-level language that evolved from the C language. C++ exploits the benefits of object-oriented technology such as code modularity, portability, and reuse.

callable services
A set of services that can be invoked by a Language Environment, featuring defined call interface, and usable by all programs sharing the Language Environment conventions.

cataloged procedure
A set of job control statements placed in a partitioned data set called the procedure library (SYS1.PROCLIB) You can use cataloged procedures to save time and reduce errors coding JCL.

called program
A program that is the object of a CALL statement.

*** calling program**
A program that executes a CALL to another program.

case structure
A program processing logic in which a series of conditions is tested in order to make a choice between a number of resulting actions.

CEEDUMP
A dump of the runtime environment for Language Environment and the member language libraries. Sections of the dump are selectively included, depending on options specified on the dump invocation. This is not a dump of the full address space, but a dump of storage and control blocks that Language Environment and its members control.

cataloged procedure
A set of job control statements placed in a partitioned data set called the procedure library (SYS1.PROCLIB). You can use cataloged procedures to save time and reduce errors coding JCL.

century window
The 100-year interval in which Language Environment assumes all 2-digit years lie. The Language Environment default century window begins 80 years before the system date.

*** character**
A letter, digit, or other symbol that is used as part of the organization, control, or representative of data. A character is often in the form of a spatial arrangement of adjacent or connected strokes.

character position
The amount of physical storage required to store a single standard data format character described as USAGE IS DISPLAY.

character set
All the valid characters for a programming language or a computer system.

*** character-string**
A sequence of contiguous characters that form a COBOL word, a literal, a PICTURE character-string, or a comment-entry. Must be delimited by separators.

checkpoint
A point at which information about the status of a job and the system can be recorded so that the job step can be later restarted.

CICS
Customer Information Control System.

CICS translator
A routine that accepts as input an application containing EXEC CICS commands and produces as output an equivalent application in which each CICS command has been translated into the language of the source.

*** class**
The entity that defines common behavior and implementation for zero, one, or more objects. The objects that share the same implementation are considered to be objects of the same class.

*** class condition**
The proposition, for which a truth value can be determined, that the content of an item is wholly alphabetic, is wholly numeric, or consists exclusively of those characters listed in the definition of a class-name.

*** Class Definition**
The COBOL source unit that defines a class.

*** class identification entry**
An entry in the CLASS-ID paragraph of the IDENTIFICATION DIVISION which contains clauses that specify the class-name and assign selected attributes to the class definition.

*** class-name**
A user-defined word defined in the SPECIAL-NAMES paragraph of the ENVIRONMENT DIVISION that assigns a name to the proposition for which a truth value can be defined, that the content of a data item consists exclusively of those characters listed in the definition of the class-name.

class object
The runtime object that represents a class.

*** clause**
An ordered set of consecutive COBOL character-strings whose purpose is to specify an attribute of an entry.

CMS (Conversational Monitor System)
A virtual machine operating system that provides general interactive, time-sharing, problem solving, and program development capabilities, and that operates only under the control of the VM/SP control program.

*** COBOL character set**
The complete COBOL character set consists of the characters listed below:

Character
Meaning

0,1...,9
digit

A,B,...,Z
uppercase letter

a,b,...,z
lowercase letter

?
space

+
plus sign

-
minus sign (hyphen)

*****
asterisk

/
slant (virgule, slash)

=
equal sign

$
currency sign

,
comma (decimal point)

;
semicolon

.
period (decimal point, full stop)

"
quotation mark

(
left parenthesis

)
right parenthesis

>
greater than symbol

<
less than symbol

:
colon

*** COBOL word**
See "word".

code page
An assignment of graphic characters and control function meanings to all code points; for example, assignment of characters and meanings to 256 code points for 8-bit code, assignment of characters and meanings to 128 code points for 7-bit code.

*** collating sequence**
The sequence in which the characters that are acceptable to a computer are ordered for purposes of sorting, merging, comparing, and for processing indexed files sequentially.

*** column**
A character position within a print line. The columns are numbered from 1, by 1, starting at the leftmost character position of the print line and extending to the rightmost position of the print line.

*** combined condition**
A condition that is the result of connecting two or more conditions with the AND or the OR logical operator.

*** comment-entry**
An entry in the IDENTIFICATION DIVISION that may be any combination of characters from the computer's character set.

*** comment line**
A source program line represented by an asterisk (*) in the indicator area of the line and any characters from the computer's character set in area A and area B of that line. The comment line serves only for documentation in a program. A special form of comment line represented by a slant (/) in the indicator area of the line and any characters from the computer's character set in area A and area B of that line causes page ejection prior to printing the comment.

*** common program**
A program which, despite being directly contained within another program, may be called from any program directly or indirectly contained in that other program.

*** compile**
(1) To translate a program expressed in a high-level language into a program expressed in an intermediate language, assembly language, or a computer language. (2) To prepare a machine language program from a computer program written in another programming language by making use of the overall logic structure of the program, or generating more than one computer instruction for each symbolic statement, or both, as well as performing the function of an assembler.

*** compile time**
The time at which a COBOL source program is translated, by a COBOL compiler, to a COBOL object program.

compiler
A program that translates a program written in a higher level language into a machine language object program.

compiler-directing statement
A statement, beginning with a compiler-directing verb, that causes the compiler to take a specific action during compilation. Compiler directives are contained in the COBOL source program. Therefore, you can specify different suboptions of the directive within the source program by using multiple compiler-directive statements.

compiler options
Keywords that can be specified to control certain aspects of compilation. Compiler options can control the nature of the program object generated by the compiler, the types of printed output to be produced, the efficient use of the compiler, and the destination of error messages. See also compile-time options.

compile-time options
Keywords that can be specified to control certain aspects of compilation. Compiler options can control the nature of the program object generated by the compiler, the types of printed output to be produced, the efficient use of the compiler, and the destination of error messages.

*** complex condition**
A condition in which one or more logical operators act upon one or more conditions. (See also "negated simple condition", "combined condition", and "negated combined condition".)

*** computer-name**
A system-name that identifies the computer upon which the program is to be compiled or run.

condition
An exception that has been enabled, or recognized, by Language Environment and thus is eligible to activate user and language condition handlers. Any alteration to the normal programmed flow of an application. Conditions can be detected by the hardware/operating system and results in an interrupt. They can also be detected by language-specific generated code or language library code.

*** condition**
A status of a program at run time for which a truth value can be determined. Where the term 'condition' (condition-1, condition-2,...) appears in these language specifications in or in reference to 'condition' (condition-1, condition-2,...) of a general format, it is a conditional expression consisting of either a simple condition optionally parenthesized, or a combined condition consisting of the syntactically correct combination of simple conditions, logical operators, and parentheses, for which a truth value can be determined.

*** conditional expression**
A simple condition or a complex condition specified in an EVALUATE, IF, PERFORM, or SEARCH statement. (See also "simple condition" and "complex condition".)

*** conditional phrase**
A conditional phrase specifies the action to be taken upon determination of the truth value of a condition resulting from the execution of a conditional statement.

*** conditional statement**
A statement specifying that the truth value of a condition is to be determined and that the subsequent action of the object program is dependent on this truth value.

*** conditional variable**
A data item one or more values of which has a condition-name assigned to it.

*** condition-name**
A user-defined word that assigns a name to a subset of values that a conditional variable may assume; or a user-defined word assigned to a status of an implementor defined switch or device. When 'condition-name' is used in the general formats, it represents a unique data item reference consisting of a syntactically correct combination of a 'condition-name', together with qualifiers and subscripts, as required for uniqueness of reference.

*** condition-name condition**
The proposition, for which a truth value can be determined, that the value of a conditional variable is a member of the set of values attributed to a condition-name associated with the conditional variable.

*** CONFIGURATION SECTION**
A section of the ENVIRONMENT DIVISION that describes overall specifications of source and object programs and class definitions.

CONSOLE
A COBOL environment-name associated with the operator console.

*** contiguous items**
Items that are described by consecutive entries in the PROCEDURE DIVISION, and that bear a definite hierarchic relationship to each other.

copybook
A file or library member containing a sequence of code that is included in the source program at compile time using the COPY statement. The file can be created by the user, supplied by COBOL, or supplied by another product.

*** counter**
A data item used for storing numbers or number representations in a manner that permits these numbers to be increased or decreased by the value of another number, or to be changed or reset to zero or to an arbitrary positive or negative value.

cross-reference listing
The portion of the compiler listing that contains information about where files, fields, and indicators are defined, referenced, and modified in a program.

currency sign
The character '$' of the COBOL character set or that character defined by the CURRENCY compiler option. If the NOCURRENCY compiler option is in effect, the currency sign is defined as the character '$'.

currency symbol
The character defined by the CURRENCY compiler option or by the CURRENCY SIGN clause in the SPECIAL-NAMES paragraph. If the NOCURRENCY compiler option is in effect for a COBOL source program and the CURRENCY SIGN clause is also **not** present in the source program, the currency symbol is identical to the currency sign.

*** current record**
In file processing, the record that is available in the record area associated with a file.

*** current volume pointer**
A conceptual entity that points to the current volume of a sequential file.

D

*** data clause**
A clause, appearing in a data description entry in the DATA DIVISION of a COBOL program, that provides information describing a particular attribute of a data item.

*** data description entry**
An entry in the DATA DIVISION of a COBOL program that is composed of a level-number followed by a data-name, if required, and then followed by a set of data clauses, as required.

DATA DIVISION
In COBOL, the part of a program that describes the files to be used in the program and the records contained within the files. It also describes any WORKING-STORAGE data items, LINKAGE SECTION data items, and LOCAL-STORAGE data items that are needed.

*** data item**
A unit of data (excluding literals) defined by a COBOL program or by the rules for function evaluation.

*** data-name**
A user-defined word that names a data item described in a data description entry. When used in the general formats, 'data-name' represents a word that must not be reference-modified, subscripted or qualified unless specifically permitted by the rules for the format.

DBCS (Double-Byte Character Set)
See "Double-Byte Character Set (DBCS)".

*** debugging line**
A debugging line is any line with a 'D' in the indicator area of the line.

*** debugging section**
A section that contains a USE FOR DEBUGGING statement.

*** declarative sentence**
A compiler-directing sentence consisting of a single USE statement terminated by the separator period.

*** declaratives**
A set of one or more special purpose sections, written at the beginning of the PROCEDURE DIVISION, the first of which is preceded by the key word DECLARATIVES and the last of which is followed by the key words END DECLARATIVES. A declarative is composed of a section header, followed by a USE compiler-directing sentence, followed by a set of zero, one, or more associated paragraphs.

*** de-edit**
The logical removal of all editing characters from a numeric edited data item in order to determine that item's unedited numeric value.

*** delimited scope statement**
Any statement that includes its explicit scope terminator.

*** delimiter**
A character or a sequence of contiguous characters that identify the end of a string of characters and separate that string of characters from the following string of characters. A delimiter is not part of the string of characters that it delimits.

*** descending key**
A key upon the values of which data is ordered starting with the highest value of key down to the lowest value of key, in accordance with the rules for comparing data items.

digit
Any of the numerals from 0 through 9. In COBOL, the term is not used in reference to any other symbol.

*** digit position**
The amount of physical storage required to store a single digit. This amount may vary depending on the usage specified in the data description entry that defines the data item.

*** direct access**
The facility to obtain data from storage devices or to enter data into a storage device in such a way that the process depends only on the location of that data and not on a reference to data previously accessed.

*** division**
A collection of zero, one or more sections or paragraphs, called the division body, that are formed and combined in accordance with a specific set of rules. Each division consists of the division

header and the related division body. There are four (4) divisions in a COBOL program: Identification, Environment, Data, and Procedure.

*** division header**
A combination of words followed by a separator period that indicates the beginning of a division. The division headers are:

```
IDENTIFICATION DIVISION.
ENVIRONMENT DIVISION.
DATA DIVISION.
PROCEDURE DIVISION.
```

DLL
See "dynamic link library".

do construction
In structured programming, a DO statement is used to group a number of statements in a procedure. In COBOL, an in-line PERFORM statement functions in the same way.

document type declaration
An XML element that contains or points to markup declarations that provide a grammar for a class of documents. This grammar is known as a document type definition, or DTD.

do-until
In structured programming, a do-until loop will be executed at least once, and until a given condition is true. In COBOL, a TEST AFTER phrase used with the PERFORM statement functions in the same way.

do-while
In structured programming, a do-while loop will be executed if, and while, a given condition is true. In COBOL, a TEST BEFORE phrase used with the PERFORM statement functions in the same way.

Double-Byte Character Set (DBCS)
A set of characters in which each character is represented by two bytes. Languages such as Japanese, Chinese, and Korean, which contain more symbols than can be represented by 256 code points, require Double-Byte Character Sets. Because each character requires two bytes, entering, displaying, and printing DBCS characters requires hardware and supporting software that are DBCS-capable.

*** dynamic access**
An access mode in which specific logical records can be obtained from or placed into a mass storage file in a nonsequential manner and obtained from a file in a sequential manner during the scope of the same OPEN statement.

dynamic link library
A file containing executable code and data bound to a program at load time or run time, rather than during linking. The code and data in a dynamic link library can be shared by several applications simultaneously.

Dynamic Storage Area (DSA)
Dynamically acquired storage composed of a register save area and an area available for dynamic storage allocation (such as program variables). DSAs are generally allocated within STACK segments managed by Language Environment.

E

*** EBCDIC (Extended Binary-Coded Decimal Interchange Code)**
A coded character set consisting of 8-bit coded characters.

EBCDIC character
Any one of the symbols included in the 8-bit EBCDIC (Extended Binary-Coded-Decimal Interchange Code) set.

edited data item
A data item that has been modified by suppressing zeroes or inserting editing characters.

*** editing character**
A single character or a fixed two-character combination belonging to the following set:

Character
Meaning

?
space

0
zero

+
plus

-
minus

CR
credit

DB
debit

Z
zero suppress

*****
check protect

$
currency sign

,
comma (decimal point)

.
period (decimal point)

/
slant (virgule, slash)

element (text element)
One logical unit of a string of text, such as the description of a single data item or verb, preceded by a unique code identifying the element type.

*** elementary item**
A data item that is described as not being further logically subdivided.

enclave
In Language Environment, an independent collection of routines, one of which is designated as the main routine and is invoked first. An enclave is roughly analogous to a program or run unit. An executable program..

***end class marker**
A combination of words, followed by a separator period, that indicates the end of a COBOL class definition. The end class marker is:

```
END CLASS class-name.
```

***end method marker**
A combination of words, followed by a separator period, that indicates the end of a COBOL method definition. The end method marker is:

```
END METHOD method-name.
```

*** end of PROCEDURE DIVISION**
The physical position of a COBOL source program after which no further procedures appear.

*** end program marker**
A combination of words, followed by a separator period, that indicates the end of a COBOL source program. The end program marker is:

```
END PROGRAM program-name.
```

*** entry**
Any descriptive set of consecutive clauses terminated by a separator period and written in the IDENTIFICATION DIVISION, ENVIRONMENT DIVISION, or DATA DIVISION of a COBOL program.

*** environment clause**
A clause that appears as part of an ENVIRONMENT DIVISION entry.

ENVIRONMENT DIVISION
One of the four main component parts of a COBOL program, class definition, or method definition. The ENVIRONMENT DIVISION describes the computers upon which the source program is compiled and those on which the object program is executed, and provides a linkage between the logical concept of files and their records, and the physical aspects of the devices on which files are stored.

environment-name
A name, specified by IBM, that identifies system logical units, printer and card punch control characters, report codes, or program switches. When an environment-name is associated with a mnemonic-name in the ENVIRONMENT DIVISION, the mnemonic-name may then be substituted in any format in which such substitution is valid.

environment variable
Any of a number of variables that describe the way an operating system is going to run and the devices it is going to recognize.

execution time
Synonym for run time.

execution-time environment
See "runtime environment".

*** explicit scope terminator**
A reserved word that terminates the scope of a particular PROCEDURE DIVISION statement.

exponent
A number, indicating the power to which another number (the base) is to be raised. Positive exponents denote multiplication, negative exponents denote division, fractional exponents denote a root of a quantity. In COBOL, an exponential expression is indicated with the symbol '**' followed by the exponent.

*** expression**
An arithmetic or conditional expression.

*** extend mode**
The state of a file after execution of an OPEN statement, with the EXTEND phrase specified for that file, and before the execution of a CLOSE statement, without the REEL or UNIT phrase for that file.

extensions
Certain COBOL syntax and semantics supported by IBM compilers in addition to those described in ANSI Standard.

*** external data**
Data that persists over the lifetime of an enclave and maintains last-used values whenever a routine within the enclave is reentered. Within an enclave consisting of a single program object, it is equivalent to any C data objects that have static storage duration, A FORTRAN common block, and COBOL EXTERNAL data.

*** external data item**
A data item which is described as part of an external record in one or more programs of a run unit and which itself may be referenced from any program in which it is described.

*** external data record**
A logical record which is described in one or more programs of a run unit and whose constituent data items may be referenced from any program in which they are described.

external decimal item
A format for representing numbers in which the digit is contained in bits 4 through 7 and the sign is contained in bits 0 through 3 of the rightmost byte. Bits 0 through 3 of all other bytes contain 1's (hex F). For example, the decimal value of +123 is represented as 1111 0001 1111 0010 1111 0011. (Also known as "zoned decimal item".)

*** external file connector**
A file connector which is accessible to one or more object programs in the run unit.

external floating-point item
A format for representing numbers in which a real number is represented by a pair of distinct numerals. In a floating-point representation, the real number is the product of the fixed-point part (the first numeral), and a value obtained by raising the implicit floating-point base to a power denoted by the exponent (the second numeral).

For example, a floating-point representation of the number 0.0001234 is: 0.1234 -3, where 0.1234 is the mantissa and -3 is the exponent.

external program
The outermost program. A program that is not nested.

*** external switch**
A hardware or software device, defined and named by the implementor, which is used to indicate that one of two alternate states exists.

F

*** figurative constant**
A compiler-generated value referenced through the use of certain reserved words.

*** file**
A named collection of related data records that is stored and retrieved by an assigned name. Equivalent to an MVS data set.

*** file attribute conflict condition**
An unsuccessful attempt has been made to execute an input-output operation on a file and the file attributes, as specified for that file in the program, do not match the fixed attributes for that file.

*** file clause**
A clause that appears as part of any of the following DATA DIVISION entries: file description entry (FD entry) and sort-merge file description entry (SD entry).

*** file connector**
A storage area which contains information about a file and is used as the linkage between a file-name and a physical file and between a file-name and its associated record area.

File-Control
The name of an ENVIRONMENT DIVISION paragraph in which the data files for a given source program are declared.

file control block
Block containing the addresses of I/O routines, information about how they were opened and closed, and a pointer to the file information block.

*** file control entry**
A SELECT clause and all its subordinate clauses which declare the relevant physical attributes of a file.

*** file description entry**
An entry in the FILE SECTION of the DATA DIVISION that is composed of the level indicator FD, followed by a file-name, and then followed by a set of file clauses as required.

*** file-name**
A user-defined word that names a file connector described in a file description entry or a sort-merge file description entry within the FILE SECTION of the DATA DIVISION.

*** file organization**
The permanent logical file structure established at the time that a file is created.

***file position indicator**
A conceptual entity that contains the value of the current key within the key of reference for an indexed file, or the record number of the current record for a sequential file, or the relative record number of the current record for a relative file, or indicates that no next logical record exists, or that an optional input file is not present, or that the at end condition already exists, or that no valid next record has been established.

*** FILE SECTION**
The section of the DATA DIVISION that contains file description entries and sort-merge file description entries together with their associated record descriptions.

file system
A collection of files and their attributes. A file system provides a name space for file serial numbers referring to those files.

*** fixed file attributes**
Information about a file which is established when a file is created and cannot subsequently be changed during the existence of the file. These attributes include the organization of the file (sequential, relative, or indexed), the prime record key, the alternate record keys, the code set, the minimum and maximum record size, the record type (fixed or variable), the collating sequence of the keys for indexed files, the blocking factor, the padding character, and the record delimiter.

*** fixed length record**
A record associated with a file whose file description or sort-merge description entry requires that all records contain the same number of character positions.

fixed-point number
A numeric data item defined with a PICTURE clause that specifies the location of an optional sign, the number of digits it contains, and the location of an optional decimal point. The format may be either binary, packed decimal, or external decimal.

floating-point number
A numeric data item containing a fraction and an exponent. Its value is obtained by multiplying the fraction by the base of the numeric data item raised to the power specified by the exponent.

*** format**
A specific arrangement of a set of data.

*** function**
A routine that is invoked by coding its name in an expression. The routine passes a result back to the invoker through the routine name.

*** function-identifier**
A syntactically correct combination of character-strings and separators that references a function. The data item represented by a function is uniquely identified by a function-name with its arguments, if any. A function-identifier may include a reference-modifier. A function-identifier that references an alphanumeric function may be specified anywhere in the general formats that an identifier may be specified, subject to certain restrictions. A function-identifier that references an integer or numeric function may be referenced anywhere in the general formats that an arithmetic expression may be specified.

function-name
A word that names the mechanism whose invocation, along with required arguments, determines the value of a function.

G

*** global name**
A name which is declared in only one program but which may be referenced from that program and from any program contained within that program. Condition-names, data-names, file-names, record-names, report-names, and some special registers may be global names.

*** group item**
A data item that is composed of subordinate data items.

H

header label
(1) A file label or data set label that precedes the data records on a unit of recording media. (2) Synonym for beginning-of-file label.

*** high order end**
The leftmost character of a string of characters.

HLL
High-level language.

I

IBM COBOL extension
Certain COBOL syntax and semantics supported by IBM compilers in addition to those described in ANSI Standard.

IDENTIFICATION DIVISION
One of the four main component parts of a COBOL program, class definition, or method definition. The IDENTIFICATION DIVISION identifies the program name, class name, or method name. The IDENTIFICATION DIVISION may include the following documentation: author name, installation, or date.

*** identifier**
A syntactically correct combination of character-strings and separators that names a data item. When referencing a data item that is not a function, an identifier consists of a data-name, together with its qualifiers, subscripts, and reference-modifier, as required for uniqueness of reference. When referencing a data item which is a function, a function-identifier is used.

IGZCBSN
The bootstrap routine for COBOL/370 Release 1. It must be link-edited with any module that contains a COBOL/370 Release 1 program.

IGZCBSO
The bootstrap routine for COBOL for MVS & VM Release 2, COBOL for OS/390 & VM and Enterprise COBOL. It must be link-edited with any module that contains a COBOL for MVS & VM Release 2, COBOL for OS/390 & VM or Enterprise COBOL program.

IGZEBST
The bootstrap routine for VS COBOL II. It must be link-edited with any module that contains a VS COBOL II program.

ILC
InterLanguage Communication. Interlanguage communication is defined as programs that call or are called by other high-level languages. Assembler is not considered a high-level language; thus, calls to and from assembler programs are not considered ILC.

*** imperative statement**
A statement that either begins with an imperative verb and specifies an unconditional action to be taken or is a conditional statement that is delimited by its explicit scope terminator (delimited scope statement). An imperative statement may consist of a sequence of imperative statements.

*** implicit scope terminator**
A separator period which terminates the scope of any preceding unterminated statement, or a phrase of a statement which by its occurrence indicates the end of the scope of any statement contained within the preceding phrase.

IMS
Information Management System, IBM licensed product. IMS supports hierarchical databases, data communication, translation processing, and database backout and recovery.

*** index**
A computer storage area or register, the content of which represents the identification of a particular element in a table.

*** index data item**
A data item in which the values associated with an index-name can be stored in a form specified by the implementor.

indexed data-name
An identifier that is composed of a data-name, followed by one or more index-names enclosed in parentheses.

*** indexed file**
A file with indexed organization.

*** indexed organization**
The permanent logical file structure in which each record is identified by the value of one or more keys within that record.

indexing
Synonymous with subscripting using index-names.

*** index-name**
A user-defined word that names an index associated with a specific table.

*** inheritance (for classes)**
A mechanism for using the implementation of one or more *classes* as the basis for another class. A *subclass* inherits from one or more *superclasses*. By definition the inheriting class conforms to the inherited classes.

*** initial program**
A program that is placed into an initial state every time the program is called in a run unit.

*** initial state**
The state of a program when it is first called in a run unit.

inline
In a program, instructions that are executed sequentially, without branching to routines, subroutines, or other programs.

*** input file**
A file that is opened in the INPUT mode.

*** input mode**
The state of a file after execution of an OPEN statement, with the INPUT phrase specified, for that file and before the execution of a CLOSE statement, without the REEL or UNIT phrase for that file.

*** input-output file**
A file that is opened in the I-O mode.

*** INPUT-OUTPUT SECTION**
The section of the ENVIRONMENT DIVISION that names the files and the external media required by an object program or method and that provides information required for transmission and handling of data during execution of the object program or method definition.

*** Input-Output statement**
A statement that causes files to be processed by performing operations upon individual records or upon the file as a unit. The input-output statements are: ACCEPT (with the identifier phrase), CLOSE, DELETE, DISPLAY, OPEN, READ, REWRITE, SET (with the TO ON or TO OFF phrase), START, and WRITE.

*** input procedure**
A set of statements, to which control is given during the execution of a format 1 SORT statement, for the purpose of controlling the release of specified records to be sorted.

instance data
Data defining the state of an object. The instance data introduced by a class is defined in the WORKING-STORAGE SECTION of the DATA DIVISION of the class definition. The state of an object also includes the state of the instance variables introduced by base classes that are inherited by the current class. A separate copy of the instance data is created for each object instance.

*** integer**
(1) A numeric literal that does not include any digit positions to the right of the decimal point.

(2) A numeric data item defined in the DATA DIVISION that does not include any digit positions to the right of the decimal point.

(3) A numeric function whose definition provides that all digits to the right of the decimal point are zero in the returned value for any possible evaluation of the function.

integer function
A function whose category is numeric and whose definition does not include any digit positions to the right of the decimal point.

interlanguage communication (ILC)
The ability of routines written in different programming languages to communicate. ILC support allows the application writer to readily build applications from component routines written in a variety of languages.

intermediate result
An intermediate field containing the results of a succession of arithmetic operations.

*** internal data**
The data described in a program excluding all external data items and external file connectors. Items described in the LINKAGE SECTION of a program are treated as internal data.

*** internal data item**
A data item which is described in one program in a run unit. An internal data item may have a global name.

internal decimal item
A format in which each byte in a field except the rightmost byte represents two numeric digits. The rightmost byte contains one digit and the sign. For example, the decimal value +123 is represented as 0001 0010 0011 1111. (Also known as packed decimal.)

*** internal file connector**
A file connector which is accessible to only one object program in the run unit.

*** intra-record data structure**
The entire collection of groups and elementary data items from a logical record which is defined by a contiguous subset of the data description entries which describe that record. These data description entries include all entries whose level-number is greater than the level-number of the first data description entry describing the intra-record data structure.

intrinsic function
A predefined function, such as a commonly used arithmetic function, called by a built-in function reference.

*** invalid key condition**
A condition, at object time, caused when a specific value of the key associated with an indexed or relative file is determined to be invalid.

*** I-O-CONTROL**
The name of an ENVIRONMENT DIVISION paragraph in which object program requirements for rerun points, sharing of same areas by several data files, and multiple file storage on a single input-output device are specified.

*** I-O-CONTROL entry**
An entry in the I-O-CONTROL paragraph of the ENVIRONMENT DIVISION which contains clauses that provide information required for the transmission and handling of data on named files during the execution of a program.

*** I-O-Mode**
The state of a file after execution of an OPEN statement, with the I-O phrase specified, for that file and before the execution of a CLOSE statement without the REEL or UNIT phase for that file.

*** I-O status**
A conceptual entity which contains the two-character value indicating the resulting status of an input-output operation. This value is made available to the program through the use of the FILE STATUS clause in the file control entry for the file.

iteration structure
A program processing logic in which a series of statements is repeated while a condition is true or until a condition is true.

K

K
When referring to storage capacity, two to the tenth power; 1024 in decimal notation.

kernel
The part of the component that contains programs for such tasks as I/O, management, and communication.

*** key**
A data item that identifies the location of a record, or a set of data items which serve to identify the ordering of data.

*** key of reference**
The key, either prime or alternate, currently being used to access records within an indexed file.

*** key word**
A reserved word or function-name whose presence is required when the format in which the word appears is used in a source program.

kilobyte (KB)
One kilobyte equals 1024 bytes.

L

*** language-name**
A system-name that specifies a particular programming language.

Language Environment
Short form of z/OS Language Environment. A set of architectural constructs and interfaces that provides a common runtime environment and runtime services for C, C++, COBOL, FORTRAN and PL/I applications. It is required for programs compiled by Language Environment-conforming compilers and for Java applications.

Language Environment-conforming
Adhering to Language Environment's common interface conventions.

last-used state
A program is in last-used state if its internal values remain the same as when the program was exited (are not reset to their initial values).

*** letter**
A character belonging to one of the following two sets:

1. Uppercase letters: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z
2. Lowercase letters: a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z

*** level indicator**
Two alphabetic characters that identify a specific type of file or a position in a hierarchy. The level indicators in the DATA DIVISION are: CD, FD, and SD.

*** level-number**
A user-defined word, expressed as a two digit number, which indicates the hierarchical position of a data item or the special properties of a data description entry. Level-numbers in the range from 1 through 49 indicate the position of a data item in the hierarchical structure of a logical record. Level-numbers in the range 1 through 9 may be written either as a single digit or as a zero followed by a significant digit. Level-numbers 66, 77 and 88 identify special properties of a data description entry.

*** library-name**
A user-defined word that names a COBOL library that is to be used by the compiler for a given source program compilation.

*** library text**
A sequence of text words, comment lines, the separator space, or the separator pseudo-text delimiter in a COBOL library.

LILIAN DATE
The number of days since the beginning of the Gregorian calendar. Day one is Friday, October 15, 1582. The Lilian date format is named in honor of Luigi Lilio, the creator of the Gregorian calendar.

*** LINAGE-COUNTER**
A special register whose value points to the current position within the page body.

link-edit
To create a loadable computer program by means of a binder (linkage-editor).

LINKAGE SECTION
The section in the DATA DIVISION of the called program that describes data items available from the calling program. These data items may be referred to by both the calling and called program.

literal
A character-string whose value is specified either by the ordered set of characters comprising the string, or by the use of a figurative constant.

little-endian
Default format used by the PC to store binary data. In this format, the most significant digit is on the highest address. Compare with "big-endian".

local
A set of attributes for a program execution environment indicating culturally sensitive considerations, such as: character code page, collating sequence, date/time format, monetary value representation, numeric value representation, or language.

local

*** LOCAL-STORAGE SECTION**
The section of the DATA DIVISION that defines storage that is allocated and freed on a per-invocation basis, depending on the value assigned in their VALUE clauses.

*** logical operator**
One of the reserved words AND, OR, or NOT. In the formation of a condition, either AND, or OR, or both can be used as logical connectives. NOT can be used for logical negation.

*** logical record**
The most inclusive data item. The level-number for a record is 01. A record may be either an elementary item or a group of items. The term is synonymous with record.

*** low order end**
The rightmost character of a string of characters.

M

main program
The first routine in an enclave to gain control from the invoker. In FORTRAN, a main program does not have a FUNCTION, SUBROUTINE, or BLOCK DATA statement as its first statement. It could have a PROGRAM statement as its first statement. Contrast with subprogram.

*** mass storage**
A storage medium in which data may be organized and maintained in both a sequential and nonsequential manner.

*** mass storage device**
A device having a large storage capacity; for example, magnetic disk, magnetic drum.

*** mass storage file**
A collection of records that is assigned to a mass storage medium.

*** megabyte (M)**
One megabyte equals 1,048,576 bytes.

*** merge file**
A collection of records to be merged by a MERGE statement. The merge file is created and can be used only by the merge function.

method
Procedural code that defines one of the operations supported by an object, and that is executed by an INVOKE statement on that object.

*** Method Definition**
The COBOL source unit that defines a method.

*** method identification entry**
An entry in the METHOD-ID paragraph of the IDENTIFICATION DIVISION which contains clauses that specify the method-name and assign selected attributes to the method definition.

*** method-name**
A user-defined word that identifies a method.

*** mnemonic-name**
A user-defined word that is associated in the ENVIRONMENT DIVISION with a specified implementor-name.

multitasking
Mode of operation that provides for the concurrent, or interleaved, execution of two or more tasks. When running under the Language Environment product, multitasking is synonymous with *multithreading*.

MVS
Multiple Virtual Storage operating system.

N

name
A word composed of not more than 30 characters that defines a COBOL operand.

*** native character set**
The implementor-defined character set associated with the computer specified in the OBJECT-COMPUTER paragraph.

*** native collating sequence**
The implementor-defined collating sequence associated with the computer specified in the OBJECT-COMPUTER paragraph.

*** negated combined condition**
The 'NOT' logical operator immediately followed by a parenthesized combined condition.

*** negated simple condition**
The 'NOT' logical operator immediately followed by a simple condition.

nested program
In COBOL, a program that is directly contained within another program.

*** next executable sentence**
The next sentence to which control will be transferred after execution of the current statement is complete.

*** next executable statement**
The next statement to which control will be transferred after execution of the current statement is complete.

*** next record**
The record that logically follows the current record of a file.

*** noncontiguous items**
Elementary data items in the WORKING-STORAGE and LINKAGE SECTIONs that bear no hierarchic relationship to other data items.

*** nonnumeric item**
A data item whose description permits its content to be composed of any combination of characters taken from the computer's character set. Certain categories of nonnumeric items may be formed from more restricted character sets.

*** nonnumeric literal**
A literal bounded by quotation marks. The string of characters may include any character in the computer's character set.

null
Empty, having no meaning.

*** numeric character**
A character that belongs to the following set of digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

numeric-edited item
A numeric item that is in such a form that it may be used in printed output. It may consist of external decimal digits from 0 through 9, the decimal point, commas, the dollar sign, editing sign control symbols, plus other editing symbols.

*** numeric function**
A function whose class and category are numeric but which for some possible evaluation does not satisfy the requirements of integer functions.

*** numeric item**
A data item whose description restricts its content to a value represented by characters chosen from the digits from '0' through '9'; if signed, the item may also contain a '+', '-', or other representation of an operational sign.

*** numeric literal**
A literal composed of one or more numeric characters that may contain either a decimal point, or an algebraic sign, or both. The decimal point must not be the rightmost character. The algebraic sign, if present, must be the leftmost character.

O

object
An entity that has state (its data values) and operations (its methods). An object is a way to encapsulate state and behavior.

object code
Output from a compiler or assembler that is itself executable machine code or is suitable for processing to produce executable machine code.

*** OBJECT-COMPUTER**
The name of an ENVIRONMENT DIVISION paragraph in which the computer environment, within which the object program is executed, is described.

*** object computer entry**
An entry in the OBJECT-COMPUTER paragraph of the ENVIRONMENT DIVISION which contains clauses that describe the computer environment in which the object program is to be executed.

object deck
A portion of an object program suitable as input to a linkage-editor. Synonymous with *object module* and *text deck*.

object module
A collection of one or more control sections produced by an assembler or compiler and used as input to the binder (linkage-editor). Synonym for text deck or object deck.

*** object of entry**
A set of operands and reserved words, within a DATA DIVISION entry of a COBOL program, that immediately follows the subject of the entry.

*** object program**
A set or group of executable machine language instructions and other material designed to interact with data to provide problem solutions. In this context, an object program is generally the machine language result of the operation of a COBOL compiler on a source program. Where there is no danger of ambiguity, the word 'program' alone may be used in place of the phrase 'object program.'

*** object time**
The time at which an object program is executed. The term is synonymous with execution time.

*** obsolete element**
A COBOL language element in Standard COBOL that is to be deleted from the next revision of Standard COBOL.

ODBC
Open Database Connectivity that provides you access to data from a variety of databases and file systems.

ODO object
In the example below,

```
WORKING-STORAGE SECTION
01  TABLE-1.
    05  X                   PICS9.
    05  Y OCCURS 3 TIMES
          DEPENDING ON X    PIC X.
```

X is the object of the OCCURS DEPENDING ON clause (ODO object). The value of the ODO object determines how many of the ODO subject appear in the table.

ODO subject
In the example above, Y is the subject of the OCCURS DEPENDING ON clause (ODO subject). The number of Y ODO subjects that appear in the table depends on the value of X.

*** open mode**
The state of a file after execution of an OPEN statement for that file and before the execution of a CLOSE statement without the REEL or UNIT phrase for that file. The particular open mode is specified in the OPEN statement as either INPUT, OUTPUT, I-O or EXTEND.

*** operand**
Whereas the general definition of operand is "that component which is operated upon", for the purposes of this document, any lowercase word (or words) that appears in a statement or entry format may be considered to be an operand and, as such, is an implied reference to the data indicated by the operand.

*** operational sign**
An algebraic sign, associated with a numeric data item or a numeric literal, to indicate whether its value is positive or negative.

*** optional file**
A file which is declared as being not necessarily present each time the object program is executed. The object program causes an interrogation for the presence or absence of the file.

*** optional word**
A reserved word that is included in a specific format only to improve the readability of the language and whose presence is optional to the user when the format in which the word appears is used in a source program.

*** output mode**
The state of a file after execution of an OPEN statement, with the OUTPUT or EXTEND phrase specified, for that file and before the execution of a CLOSE statement without the REEL or UNIT phrase for that file.

*** output procedure**
A set of statements to which control is given during execution of a format 1 SORT statement after the sort function is completed, or during execution of a MERGE statement after the merge function reaches a point at which it can select the next record in merged order when requested.

overflow condition
A condition that occurs when a portion of the result of an operation exceeds the capacity of the intended unit of storage.

P

packed decimal item
See "internal decimal item".

*** padding character**
An alphanumeric character used to fill the unused character positions in a physical record.

page
A vertical division of output data representing a physical separation of such data, the separation being based on internal logical requirements or external characteristics of the output medium.

*** page body**
That part of the logical page in which lines can be written or spaced.

*** paragraph**
In the PROCEDURE DIVISION, a paragraph-name followed by a separator period and by zero, one, or more sentences. In the IDENTIFICATION and ENVIRONMENT DIVISION, a paragraph header followed by zero, one, or more entries.

*** paragraph header**
A reserved word, followed by the separator period, that indicates the beginning of a paragraph in the IDENTIFICATION and ENVIRONMENT DIVISION. The permissible paragraph headers in the IDENTIFICATION DIVISION are:

```
PROGRAM-ID. (Program ID DIVISION)
CLASS-ID. (Class ID DIVISION)
METHOD-ID. (Method ID DIVISION)
AUTHOR.
INSTALLATION.
DATE-WRITTEN.
DATE-COMPILED.
SECURITY.
```

The permissible paragraph headers in the ENVIRONMENT DIVISION are:

```
SOURCE-COMPUTER.
OBJECT-COMPUTER.
SPECIAL-NAMES.
REPOSITORY. (Program or Class
   CONFIGURATION SECTION)
FILE-CONTROL.
I-O-CONTROL.
```

*** paragraph-name**
A user-defined word that identifies and begins a paragraph in the PROCEDURE DIVISION.

parameter
Data items that are received by a routine. The term used in certain other languages for the FORTRAN term dummy argument.

password
A unique string of characters that a program, computer operator, or user must supply to meet security requirements before gaining access to data.

*** phrase**
A phrase is an ordered set of one or more consecutive COBOL character-strings that form a portion of a COBOL procedural statement or of a COBOL clause.

*** physical record**
See "block".

pointer data item
A data item in which address values can be stored. Data items are explicitly defined as pointers with the USAGE IS POINTER clause. ADDRESS OF special registers are implicitly defined as pointer data items. Pointer data items can be compared for equality or moved to other pointer data items.

portability
The ability to transfer an application program from one application platform to another with relatively few changes to the source program.

preloaded
In COBOL this refers to COBOL programs that remain resident in storage under IMS instead of being loaded each time they are called.

*** prime record key**
A key whose contents uniquely identify a record within an indexed file.

*** priority-number**
A user-defined word which classifies sections in the PROCEDURE DIVISION for purposes of segmentation. Segment-numbers may contain only the characters '0','1', ... , '9'. A segment-number may be expressed either as a one- or two-digit number.

*** procedure**
In COBOL, a procedure is a paragraph or section that can only be performed from within the program. In PL/I, a named block of code that can be invoked externally, usually via a call..

*** procedure branching statement**
A statement that causes the explicit transfer of control to a statement other than the next executable statement in the sequence in which the statements are written in the source program. The procedure branching statements are: ALTER, CALL, EXIT, EXIT PROGRAM, GO TO, MERGE, (with the OUTPUT PROCEDURE phrase), PERFORM and SORT (with the INPUT PROCEDURE or OUTPUT PROCEDURE phrase).

PROCEDURE DIVISION
One of the four main component parts of a COBOL program, class definition, or method definition. The PROCEDURE DIVISION contains instructions for solving a problem. The Program and Method Procedure Divisions may contain imperative statements, conditional statements, compiler-directing statements, paragraphs, procedures, and sections. The Class Procedure Division contains only method definitions.

procedure integration
One of the functions of the COBOL optimizer is to simplify calls to performed procedures or contained programs.

PERFORM procedure integration is the process whereby a PERFORM statement is replaced by its performed procedures. Contained program procedure integration is the process where a CALL to a contained program is replaced by the program code.

*** procedure-name**
A user-defined word that is used to name a paragraph or section in the PROCEDURE DIVISION. It consists of a paragraph-name (which may be qualified) or a section-name.

procedure-pointer data item
A data item in which a pointer to an entry point can be stored. A data item defined with the USAGE IS PROCEDURE-POINTER clause contains the address of a procedure entry point.

*** program identification entry**
An entry in the PROGRAM-ID paragraph of the IDENTIFICATION DIVISION which contains clauses that specify the program-name and assign selected program attributes to the program.

program-name
In the IDENTIFICATION DIVISION and the end program marker, a user-defined word or alphanumeric literal that identifies a COBOL source program.

*** pseudo-text**
A sequence of text words, comment lines, or the separator space in a source program or COBOL library bounded by, but not including, pseudo-text delimiters.

*** pseudo-text delimiter**
Two contiguous equal sign characters (==) used to delimit pseudo-text.

*** punctuation character**
A character that belongs to the following set:

Character	Meaning
,	comma
;	semicolon

:
colon

.
period (full stop)

"
quotation mark

(
left parenthesis

)
right parenthesis

?
space

=
equal sign

Q

QSAM (Queued Sequential Access Method)
An extended version of the basic sequential access method (BSAM). When this method is used, a queue is formed of input data blocks that are awaiting processing or of output data blocks that have been processed and are awaiting transfer to auxiliary storage or to an output device.

*** qualified data-name**
An identifier that is composed of a data-name followed by one or more sets of either of the connectives OF and IN followed by a data-name qualifier.

*** qualifier**

1. A data-name or a name associated with a level indicator which is used in a reference either together with another data-name which is the name of an item that is subordinate to the qualifier or together with a condition-name.
2. A section-name that is used in a reference together with a paragraph-name specified in that section.
3. A library-name that is used in a reference together with a text-name associated with that library.

R

*** random access**
An access mode in which the program-specified value of a key data item identifies the logical record that is obtained from, deleted from, or placed into a relative or indexed file.

*** record**
See "logical record".

*** record area**
A storage area allocated for the purpose of processing the record described in a record description entry in the FILE SECTION of the DATA DIVISION. In the FILE SECTION, the current number of character positions in the record area is determined by the explicit or implicit RECORD clause.

*** record description**
See "record description entry".

*** record description entry**
The total set of data description entries associated with a particular record. The term is synonymous with record description.

recording mode
The format of the logical records in a file. Recording mode can be F (fixed-length), V (variable-length), S (spanned), or U (undefined).

record key
A key whose contents identify a record within an indexed file.

*** record-name**
A user-defined word that names a record described in a record description entry in the DATA DIVISION of a COBOL program.

*** record number**
The ordinal number of a record in the file whose organization is sequential.

recursion
A program calling itself or being directly or indirectly called by a one of its called programs.

recursively capable
A program is recursively capable (can be called recursively) if the RECURSIVE attribute is on the PROGRAM-ID statement.

reel
A discrete portion of a storage medium, the dimensions of which are determined by each implementor that contains part of a file, all of a file, or any number of files. The term is synonymous with unit and volume.

reentrant
The attribute of a program or routine that allows more than one user to share a single copy of a program object.

*** reference format**
A format that provides a standard method for describing COBOL source programs.

reference modification
A method of defining a new alphanumeric data item by specifying the leftmost character and length relative to the leftmost character of another alphanumeric data item.

*** reference-modifier**
A syntactically correct combination of character-strings and separators that defines a unique data item. It includes a delimiting left parenthesis separator, the leftmost character position, a colon separator, optionally a length, and a delimiting right parenthesis separator.

*** relation**
See "relational operator" or "relation condition".

*** relational operator**
A reserved word, a relation character, a group of consecutive reserved words, or a group of consecutive reserved words and relation characters used in the construction of a relation condition. The permissible operators and their meanings are:

Operator
Meaning

IS GREATER THAN
Greater than

IS >
Greater than

IS NOT GREATER THAN
Not greater than

IS NOT >
Not greater than

IS LESS THAN
Less than

IS <
Less than

IS NOT LESS THAN
Not less than

IS NOT <
Not less than

IS EQUAL TO
Equal to

IS =
Equal to

IS NOT EQUAL TO
Not equal to

IS NOT =
Not equal to

IS GREATER THAN OR EQUAL TO
Greater than or equal to

IS >=
Greater than or equal to

IS LESS THAN OR EQUAL TO
Less than or equal to

IS <=
Less than or equal to

*** relation character**
A character that belongs to the following set:

Character
Meaning

>
greater than

<
less than

=
equal to

*** relation condition**
The proposition, for which a truth value can be determined, that the value of an arithmetic expression, data item, nonnumeric literal, or index-name has a specific relationship to the value of another arithmetic expression, data item, nonnumeric literal, or index name. (See also "relational operator".)

*** relative file**
A file with relative organization.

*** relative key**
A key whose contents identify a logical record in a relative file.

*** relative organization**
The permanent logical file structure in which each record is uniquely identified by an integer value greater than zero, which specifies the record's logical ordinal position in the file.

*** relative record number**
The ordinal number of a record in a file whose organization is relative. This number is treated as a numeric literal which is an integer.

*** reserved word**
A COBOL word specified in the list of words that may be used in a COBOL source program, but that must not appear in the program as user-defined words or system-names.

*** resource**
A facility or service, controlled by the operating system, that can be used by an executing program.

*** resultant identifier**
A user-defined data item that is to contain the result of an arithmetic operation.

reusable environment
A reusable environment is when you establish an assembler program as the main program by using either ILBOSTP0 programs, IGZERRE programs, or the RTEREUS runtime option.

routine
A set of statements in a COBOL program that causes the computer to perform an operation or series of related operations. In Language Environment, refers to either a procedure, function, or subroutine.

*** routine-name**
A user-defined word that identifies a procedure written in a language other than COBOL.

*** run time**
The time at which an object program is executed. The term is synonymous with object time.

runtime environment
The environment in which a COBOL program executes.

*** run unit**
One or more object programs that are executed together. In Language Environment, a run unit is the equivalent of an enclave.

S

SBCS (Single Byte Character Set)
See "Single Byte Character Set (SBCS)".

scope terminator
A COBOL reserved word that marks the end of certain PROCEDURE DIVISION statements. It may be either explicit (END-ADD, for example) or implicit (separator period). A variable at the end of a statement.

*** section**
A set of zero, one or more paragraphs or entities, called a section body, the first of which is preceded by a section header. Each section consists of the section header and the related section body.

*** section header**
A combination of words followed by a separator period that indicates the beginning of a section in the ENVIRONMENT, DATA, and PROCEDURE DIVISION. In the ENVIRONMENT and DATA DIVISION, a section header is composed of reserved words followed by a separator period. The permissible section headers in the ENVIRONMENT DIVISION are:

```
CONFIGURATION SECTION.
INPUT-OUTPUT SECTION.
```

The permissible section headers in the DATA DIVISION are:

```
FILE SECTION.
WORKING-STORAGE SECTION.
LOCAL-STORAGE SECTION.
LINKAGE SECTION.
```

In the PROCEDURE DIVISION, a section header is composed of a section-name, followed by the reserved word SECTION, followed by a separator period.

*** section-name**
A user-defined word that names a section in the PROCEDURE DIVISION.

selection structure
A program processing logic in which one or another series of statements is executed, depending on whether a condition is true or false.

*** sentence**
A sequence of one or more statements, the last of which is terminated by a separator period.

*** separately compiled program**
A program which, together with its contained programs, is compiled separately from all other programs.

*** separator**
A character or two contiguous characters used to delimit character-strings.

*** separator comma**
A comma (,) followed by a space used to delimit character-strings.

*** separator period**
A period (.) followed by a space used to delimit character-strings.

*** separator semicolon**
A semicolon (;) followed by a space used to delimit character-strings.

sequence structure
A program processing logic in which a series of statements is executed in sequential order.

*** sequential access**
An access mode in which logical records are obtained from or placed into a file in a consecutive predecessor-to-successor logical record sequence determined by the order of records in the file.

*** sequential file**
A file with sequential organization.

*** sequential organization**
The permanent logical file structure in which a record is identified by a predecessor-successor relationship established when the record is placed into the file.

serial search
A search in which the members of a set are consecutively examined, beginning with the first member and ending with the last.

*** 77-level-description-entry**
A data description entry that describes a noncontiguous data item with the level-number 77.

*** sign condition**
The proposition, for which a truth value can be determined, that the algebraic value of a data item or an arithmetic expression is either less than, greater than, or equal to zero.

*** simple condition**
Any single condition chosen from the set:

Relation condition
Class condition
Condition-name condition
Switch-status condition
Sign condition

Single Byte Character Set (SBCS)
A set of characters in which each character is represented by a single byte. See also "EBCDIC (Extended Binary-Coded Decimal Interchange Code)."

slack bytes
Bytes inserted between data items or records to ensure correct alignment of some numeric items. Slack bytes contain no meaningful data. In some cases, they are inserted by the compiler; in others, it is the responsibility of the programmer to insert them. The SYNCHRONIZED clause instructs the compiler to insert slack bytes when they are needed for proper alignment. Slack bytes between records are inserted by the programmer.

*** sort file**
A collection of records to be sorted by a format 1 SORT statement. The sort file is created and can be used by the sort function only.

*** sort-merge file description entry**
An entry in the FILE SECTION of the DATA DIVISION that is composed of the level indicator SD, followed by a file-name, and then followed by a set of file clauses as required.

*** SOURCE-COMPUTER**
The name of an ENVIRONMENT DIVISION paragraph in which the computer environment, within which the source program is compiled, is described.

*** source computer entry**
An entry in the SOURCE-COMPUTER paragraph of the ENVIRONMENT DIVISION which contains clauses that describe the computer environment in which the source program is to be compiled.

*** source item**
An identifier designated by a SOURCE clause that provides the value of a printable item.

source program
Although it is recognized that a source program may be represented by other forms and symbols, in this information it always refers to a syntactically correct set of COBOL statements. A COBOL source program commences with the IDENTIFICATION DIVISION or a COPY statement. A COBOL source program is terminated by the end program marker, if specified, or by the absence of additional source program lines. A source program contains a set of instructions written in a programming language that must be translated to machine language before the program can be run.

special character
A character that belongs to the following set:

Character	Meaning
+	plus sign
-	minus sign (hyphen)
*	asterisk
/	slant (forward slash)
=	equal sign
$	currency sign
,	comma
;	semicolon
.	period (decimal point, full stop)
"	quotation mark
'	apostrophe
(	left parenthesis
)	right parenthesis
>	greater than
<	less than
:	colon
_	underscore

***>**
floating comment indicator

*** special-character word**
A reserved word that is an arithmetic operator or a relation character.

SPECIAL-NAMES
The name of an ENVIRONMENT DIVISION paragraph in which environment-names are related to user-specified mnemonic-names.

*** special names entry**
An entry in the SPECIAL-NAMES paragraph of the ENVIRONMENT DIVISION which provides means for specifying the currency sign; choosing the decimal point; specifying symbolic characters; relating implementor-names to user-specified mnemonic-names; relating alphabet-names to character sets or collating sequences; and relating class-names to sets of characters.

*** special registers**
Certain compiler generated storage areas whose primary use is to store information produced in conjunction with the use of a specific COBOL feature.

*** standard data format**
The concept used in describing the characteristics of data in a COBOL DATA DIVISION under which the characteristics or properties of the data are expressed in a form oriented to the appearance of the data on a printed page of infinite length and breadth, rather than a form oriented to the manner in which the data is stored internally in the computer, or on a particular external medium.

*** statement**
A syntactically valid combination of words, literals, and separators, beginning with a verb, written in a COBOL source program.

STL
STL File System: native workstation and PC file system for COBOL and PL/I. Supports sequential, relative, and indexed files, including the full ANSI 85 COBOL standard I/O language and all of the extensions described in the *COBOL Language Reference*, unless exceptions are explicitly noted.

structured programming
A technique for organizing and coding a computer program in which the program comprises a hierarchy of segments, each segment having a single entry point and a single exit point. Control is passed downward through the structure without unconditional branches to higher levels of the hierarchy.

*** subclass**
A class that inherits from another class. When two classes in an inheritance relationship are considered together, the subclass is the inheritor or inheriting class; the *superclass* is the inheritee or inherited class.

*** subject of entry**
An operand or reserved word that appears immediately following the level indicator or the level-number in a DATA DIVISION entry.

*** subprogram**
See "called program".

*** subscript**
An occurrence number represented by either an integer, a data-name optionally followed by an integer with the operator + or -, or an index-name optionally followed by an integer with the operator + or -, that identifies a particular element in a table. A subscript may be the word ALL when the subscripted identifier is used as a function argument for a function allowing a variable number of arguments.

*** subscripted data-name**
An identifier that is composed of a data-name followed by one or more subscripts enclosed in parentheses.

*** superclass**
A class that is inherited by another class. See also *subclass*.

switch-status condition
The proposition, for which a truth value can be determined, that an UPSI switch, capable of being set to an 'on' or 'off' status, has been set to a specific status.

*** symbolic-character**
A user-defined word that specifies a user-defined figurative constant.

syntax
The rules governing the structure of a programming language and the construction of a statement in a programming language.

T

*** table**
A set of logically consecutive items of data that are defined in the DATA DIVISION by means of the OCCURS clause.

*** table element**
A data item that belongs to the set of repeated items comprising a table.

text deck
Synonym for *object deck* or *object module*.

*** text-name**
A user-defined word that identifies library text.

*** text word**
A character or a sequence of contiguous characters between margin A and margin R in a COBOL library, source program, or in pseudo-text which is:

- A separator, except for: space; a pseudo-text delimiter; and the opening and closing delimiters for nonnumeric literals. The right parenthesis and left parenthesis characters, regardless of context within the library, source program, or pseudo-text, are always considered text words.
- A literal including, in the case of nonnumeric literals, the opening quotation mark and the closing quotation mark that bound the literal.
- Any other sequence of contiguous COBOL characters except comment lines and the word 'COPY' bounded by separators that are neither a separator nor a literal.

top-down design
The design of a computer program using a hierarchic structure in which related functions are performed at each level of the structure.

top-down development
See "structured programming".

trailer-label
(1) A file or data set label that follows the data records on a unit of recording medium. (2) Synonym for end-of-file label.

*** truth value**
The representation of the result of the evaluation of a condition in terms of one of two values: true or false.

U

*** unary operator**
A plus (+) or a minus (-) sign, that precedes a variable or a left parenthesis in an arithmetic expression and that has the effect of multiplying the expression by +1 or -1, respectively.

unit
A module of direct access, the dimensions of which are determined by IBM.

universal object reference
A data-name that can refer to an object of any class.

unpacked decimal format
A format for representing numbers in which the digit is contained in bits 4 through 7 and the sign is contained in bits 0 through 3 of the rightmost byte. Bits 0 through 3 of all other bytes contain 1s

(hex F). For example, the decimal value of +123 is represented as 1111 0001 1111 0010 1111 0011. Synonymous with zoned decimal format.

*** unsuccessful execution**
The attempted execution of a statement that does not result in the execution of all the operations specified by that statement. The unsuccessful execution of a statement does not affect any data referenced by that statement, but may affect status indicators.

UPSI switch
A program switch that performs the functions of a hardware switch. Eight are provided: UPSI-0 through UPSI-7.

*** user-defined word**
A COBOL word that must be supplied by the user to satisfy the format of a clause or statement.

V

*** variable**
A data item whose value may be changed by execution of the object program. A variable used in an arithmetic expression must be a numeric elementary item.

*** variable-length record**
A record associated with a file whose file description or sort-merge description entry permits records to contain a varying number of character positions.

*** variable occurrence data item**
A variable occurrence data item is a table element which is repeated a variable number of times. Such an item must contain an OCCURS DEPENDING ON clause in its data description entry, or be subordinate to such an item.

*** variably located group.**
A group item following, and not subordinate to, a variable-length table in the same level-01 record.

*** variably located item.**
A data item following, and not subordinate to, a variable-length table in the same level-01 record.

*** verb**
A word that expresses an action to be taken by a COBOL compiler or object program.

volume
A certain portion of data, together with its data carrier, that can be handled conveniently as a unit. A data carrier mounted and demounted as a unit; for example, a reel of magnetic tape, a disk pack.

volume switch procedures
System specific procedures executed automatically when the end of a unit or reel has been reached before end-of-file has been reached.

VSAM (Virtual Storage Access Method)
A high-performance mass storage access method. Three types of data organization are available: entry sequenced data sets (ESDS), key sequenced data sets (KSDS), and relative record data sets (RRDS). Their COBOL equivalents are, respectively: sequential, indexed, and relative organizations.

W

*** word**
A character-string of not more than 30 characters which forms a user-defined word, a system-name, a reserved word, or a function-name.

*** WORKING-STORAGE SECTION**
The section of the DATA DIVISION that describes working storage data items, composed either of noncontiguous items or working storage records or of both.

X

XML
Extensible Markup Language. A standard metalanguage for defining markup languages that was derived from and is a subset of SGML. XML omits the more complex and less-used parts of SGML and makes it much easier to write applications to handle document types, author and manage structured information, and transmit and share structured information across diverse computing systems. The

use of XML does not require the robust applications and processing that is necessary for SGML. XML is developed under the auspices of the World Wide Web Consortium (W3C).

XML data
Data that is organized into a hierarchical structure with XML elements. The data definitions are defined in XML element type declarations.

XML declaration
XML text that specifies characteristics of the XML document such as the version of XML being used and the encoding of the document.

XML document
A data object that is well formed as defined by the W3C XML specification.

XML namespace
A mechanism, defined by the W3C XML Namespace specifications, that limits the scope of a collection of element names and attribute names. A uniquely chosen XML namespace ensures the unique identity of an element name or attribute name across multiple XML documents or multiple contexts within an XML document.

XML schema
A mechanism, defined by the W3C, for describing and constraining the structure and content of XML documents. An XML schema, which is itself expressed in XML, effectively defines a class of XML documents of a given type, for example, purchase orders.

year 2000 problem
The Year 2000 problem refers to the limitation of 2-digit year date fields that were used to save storage in the 1960s and 1970s. For example, it is not possible to compute the age of someone who is older than 100 years with 2-digit year date fields, and on 1/1/2000, the current date will not be greater than the previous day's date. Because so many applications and data have only 2-digit year data, they must all be changed before the year 2000 to avoid failure.

Z

zoned decimal format
Synonym for unpacked decimal format.

zoned decimal item
See "external decimal item".

#

85 COBOL Standard
The COBOL language defined by the following standards:

- *ANSI INCITS 23-1985, Programming languages - COBOL*, as amended by *ANSI INCITS 23a-1989, Programming Languages - COBOL - Intrinsic Function Module for COBOL* and *ANSI INCITS 23b-1993, Programming Languages - Correction Amendment for COBOL*
- *ISO 1989:1985, Programming languages - COBOL*, as amended by *ISO/IEC 1989/AMD1:1992, Programming languages - COBOL: Intrinsic function module* and *ISO/IEC 1989/AMD2:1994, Programming languages - Correction and clarification amendment for COBOL*

2002 COBOL Standard
The COBOL language defined by the following standards:

- INCITS/ISO/IEC 1989-2002, Information Technology - Programming Languages - COBOL
- ISO/IEC 1989:2002, Information technology -- Programming languages -- COBOL

List of resources

Enterprise COBOL for z/OS

COBOL for z/OS publications

You can find the following publications in the Enterprise COBOL for z/OS library:

- *Customization Guide*, SC27-8712
- *Language Reference*, SC27-8713
- *Programming Guide*, SC27-8714
- *Migration Guide*, GC27-8715
- *Program Directory*, GI13-4526
- *Licensed Program Specifications*, GI13-4532

Softcopy publications

The following collection kits contain Enterprise COBOL and other product publications. You can find them at http://www.ibm.com/e-business/linkweb/publications/servlet/pbi.wss.

- *z/OS Software Products Collection*
- *z/OS and Software Products DVD Collection*

Support

Enterprise COBOL Version 6 Release 1 Performance Tuning Guide, www.ibm.com/support/docview.wss?uid=swg27047580.

If you have a problem using Enterprise COBOL for z/OS, see the following site that provides up-to-date support information: https://www.ibm.com/support/home/product/B984385H82239E03/Enterprise_COBOL_for_z/OS.

Related publications

z/OS library publications

You can find the following publications in the z/OS Internet Library.

Run-Time Library Extensions

- *Common Debug Architecture Library Reference*
- *Common Debug Architecture User's Guide*
- *DWARF/ELF Extensions Library Reference*

z/Architecture

- *Principles of Operation*

z/OS DFSMS

- *Access Method Services for Catalogs*
- *Checkpoint/Restart*
- *Macro Instructions for Data Sets*
- *Using Data Sets*

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- *Utilities*

z/OS DFSORT

- *Application Programming Guide*
- *Installation and Customization*

z/OS ISPF

- *Dialog Developer's Guide and Reference*
- *User's Guide Vol I*
- *User's Guide Vol II*

z/OS Language Environment

- *Concepts Guide*
- *Customization*
- *Debugging Guide*
- *Language Environment Vendor Interfaces*
- *Programming Guide*
- *Programming Reference*
- *Run-Time Messages*
- *Run-Time Application Migration Guide*
- *Writing Interlanguage Communication Applications*

z/OS MVS

- *JCL Reference*
- *JCL User's Guide*
- *Programming: Callable Services for High-Level Languages*
- *Program Management: User's Guide and Reference*
- *System Commands*
- *z/OS Unicode Services User's Guide and Reference*
- *z/OS XML System Services User's Guide and Reference*

z/OS TSO/E

- *Command Reference*
- *Primer*
- *User's Guide*

z/OS UNIX System Services

- *Command Reference*
- *Programming: Assembler Callable Services Reference*
- *User's Guide*

z/OS XL C/C++

- *Programming Guide*
- *Run-Time Library Reference*

CICS Transaction Server for z/OS

You can find the following publications in the CICS library:

- *Developing CICS Applications*

- *API (EXEC CICS) Reference*
- *Developing CICS System Programs*
- *Global User Exit Reference*
- *XPI Reference*
- *Using EXCI with CICS*

COBOL Report Writer Precompiler

- *Programmer's Manual*, SC26-4301
- *Installation and Operation*, SC26-4302

DB2 for z/OS

You can find the following publications in the DB2 Library:

- *Application Programming and SQL Guide*
- *Command Reference*
- *SQL Reference*

IBM Debug for z/OS (formerly IBM Debug for z Systems and IBM Debug Tool for z/OS)

You can find information about IBM Debug for z/OS in the IBM Debug for z/OS Library.

IBM Debug for z/OS supersedes IBM Debug for z Systems and IBM Debug Tool for z/OS. Not all references to IBM Debug for z Systems and IBM Debug Tool for z/OS have been changed in the COBOL documentation library. It is recommended that you upgrade your debugger to the latest level in order to have the full range of debugging features available. In some cases, you must upgrade your debugger to a certain version depending on what level of Enterprise COBOL you are using to create the COBOL application:

- IBM Debug Tool V13.1 supports Enterprise COBOL V5.1 and earlier versions
- IBM Debug for z Systems V14.0 supports Enterprise COBOL V6.1 and earlier versions

To find out which IBM debug product best suits your needs, see https://www.ibm.com/support/knowledgecenter/SSQ2R2_14.2.0/com.ibm.debug.cg.doc/common/dcompo.html?sc=SSQ2R2_latest.

IMS

- *Application Programming API Reference*, SC18-9699
- *Application Programming Guide*, SC18-9698

WebSphere® Application Server for z/OS

- *Applications*, SA22-7959

Softcopy publications for z/OS

The following collection kit contains z/OS and related product publications:

- *z/OS CD Collection Kit*, SK3T-4269

Java

- *IBM SDK for Java - Tools Documentation*, publib.boulder.ibm.com/infocenter/javasdk/tools/index.jsp
- *The Java 2 Enterprise Edition Developer's Guide*, download.oracle.com/javaee/1.2.1/devguide/html/DevGuideTOC.html

- *Java 2 on z/OS*, www.ibm.com/servers/eserver/zseries/software/java/
- *The Java EE 5 Tutorial*, download.oracle.com/javaee/5/tutorial/doc/
- *The Java Language Specification, Third Edition*, by Gosling et al., java.sun.com/docs/books/jls/
- *The Java Native Interface*, download.oracle.com/javase/1.5.0/docs/guide/jni/
- *JDK 5.0 Documentation*, download.oracle.com/javase/1.5.0/docs/

Unicode and character representation

- *Unicode*, www.unicode.org/
- *Character Data Representation Architecture Reference and Registry*, SC09-2190

XML

- *Extensible Markup Language (XML)*, www.w3.org/XML/
- *Namespaces in XML 1.0*, www.w3.org/TR/xml-names/
- *Namespaces in XML 1.1*, www.w3.org/TR/xml-names11/
- *XML specification*, www.w3.org/TR/xml/

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