Enterprise COBOL for z/OS 6.5

Migration Guide

GC27-8715-03

Note

Before using this information and the product it supports, be sure to read the general information under “Notices” on page 357.

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Preface

About this information

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

Throughout this information, "COBOL" or "Enterprise COBOL" refers to "IBM Enterprise COBOL for z/OS®" or "IBM Enterprise COBOL Value Unit Edition for z/OS".

Because the changes required during migration from COBOL 5 to COBOL 6 are small, this document assumes that you are migrating from COBOL 4 or earlier versions to COBOL 5 or 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® 3.1
- IBM Enterprise COBOL for z/OS and OS/390 3.2
- IBM Enterprise COBOL for z/OS 3.3
- IBM Enterprise COBOL for z/OS 3.4
- IBM Enterprise COBOL for z/OS 4.1
- IBM Enterprise COBOL for z/OS 4.2
- IBM Enterprise COBOL for z/OS 5.1
- IBM Enterprise COBOL for z/OS 5.2
- IBM Enterprise COBOL Value Unit Edition for z/OS 5.2
- IBM Enterprise COBOL for z/OS 6.1
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- IBM Enterprise COBOL for z/OS 6.2
- IBM Enterprise COBOL Value Unit Edition for z/OS 6.2
- IBM Enterprise COBOL for z/OS 6.3
- IBM Enterprise COBOL Value Unit Edition for z/OS 6.3
- IBM Enterprise COBOL for z/OS 6.4
- IBM Enterprise COBOL Value Unit Edition for z/OS 6.4

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

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

- COBOL/370 1.1
- COBOL for MVS & VM 1.2
- COBOL for OS/390 & VM 2.1
- COBOL for OS/390 & VM 2.2

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

How to use examples

This information shows numerous examples of sample COBOL statements, program fragments, and small programs to illustrate the coding techniques being described. The examples of program code are written in lowercase, uppercase, or mixed case to demonstrate that you can write your programs in any of these ways.

To more clearly separate some examples from the explanatory text, they are presented in a `monospace font`.

COBOL keywords and compiler options that appear in text are generally shown in SMALL UPPERCASE. Other terms such as program variable names are sometimes shown in *an italic font* for clarity.

If you copy and paste examples from the PDF format documentation, make sure that the spaces in the examples (if any) are in place; you might need to manually add some missing spaces to ensure that COBOL source text aligns to the required columns per the COBOL reference format in the *Enterprise COBOL for z/OS Language Reference*. Alternatively, you can copy and paste examples from the HTML format documentation and the spaces should be already in place.

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.

Related publications

The information provided with Enterprise COBOL and Language Environment is designed to help you install and customize Enterprise COBOL and create COBOL applications for z/OS.

Enterprise COBOL for z/OS publications

Table 1. 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, see *Chapter 3. Planning the move to Language Environment* in the *Enterprise COBOL 4.2 Compiler and Runtime Migration Guide*.
Customize Enterprise COBOL for z/OS	*Enterprise COBOL for z/OS Customization Guide*
Prepare and test your programs and get details about compiler options	*Enterprise COBOL for z/OS Programming Guide*

Table 1. The Enterprise COBOL for z/OS publications (continued)

Task	Information
Get details about COBOL syntax and specifications of language elements	*Enterprise COBOL for z/OS Language Reference*
Know key performance benefits and tuning considerations when using Enterprise COBOL for z/OS	*Enterprise COBOL for z/OS Performance Tuning Guide*
Understand COBOL compiler messages and return codes to diagnose problems	*Enterprise COBOL for z/OS Messages and Codes*
Get an overview of new functions in the latest COBOL compiler	*Enterprise COBOL for z/OS What's New*

Language Environment element of z/OS publications

Table 2. 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*
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 the COBOL compilers

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

For any changes to IBM Enterprise COBOL for z/OS 6.5, refer to What's new in Enterprise COBOL for z/OS 6.5.

Changes in IBM Enterprise COBOL for z/OS 6.4 with PTFs installed

Changed statements

- PH48667: A problem is fixed for using figurative constant HIGH-VALUES with fixed byte-length UTF-8 data items of a length not a multiple of 4 bytes.

New and changed compiler options

- PH50925: NUMCHECK: The NUMCHECK compiler option is updated to avoid generating runtime checking code of zoned-decimal senders in MOVE statements when the receiver is an alphanumeric data item and NUMCHECK(ZON(LAX)) is in effect.
- PH50296: CONDCOMP: The new CONDCOMP compiler option is introduced to control how conditional code will be displayed in the listing.

COBOL/Java interoperability enhancement

- PH48453: New sample files demonstrating a COBOL/Java interoperable application and how to build it are provided in the demo subdirectory of your COBOL install directory in the z/OS UNIX file system.
- PH49967: A new cjbuild command reference section is added to address various usability and stability issues relating to the non-OO Java/COBOL interoperability feature.
- PH51752: A new sample JCL is provided to demonstrate how a non-OO COBOL/Java interoperable application can be built and run entirely using JCL.
- PH53631: Enhanced the ON EXCEPTION phrase support to deal with exceptions in the non-OO COBOL/Java interoperability framework.

Changes in IBM Enterprise COBOL for z/OS 6.4

Compiler option changes

- The following compiler options are new:
  - SMARTBIN: Use SMARTBIN to instruct the compiler to generate modules containing additional binary metadata that enables them to be optimized by IBM Automatic Binary Optimizer (ABO) for z/OS 2.2.
  - JAVAIOP: Use JAVAIOP to control the behavior of COBOL programs that interoperate with Java™ though the JAVA-CALLABLE or JAVA-SHAREABLE directives or by calling Java static methods using the CALL statement.
- The following compiler options are modified:
  - ARCH: ARCH(8) and ARCH(9) are no longer accepted. A new higher level of ARCH(14) is accepted. ARCH(10) is the default.
  - RULES: If there are multiple RULES specifications for a compilation, the suboptions are additive, which means they are accumulated.
  - TUNE: TUNE(8) and TUNE(9) are no longer accepted. A new higher level of TUNE(14) is accepted. TUNE(10) is the default if ARCH is not specified.

Improved COBOL/Java interoperability

Interoperability between your COBOL and Java applications is simplified and improved so that you can easily extend your COBOL applications with Java.

Interoperability between AMODE 31 (31-bit) and AMODE 64 (64-bit) COBOL programs

AMODE 64 (64-bit) COBOL applications can interoperate with your existing AMODE 31 (31-bit) COBOL applications. Dynamic call is supported in a mixed AMODE 31/AMODE 64 environment.

User-defined function support

You can define your own functions by specifying a FUNCTION-ID paragraph in the IDENTIFICATION DIVISION and invoke them by using a reference to a function identifier. This is part of the 2002 COBOL Standard.

Improved integration with IBM Automatic Binary Optimizer for z/OS (ABO)

COBOL modules that you compile today can be easily optimized in the future by ABO to utilize future IBM Z® hardware enhancements, without having to be recompiled.

- ABO (sold separately) improves the performance of already-compiled COBOL program modules without recompiling, source code migration, or performance tuning.
- With the new SMARTBIN compiler option in effect, COBOL compiler generates binary metadata that is designed to allow modules compiled with COBOL 6.4 to be easily optimized in the future by ABO.
- Use the latest version of Enterprise COBOL for new development, modernization, and maintenance. Use ABO to improve the performance of COBOL modules that are stable and do not need any source changes.

For details about ABO, visit the ABO product page.

PERFORM ... UNTIL EXIT support

You can specify EXIT in place of a condition in a PERFORM statement. If the UNTIL phrase with the EXIT reserved word is specified, execution proceeds exactly as if the same PERFORM statement were coded with *condition-1* specified, except that *condition-1* never evaluates as true.

Debugging enhancement

You can use ddname IGZPROUT at the run step of your JCL to generate a report of all dynamically called programs that are compiled with Enterprise COBOL 5 or later.

Changes in IBM Enterprise COBOL for z/OS 6.3 with PTFs installed

Changed statements

- Runtime APARs PH20569(z/OS 2.2) and PH21261(z/OS 2.3/2.4): 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 5 or later versions. (“Using DFSORT option NOBLKSET” on page 224)
- PH18641: A new "NAME is OMITTED" phrase is added to the JSON GENERATE statement to allow generation of an anonymous JSON object, whose top-level parent name is not generated.
- PH20724: The use of passing a *file-name* to a subprogram with the USING phrase of the CALL statement is restored. (“Use of file-name in CALL ... USING statement” on page 191)
- PH26789: A new "CONVERTING" phrase is added to the JSON GENERATE and JSON PARSE statements so that you can generate and parse JSON boolean values.

  Note: COBOL Runtime LE APAR PH26698 must also be applied on all systems where programs that make use of this new feature are linked or run.
- PH30975: New "when-phrase" and "generic-suppression-phrase" are added to the JSON GENERATE statement so that you can conditionally suppress data items during JSON GENERATE.

Note: COBOL Runtime LE APAR PH31172 must also be applied on all systems where programs that make use of this new feature are linked or run.

Changed intrinsic functions

- PH20997: The UUID4 intrinsic function is introduced.

  Note: COBOL Runtime LE PTF UI66560(z/OS 2.2)/UI66555(z/OS 2.3)/UI66557(z/OS 2.4) must also be applied on all systems where programs that make use of this new feature are linked or run.
- PH31047: New date and time intrinsic functions are introduced that support encoding and decoding of date and time information to and from formats specified in ISO 8601, and that support encoding and decoding date and time information to and from integers that are suitable for arithmetic.

  Note: COBOL Runtime LE APAR PH31133 must also be applied on all systems where programs that make use of these new date and time intrinsic functions are linked or run.

  The following intrinsic functions are added as part of the 2002 COBOL Standard:

  – TEST-DATE-YYYYMMDD: The TEST-DATE-YYYYMMDD function tests whether a date in standard date form (YYYYMMDD) is a valid date in the Gregorian calendar.
  – TEST-DAY-YYYYDDD: The TEST-DAY-YYYYDDD function tests whether a date in Julian date form (YYYYDDD) is a valid date in the Gregorian calendar.

  The following intrinsic functions are added as part of the 2014 COBOL Standard:

  – COMBINED-DATETIME: The COMBINED-DATETIME function combines a date in integer date form and a time in standard numeric time form into a single numeric item from which both date and time components can be derived.
  – FORMATTED-CURRENT-DATE: The FORMATTED-CURRENT-DATE function returns a character string that represents the current date and time provided by the system on which the function is evaluated.
  – FORMATTED-DATE: The FORMATTED-DATE function converts a date from its integer date form to the requested format.
  – FORMATTED-DATETIME: The FORMATTED-DATETIME function uses a combined time and date format to convert and combine a date in the integer date form and a numeric time expressed as seconds past midnight to a formatted date and time representation according to that combined date and time format.
  – FORMATTED-TIME: The FORMATTED-TIME function uses a format to convert a value that represents seconds past midnight to a formatted time of day in the requested format.
  – INTEGER-OF-FORMATTED-DATE: The INTEGER-OF-FORMATTED-DATE function converts a date that is in a specified format to an integer date form.
  – SECONDS-FROM-FORMATTED-TIME: The SECONDS-FROM-FORMATTED-TIME function converts a time that is in a specified format to a numeric value that represents the number of seconds after midnight.
  – SECONDS-PAST-MIDNIGHT: The SECONDS-PAST-MIDNIGHT function returns a value in standard numeric time form that represents the current local time of day provided by the system on which the function is evaluated.
  – TEST-FORMATTED-DATETIME: The TEST-FORMATTED-DATETIME function tests whether a data item that represents a date, a time, or a combined date and time is valid according to the specified format.
- PH34885: The UUID4 randomness and UUID4 intrinsic function requires significant CPU usage.

New and changed compiler options

- PH22581: 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.

- PH27536: NUMCHECK(ZON): New suboptions LAXREDEF | STRICTREDEF are added to the NUMCHECK(ZON) option to control whether the compiler will check and issue warning messages for redefined items.
- PH29542: NUMCHECK(BIN): New suboptions TRUNCBIN | NOTRUNCBIN are added to the NUMCHECK(BIN) option to control whether the compiler will generate the checking code for binary data items.
- PTF UI71591 (no APAR number): New functionality is added to NUMCHECK to check alphanumeric senders whose contents are being moved to a numeric receiver. For alphanumeric senders whose contents are being moved to a numeric receiver, the compiler treats the sender as a numeric integer so NUMCHECK generates an implicit numeric class test for each alphanumeric sender.
- Runtime APARs PH29755(z/OS 2.3/2.4) and PH30338(z/OS 2.3/2.4 AMODE 64): TEST: New support is added for LLA/VLF managed programs where DWARF diagnostic information is included.
- PH33122: RULES: New suboptions LAXREDEF | NOLAXREDEF are added to the RULES option to inform users of redefined items with mismatched lengths.
- PH34804: TUNE: The new TUNE option specifies the architecture for which the executable program will be optimized.
- PH35643: SOURCE: New suboptions DEC | HEX are added to the SOURCE option to control whether the generated sequence numbers for the listing of the source are in decimal or hexadecimal format.
- PH35652: OFFSET: The behaviour of OFFSET is improved. If multiple blocks of instructions are for a single line of COBOL code, there will be multiple entries in the offset table for a given COBOL statement.
- PH37328: INVDATA: The new INVDATA compiler option replaces the deprecated ZONEDATA compiler option and provides users fine-grained control over how the compiler generates code to handle USAGE DISPLAY and USAGE PACKED-DECIMAL data items that contain invalid data.
- PH40356: NUMCHECK(ZON): LAXREDEF|STRICTREDEF is deprecated but is tolerated for compatibility, and it is replaced by the LAX|STRICT option.
- PH50296: CONDCOMP: The new CONDCOMP compiler option is introduced to control how conditional code will be displayed in the listing.

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. (“Controlling initialization of QSAM buffer (IGZ4OPT)” on page 353)

Installation customization changes

- PH37331: Adds support for diagnosing miscoded options or options coded as OPTION() instead of OPTION= in the COBOL customization macro.

Changes in IBM Enterprise COBOL for z/OS 6.3

Compiler option changes

- The following compiler option is new:
  - LP: The new LP compiler option can be used to indicate whether an AMODE 31 (31-bit) or AMODE 64 (64-bit) program should be generated with the related language features enabled. LP(32) is the default.
- The following compiler options are modified:
  - ARCH: ARCH(7) is no longer accepted. A new higher level of ARCH(13) is accepted. ARCH(8) is the default.
  - NUMCHECK: Regardless of whether NUMCHECK(MSG) or NUMCHECK(ABD) is in effect, invalid data found at compile time will produce a compile-time error message and the check will be removed.

AMODE 64 support

You can use Enterprise COBOL to develop AMODE 31 (31-bit) or AMODE 64 (64-bit) applications. Adapt your code as appropriate for your applications to support the 64-bit environment.

Language element changes

- A DYNAMIC LENGTH clause is supported to specify a dynamic-length elementary item. A dynamic-length elementary item is a data item whose length might change at run time. This is part of the 2014 COBOL Standard.
- A UTF-8 phrase is added to the USAGE clause to indicate a new UTF-8 data type. A picture symbol 'U' that indicates UTF-8 character data is also added. The new USAGE indicates a new class of data (UTF-8) and a new category of data (UTF-8).
- A POINTER-32 phrase is added to the USAGE clause, which can be used to define pointer data items or data-pointers. The POINTER-32 data item is a 4-byte elementary data item regardless of the LP, compiler option setting, and can be used in both LP(32) and LP(64).
- The REPOSITORY paragraph FUNCTION specifier INTRINSIC allows declaration of intrinsic function names that may be used without specifying the word FUNCTION. This is part of the 2002 COBOL Standard.

Listing changes

Listing terminologies change as follows:

- `Static map` is changed to `initial heap storage map`.
- `Writeable static area (WSA)` is changed to `storage`.
- `WSA24` is changed to `below the line storage`.
- `Automatic map` is changed to `stack storage map`.

Compiler phases in shared storage changes

- The installation customization for placing compiler phases into shared storage is removed.

Use of *file-name* in CALL ... USING statement

Programs can no longer pass a *file-name* to a subprogram with the USING phrase of the CALL statement.

Changes in IBM Enterprise COBOL for z/OS 6.2 with PTFs installed

New and changed compiler options

- The following compiler option is new:
  - PI91584: `COPYLOC`: The new `COPYLOC` compiler option 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.
  - PH05855: `INITIAL`: The new `INITIAL` compiler option allows you to get a program that has initial values in data items each time the program is called, without having to add the `IS INITIAL` clause to the `PROGRAM-ID` paragraph, and without having to use dynamic `CALL` and `CANCEL` statements.
  - PH37328: `INVDATA`: The new `INVDATA` compiler option replaces the now-deprecated ZONEDATA compiler option and provides users fine-grained control over how the compiler generates code to handle USAGE DISPLAY and USAGE PACKED-DECIMAL data items containing invalid data.
- The following compiler options are modified:

  - PI90571: 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.
  - PI91585: RULES: New suboptions OMITODOMIN | NOOMITODOMIN are added to the RULES option to control whether the compiler will issue warning messages for any OCCURS DEPENDING ON clauses that are specified without *integer-1* (the minimum number of occurrences).
  - PI91586: RULES: New suboptions UNREF | NOUNREFALL | NOUNREFSOURCE are added to the RULES option to control whether the compiler will report unreferenced data items, and to control whether the reporting is done only for data items not declared in a copy member (NOUNREFSOURCE) or all data items (NOUNREFALL).
  - PI96135: NUMCHECK(PAC): For packed decimal (COMP-3) data items that have an even number of digits, the unused bits are checked for zeros.
  - PI98480: 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.
  - PH04369: RULES(NOEVENPACK) will not issue messages for even-digit PACKED-DECIMAL data items whose names start with DFH, DSN, EYU or SQL, that is, data items generated for/by CICS® and Db2®.
  - PH04485: TEST： New suboptions DSNAME | NODSNAME are added to the TEST|NOTEST(SEPARATE) option to control whether the external file name, which is the SYSDEBUG dataset name used during compilation, will or will not be stored in the object program.
  - PH08642: NUMCHECK: Redundant checks previously added by the NUMCHECK option have been removed, improving performance, and some checks can be done at compile time. Specifying NUMCHECK may also cause the compiler to produce some messages at compile time instead of at runtime.
  - PH09225: INITCHECK: The INITCHECK option can be specified with OPTIMIZE(0).
  - PH11667: NUMCHECK(BIN): NUMCHECK(BIN) will check for binary data items (COMP, COMP-4, and USAGE BINARY) even when TRUNC(BIN) is in effect.
  - PH24340: NUMCHECK(ZON): New suboptions LAXREDEF | STRICTREDEF are added to the NUMCHECK(ZON) option to control whether the compiler will check and issue warning messages for redefined items.
  - PH24413: 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.
  - PH26794: NUMCHECK(BIN): New suboptions TRUNCBIN | NOTRUNCBIN are added to the NUMCHECK(BIN) option to control whether the compiler will generate the checking code for binary data items.
  - Runtime APAR PH20569(z/OS 2.2/2.3/2.4): The included DWARF diagnostic information when TEST(NOSEPARATE) is effect can be extracted from the LLA/VLF managed programs.
- The following compiler option is deprecated:
  - PH7328: ZONEDATA: This compiler option is deprecated but tolerated and is automatically mapped to an equivalent form of the new INVDATA compiler option.

New and changed statements

- PI91584: As the new compiler option COPYLOC is introduced, the COPY statement is updated.
- PI95081: 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.
- PI97160: SET TO FALSE and WHEN SET TO FALSE are introduced as defined in the 2002 COBOL Standard, which allows you to avoid explicit references to invalid values in the PROCEDURE DIVISION.

- Runtime APARs PH20569(z/OS 2.2) and PH21261(z/OS 2.3/2.4): 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 5 or later versions.
- PH28546: A new "CONVERTING" phrase is added to the JSON GENERATE and JSON PARSE statements so that you can generate and parse JSON boolean values.
  Note that COBOL Runtime LE APAR PH26698 must also be applied on all systems where programs that make use of this new feature are linked or run.

IBM-supplied CICS reserved-word table changes

- PI91589: New COBOL words are added to the IBM-supplied CICS reserved-word table.

Intrinsic function enhancements

- PI97434: Add support for processing national data items with the following intrinsic functions:
  - REVERSE
  - ULENGTH
  - UPOS
  - USUBSTR
  - UWIDTH

  This PTF pre-reqs the PTF(s) for Language Environment (LE) APAR PI97224 (z/OS 2.1/2.2) and APAR PI97712 (z/OS 2.3). Make sure that the PTF(s) for APAR PI97224 or APAR PI97712 are installed on Language Environment (LE) on all systems where COBOL programs will be run before using the compiler with the PTF for PI97434 installed.

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. (“Controlling initialization of QSAM buffer (IGZ4OPT)” on page 353)

Changes in IBM Enterprise COBOL for z/OS 6.2

New, changed, and removed compiler options

- The following compiler options are new:
  - `DEFINE`
  - `INITCHECK`
  - `INLINE`
  - `NUMCHECK`
  - `PARMCHECK`
- The following compiler options are modified:
  - `AFP`: The default value is changed to `AFP(NOVOLATILE)`.
  - `ARCH`: A new higher level of `ARCH(12)` is accepted. `ARCH(7)` is still the default.
  - `MAXPCF`: The default value is changed to `MAXPCF(100000)` to reflect the increased capacity of the COBOL 6 compiler.
  - `NOSTGOPT`: In earlier versions, data items can get optimized with `OPT(2)` even when `NOSTGOPT` was in effect. `NOSTGOPT` was changed in this version so that no optimization of storage or data items occurs even with `OPT(2)`. This is especially helpful for `WORKING-STORAGE` eye-catchers.
  - `SSRANGE`: New suboptions `MSG | ABD` and `ZLEN | NOZLEN` are added to the `SSRANGE` compiler option to allow, respectively:

    - A message instead of an abend and continued processing for additional reporting of out-of-range conditions in a single run.
    - A reference modification of zero length to proceed without a message or abend.
  - TEST: New suboptions SEPARATE and NOSEPARATE are added to the TEST compiler option to control program object size on disk while retaining debugging capability. In addition, new combinations of suboptions are supported in both the TEST and NOTEST compiler options, including `TEST(NODWARF)`, `TEST (SEPARATE)`, and `NOTEST(DWARF,SOURCE)`.
- The following compiler option is removed:
  - `ZONECHECK` is deprecated but is tolerated for compatibility, and it is replaced by `NUMCHECK(ZON)`.

New statements

- The new JSON PARSE statement converts JSON text to COBOL data formats.

New and changed special registers

- The new JSON-STATUS special register is used to indicate either that a JSON PARSE statement executed successfully or that a nonexception condition occurred.
- The JSON-CODE special register is also used to indicate either that a JSON PARSE statement executed successfully or that an exception condition occurred.

New directives

- The following new compiler directives are added to support conditional compilation as defined in the 2002 COBOL Standard:
  - The DEFINE directive defines or undefines a compilation variable.
  - The EVALUATE directive provides a multi-branch method of choosing the source lines to include in a compilation group.
  - The IF directive provides for a one-way or two-way conditional compilation.
- The new INLINE directive allows the compiler to decide whether to inline procedures referenced by PERFORM statements in the source program.

Debugging changes

- TEST(SEPARATE) supports generating the debug information into side files to control module size while retaining debugging capability.

Listing changes

- Compiler diagnostic messages now appear at the end of the listing, as was the case in COBOL compilers before Enterprise COBOL 5.
- Addition of MD5 signature to program objects and debug data to allow matching of debug data with executables even if a program is recompiled.
- Three new fields are added at the end of PPA4:
  - Offset of the first user-defined data item in WORKING-STORAGE.
  - Total length of user-defined data items in WORKING-STORAGE.
  - Bit to indicate whether there are EXTERNAL data items.

Changes in IBM Enterprise COBOL for z/OS 6.1 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(z/OS 2.2/2.3/2.4): The included DWARF diagnostic information when TEST(NOSEPARATE) is effect can be extracted from the LLA/VLF managed programs.
- 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(z/OS 2.2) and PH21261(z/OS 2.3/2.4): 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 5 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. (“Controlling initialization of QSAM buffer (IGZ4OPT)” on page 353)

Changes in IBM Enterprise COBOL for z/OS 6.1

New and changed options

- The following compiler options are new:
  - SUPPRESS
  - VSAMOPENFS
  - ZONECHECK
- 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 6, the compiler starts using storage above the 2 GB BAR to compile programs, even those that are not large. 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 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`. If you encounter this error message, set `REGION=0M` and `MEMLIMIT=3G` on the job card and recompile your programs. If it is successful, consider changing the system MEMLIMIT default that was set in IEFUSI, SMFPRMxx, or SMFLIMxx to no less than 2 GB.

Note: The SMFLIMxx PARMLIB member is only available in z/OS 2.2 and later versions.

Debugging changes

The allocation and management of WORKING-STORAGE SECTION have been changed since Enterprise COBOL 5. 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 5.2 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 4 does when using NUMPROC=NOPFD|PFD with COBOL 4.
  - 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 behavior 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 5.2

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 5.2 if your programs are compiled with Enterprise COBOL 4 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 5 compiler for programs with XML PARSE statements that were compiled with Enterprise COBOL 3, or with COBOL 4 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 5.1.1

- Except for a few exception cases, AMODE 24 execution of COBOL programs is supported. Many programs compiled by IBM Enterprise COBOL for z/OS 5.1.1 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 5.1.0 appears to be 5.1.1 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 5.1

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 5 programs. XML PARSE statements in COBOL 5 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 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 5. Both the called and calling programs must be recompiled with Enterprise COBOL 5 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 5.1 that result in different behaviors.

- AMODE 24 execution of programs compiled with Enterprise COBOL 5.1.0 is no longer supported. Enterprise COBOL 5.1.0 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 5.
- The IGZBRDGE macro, for converting static calls to dynamic calls, is not supported for programs compiled with Enterprise COBOL 5.
- The compatibility-mode COBOL XML parser from the COBOL library, the old parser from Enterprise COBOL 3, is no longer supported for use by Enterprise COBOL 5 programs. XML PARSE statements in COBOL 5 programs always use the z/OS System Services XML parser (XMLSS).
- Enterprise COBOL 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 5.1 has a new Language Environment member ID, 4. Prior versions of COBOL use ID 5.
- Enterprise COBOL 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 29.
- COBOL programs with the following characteristics may behave differently with Enterprise COBOL 5 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 5 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 5.1 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 5 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 5.1.

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

Enterprise COBOL 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 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 5.1 can compile programs only when the exit is an assembler program in a PDS data set that LOADs and calls a COBOL 5.1 program in a PDSE. For

workarounds to handle the restriction, see Chapter 26, “Moving IMS programs to Enterprise COBOL 5 or 6,” on page 261.

Changes in IBM Enterprise COBOL for z/OS 4.2

- 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 4.1.
  - 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 4.1

- 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 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 IBM 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® 9 exploitation and improvements in coprocessor integration and usability:
  - Support for new SQL data types and new SQL syntax provided by DB2 9
  - Db2 precompiler options are shown in the compiler listing (DB2 9 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 8 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 3.4 with PTFs installed

- 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 COBOL 3.4. 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 3.4

- 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 Enterprise COBOL for z/OS 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 3.3

- 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 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 3.2

- 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 3.1

- 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 2.2

- 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 2.1.2

- 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 2.1.1

- 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 2.1

- Support has been added for dynamic link libraries (DLLs)
- Due to changes in the SOMobjects product that is delivered with OS/390 1.3, 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.

When you send information to IBM, you grant IBM a nonexclusive right to use or distribute the information in any way it believes appropriate without incurring any obligation to you.

Part 1. Overview

Chapter 1. COBOL compiler versions, required runtimes, and support information

COBOL compilers by name and version

Table 3. COBOL compiler names, versions and releases, product identifiers, GA and EOS dates, and required runtimes

Compiler	Version, release, and modification level	Product identifier (PID)	General availability (GA) date (Year-Month-Day)	End of support (EOS) date[1] (Year-Month-Day)	Required runtimes[2]
OS/VS COBOL	1.2.1	-	-	-	-
OS/VS COBOL	1.2.2	-	-	-	-
OS/VS COBOL	1.2.3	5740-CB1	1974-09-23	1999-12-31	• OS/VS COBOL runtime library; or • VS COBOL II runtime library; or • z/OS Language Environment
OS/VS COBOL	1.2.4	5740-CB1	1976-09-23	1999-12-31	• OS/VS COBOL runtime library; or • VS COBOL II runtime library; or • z/OS Language Environment
VS COBOL II	1.1	5668-958	1985-10-01	1997-06-30	• VS COBOL II runtime library; or • z/OS Language Environment

Table 3. COBOL compiler names, versions and releases, product identifiers, GA and EOS dates, and required runtimes (continued)

Compiler	Version, release, and modification level	Product identifier (PID)	General availability (GA) date (Year-Month-Day)	End of support (EOS) date[1] (Year-Month-Day)	Required runtimes[2]
VS COBOL II	1.2	5668-958	1986-12-19	1997-06-30	• VS COBOL II runtime library; or • z/OS Language Environment
VS COBOL II	1.3[3]	5668-958	1988-12-16	1996-06-30	• VS COBOL II runtime library; or • z/OS Language Environment
VS COBOL II	1.4[3]	5668-958	1993-03-12	2001-03-31	• VS COBOL II runtime library; or • z/OS Language Environment
COBOL/370	1.1	5688-197	1991-12-20	1997-09-30	z/OS Language Environment
COBOL for MVS & VM	1.2	5688-197	1995-10-27	2001-12-31	z/OS Language Environment
COBOL for OS/390 & VM	2.1[3]	5648-A25	1997-05-23	2004-12-31	z/OS Language Environment
COBOL for OS/390 & VM	2.2[3]	5648-A25	2000-09-29	2004-12-31	z/OS Language Environment
Enterprise COBOL for z/OS	3.1	5655-G53	2001-11-30	2004-04-04	z/OS Language Environment
Enterprise COBOL for z/OS	3.2	5655-G53	2002-09-27	2005-10-03	z/OS Language Environment
Enterprise COBOL for z/OS	3.3	5655-G53	2004-02-27	2007-04-30	z/OS Language Environment
Enterprise COBOL for z/OS	3.4	5655-G53	2005-07-01	2015-04-30	z/OS Language Environment

Table 3. COBOL compiler names, versions and releases, product identifiers, GA and EOS dates, and required runtimes (continued)

Compiler	Version, release, and modification level	Product identifier (PID)	General availability (GA) date (Year-Month-Day)	End of support (EOS) date[1] (Year-Month-Day)	Required runtimes[2]
Enterprise COBOL for z/OS	4.1	5655-S71	2007-12-14	2014-04-30	z/OS Language Environment
Enterprise COBOL for z/OS	4.2	5655-S71	2009-08-28	2022-04-30	z/OS Language Environment
Enterprise COBOL for z/OS	5.1	5655-W32	2013-06-21	2020-04-30	z/OS Language Environment
Enterprise COBOL for z/OS	5.2	5655-W32	2015-02-27	2020-04-30	z/OS Language Environment
Enterprise COBOL Value Unit Edition for z/OS[4]	5.2	5697-ECV	2015-10-06	2020-04-30	z/OS Language Environment
Enterprise COBOL for z/OS	6.1	5655-EC6	2016-03-18	2022-09-30	z/OS Language Environment
Enterprise COBOL Value Unit Edition for z/OS[4]	6.1	5697-V61	2016-03-18	2022-09-30	z/OS Language Environment
Enterprise COBOL for z/OS	6.2	5655-EC6	2017-09-08	2024-09-30	z/OS Language Environment
Enterprise COBOL Value Unit Edition for z/OS[4]	6.2	5697-V61	2017-09-08	2024-09-30	z/OS Language Environment
Enterprise COBOL for z/OS	6.3	5655-EC6	2019-09-06	2025-09-30	z/OS Language Environment
Enterprise COBOL Value Unit Edition for z/OS[4]	6.3	5697-V61	2019-09-06	2025-09-30	z/OS Language Environment

Table 3. COBOL compiler names, versions and releases, product identifiers, GA and EOS dates, and required runtimes (continued)

Compiler	Version, release, and modification level	Product identifier (PID)	General availability (GA) date (Year-Month-Day)	End of support (EOS) date[1] (Year-Month-Day)	Required runtimes[2]
Enterprise COBOL for z/OS	6.4	5655-EC6	2022-05-27	To be determined	z/OS Language Environment
Enterprise COBOL Value Unit Edition for z/OS[4]	6.4	5697-V61	2022-05-27	To be determined	z/OS Language Environment
Enterprise COBOL for z/OS	6.5	5655-EC6	2025-06-13	To be determined	z/OS Language Environment
Enterprise COBOL Value Unit Edition for z/OS[4]	6.5	5697-V61	2025-06-13	To be determined	z/OS Language Environment

Notes:

1. EOS stands for *End of Support* and refers to the last date on which IBM will deliver standard support services unless extensions or support upgrades are purchased. To check lifecycle details (lifecycle dates, announcement letters, and other information) for Enterprise COBOL for z/OS products, visit the COBOL for z/OS lifecycle website.
2. For details about runtime components and their EOS dates, see Table 4 on page 7.
3. VS COBOL II 1.3 and 1.4, along with COBOL for OS/390 & VM 2.1 and 2.2, are all commonly referred to as *COBOL 2*. To ensure clear communication, it's important to specify the exact compiler version you are using when discussing migration, as the term *COBOL 2* can be ambiguous.
4. Enterprise COBOL Value Unit Edition for z/OS is the same as Enterprise COBOL for z/OS made available under a different product identifier and pricing metric.

Runtime libraries for COBOL programs

Every COBOL program requires runtime library routines to execute. Runtime libraries offer a variety of predefined functionalities, optimized for IBM Z hardware. Runtime libraries are sold either bundled with other products or as standalone products. In the latter case, runtime libraries are serviced by their own APARs and PTFs.

OS/VS COBOL and VS COBOL II runtime libraries were either bundled with the old compilers at purchase or needed to be purchased separately. In contrast, z/OS Language Environment is a base element exclusive to z/OS (existing only within z/OS) and does not need to be purchased separately. If you still use OS/VS COBOL and VS COBOL II runtime libraries, you are encouraged to move to z/OS Language Environment.

In addition to cost benefits, z/OS Language Environment provides a single language runtime library for COBOL, PL/I, C/C++, and FORTRAN. It supports existing applications and offers 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.

For details, see *COBOL runtime options* in the *Enterprise COBOL Programming Guide* and the *z/OS Language Environment Vendor Interfaces*.

Table 4. Runtime libraries for COBOL programs, product identifiers, components, and EOS dates

Runtime library	Supported COBOL programs	Product identifiers (PIDs)	Component ID	End of support (EOS) date (Year-Month-Day)
OS/VS COBOL runtime library	OS/VS COBOL	• 5740-CB1 (compiler and library) • 5740-LM1 (library only)	• 5740CB103 • 5740LM103	1999-12-31
VS COBOL II runtime library	• OS/VS COBOL • VS COBOL II	• 5668-958 (compiler, debugger, and library) • 5688-023 (compiler and library) • 5668-940 (library only) • 5688-022 (library only)	• 566895801 • 566894001	2001-03-31
z/OS Language Environment	• OS/VS COBOL[2] • VS COBOL II[2] • COBOL/370 • COBOL for MVS & VM • COBOL for OS/390 & VM • Enterprise COBOL for z/OS 3.1 through 4.2[3]	• 5694-A01 • 5650-ZOS • 5655-ZOS	• 568819801 (Language Environment Common Execution Library) • 568819802 (Language Environment COBOL Library)[1]	z/OS Language Environment is a component of z/OS and follows the lifecycle of z/OS[4]
	Enterprise COBOL for z/OS 5.1 and later[3]	• 5694-A01 • 5650-ZOS • 5655-ZOS	• 568819801 (Language Environment Common Execution Library) • 568819812 (Language Environment Enterprise COBOL Library)[1]	

Table 4. Runtime libraries for COBOL programs, product identifiers, components, and EOS dates (continued)

Runtime library	Supported COBOL programs	Product identifiers (PIDs)	Component ID	End of support (EOS) date (Year-Month-Day)

Notes:

1. Component ID identifies each component in z/OS. For details, see *Identifying modules, components, and products* in *z/OS MVS Diagnosis: Reference*.
2. 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 1.1 in 1991, all COBOL compilers default to the RES behavior. If you want to link-edit those programs with z/OS Language Environment, see "Moving to Language Environment" on page 27.
3. Different versions of Enterprise COBOL have different minimum release level requirements for z/OS Language Environment. For details, see "Language Environment's runtime support for different compilers" on page 14.
4. Different z/OS versions and their releases have specific EOS dates. To check the EOS date for a specific z/OS release, visit the z/OS lifecycle website.

Support for COBOL programs after EOS

End of Support (EOS) refers to the last date on which IBM will deliver standard support services unless extensions or support upgrades are purchased. COBOL support has two aspects:

- **Support for the compiler**: Support for compiling your program. Compilation is required after you make source code changes for new development or maintenance fixes. When COBOL compilers reach EOS, IBM discontinues support services for the compilers. However, COBOL programs generated by these compilers continue to run on the latest z/OS systems. Existing programs will continue to run on the latest z/OS systems without needing to be recompiled with a supported COBOL compiler. While you can continue using COBOL compilers that have reached EOS, IBM will not provide support services if you encounter any issues during the compilation of your programs.
- **Support for the runtime**: Support for the execution of an existing COBOL program. If you encounter any issues during the execution of your programs, IBM will provide runtime support services for COBOL programs (including those generated from compilers that have reached EOS) that use a supported version of z/OS Language Environment as their runtime, as shown in Table 4 on page 7.

Tools and information to assist your COBOL migration

In general, the migration process involves compiler migration (recompiling source programs with the Enterprise COBOL for z/OS compiler) and runtime migration (moving your applications to z/OS Language Environment).

Basic information for compiler and runtime migration, and best practices

There are differences between older COBOL compilers and the Enterprise COBOL compilers that require you to upgrade your COBOL source programs. For example, COBOL 3 and later compilers require source code to be at the 85 COBOL Standard level or later. To aid in upgrading your COBOL programs, the COBOL 6 Migration Guide describes 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. For details, see "Conversion tools for source programs" on page 298.

To aid in moving your runtime library to z/OS Language Environment, refer to "Moving to Language Environment" on page 27. For details about 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, see *Chapter 5. Running existing applications under Language Environment* in the *Enterprise COBOL 4.2 Compiler and Runtime Migration Guide*.

One major migration challenge is the problems caused by invalid COBOL data, which cannot be detected by inspecting source code. You might get different results with COBOL 6 than with earlier compilers. To address this, you can go through a 2-compile and 2-test process with migration options. For details, see Chapter 5, "Upgrade recommendations and best practices," on page 37.

The COBOL 6 Migration Guide also describes other differences that might require changes in your application development process in order to use Enterprise COBOL.

Additional resources and guidance to kickstart your COBOL migration

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

- "COBOL Upgrade Advisor for z/OS" on page 307

  You can use the COBOL Upgrade Advisor for z/OS to simplify and accelerate the compiler migration process from Enterprise COBOL 4 or earlier versions to Enterprise COBOL 6.
- COBOL upgrade 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 4 or earlier versions to Enterprise COBOL 6.

Use IBM Automatic Binary Optimizer for z/OS (ABO) to reduce your COBOL migration scope and effort

IBM Automatic Binary Optimizer for z/OS (ABO) enables you to improve the performance of already compiled IBM COBOL programs without the need for recompilation. Using ABO 2.3 to optimize your COBOL 4.2 applications delivers comparable performance to applications compiled with COBOL 6.5.[1] You can reduce the scope of COBOL migration by focusing on source code that is under active development. Use ABO to improve the performance of all other modules compiled with VS COBOL II 1.3 and later that do not have a recompilation plan.

To learn more about the relationship between COBOL and ABO, see Using ABO and Enterprise COBOL together in the *IBM Automatic Binary Optimizer for z/OS User's Guide*. To learn more about ABO, see the ABO product page.

[1] DISCLAIMER: The performance improvements are based on the geometric mean of IBM internal measurements. Performance results for customer applications will vary, depending on the source code, the compiler options specified, and other factors.

Chapter 2. Overview of the Enterprise COBOL for z/OS compilers and z/OS Language Environment runtime

This section provides an overview of the IBM Enterprise COBOL for z/OS compilers and the z/OS Language Environment runtime.

Enterprise COBOL 5 or 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 upgrade to Language Environment. What does this mean? Follow these steps to ensure COBOL runtime upgrade is complete:

1. Add Language Environment to the LNKLST/LPALST. This moves Language Environment into production, and all COBOL applications will run under Language Environment by default.
   - The only COBOL runtime library present should be SCEERUN. Remove any instances of COBLIB, VSCLLIB, or COB2LIB in JCL STEPLIB or JOBLIB statements or in CICS startup JCL.
   - **Note:** Only use one library for a given language in LNKLST/LPALST. For example, if you install Language Environment with the COBOL component in LNKLST/LPALST, do not have the OS/VS COBOL library or the VS COBOL II library installed in LNKLST/LPALST.

   Optional: Add Language Environment to the STEPLIB JCL. This is a more gradual approach where Language Environment is phased in one region (CICS or IMS) or user (TSO) at a time.

   Note: Programs run slower and use more virtual storage with this approach than using LNKLST/LPALST to access Language Environment.
2. For programs compiled with NORES, use REPLACE linkage-editor control statements to replace the existing runtime library routines compiled with Language Environment versions.
3. Ensure that SCEERUN is the only COBOL runtime library available in LNKLST/LPALST. Remove any other COBOL runtime libraries present, such as COBLIB, VSCLLIB, or COB2LIB.
4. For VS COBOL II programs IGZEBST bootstrap models compiled with RES, do one of the following tasks:
   - Link to a runtime version of IGZEBST with APAR PN74000 applied
   - REPLACE 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. For help in completing your migration to Language Environment, see *Chapter 3. Planning the move to Language Environment* in the *Enterprise COBOL 4.2 Compiler and Runtime Migration Guide*.

Using Language Environment with Enterprise COBOL 5 or 6 and VS COBOL II programs

When running a mixture of VS COBOL II NORES programs and Enterprise COBOL 5 or 6 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 5 or 6 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 5 or 6 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 COBOL 5 or 6 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 5 or 6 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 8, “Planning to upgrade source programs,” on page 45.

If you do not understand these conditions, then continue reading these overview chapters. If you then discover that your shop has not completed its runtime library migration, see *Chapter 3. Planning the move to Language Environment* in the *Enterprise COBOL 4.2 Compiler and Runtime Migration Guide* for help in completing your runtime library migration.

Product relationships: compiler, runtime library, debug

IBM Enterprise COBOL for z/OS is IBM's strategic COBOL compiler for the IBM Z 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 and JSON 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 the 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 z/OS Debugger. z/OS Debugger 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 3, Debug Tool was included with the full-function version of the compiler.

With Enterprise COBOL 5 and 6, the compiler, the debugging component, and the runtime library are all separate, although the runtime library (Language Environment) is a base element exclusive to z/OS (existing only within z/OS) and does not need to be purchased separately.

Comparison of COBOL compilers

Table 5 on page 13 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 5. 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, OO, integrated CICS translator, multithreading, Unicode, JSON
			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
	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 and select features from 2002 COBOL Standard and 2014 COBOL Standard, Structured programming, DBCS National language, Improved CICS interface, 31-bit addressing, Reentrancy, Fast Sort Optimizer, Interactive debugging (full-screen mode)

Table 5. 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**
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.

Table 6. Minimum z/OS Language Environment version required for different Enterprise COBOL versions	
Enterprise COBOL for z/OS version	**Minimum z/OS Language Environment version required**
Enterprise COBOL for z/OS 4.2	z/OS 1.9
Enterprise COBOL for z/OS 5.1	z/OS 1.13
Enterprise COBOL for z/OS 5.2	z/OS 1.13
Enterprise COBOL for z/OS 6.1	z/OS 2.1
Enterprise COBOL for z/OS 6.2	z/OS 2.1
Enterprise COBOL for z/OS 6.3	z/OS 2.2
Enterprise COBOL for z/OS 6.4	z/OS 2.3
Enterprise COBOL for z/OS 6.5	z/OS 2.5

Related references

Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3

Advantages of the Enterprise COBOL for z/OS compilers and z/OS Language Environment runtime

The Enterprise COBOL compiler and Language Environment run time provide additional functions over OS/VS COBOL, VS COBOL II, and IBM COBOL. Table 7 on page 15 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 7. 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 2 GB. 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	In Enterprise COBOL 6.1, support for generation of JSON texts Starting in Enterprise COBOL 6.2, support for both generation and parsing of JSON texts	X	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

Table 7. Advantages of Enterprise COBOL and Language Environment (continued)

Advantage	Notes	Advantage over		
		OS/VS COBOL	VS COBOL II	IBM COBOL
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	
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 2.2 added support to generate more efficient code when the TRUNC(BIN) compiler option is used.	N/A	X	

Table 7. Advantages of Enterprise COBOL and Language Environment (continued)

Advantage	Notes	Advantage over		
		OS/VS COBOL	VS COBOL II	IBM COBOL
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		
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		

Table 7. Advantages of Enterprise COBOL and Language Environment (continued)

Advantage	Notes	Advantage over		
		OS/VS COBOL	VS COBOL II	IBM COBOL
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 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
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 5 and 6	There have been many changes to compiler options and suboptions for Enterprise COBOL 5 and 6. For details about those changes, see “Compiler option changes in Enterprise COBOL 5 and 6” on page 204.	X	X	X

Table 7. 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 5 and 6 *(continued)*	• The SQLIMS and VLR options are available in Enterprise COBOL 5.1 with the service PTFs, COBOL 5.2, and COBOL 6. • The SUPPRESS and VSAMOPENFS options are available in Enterprise COBOL 6.1 and 6.2. • The XMLPARSE option was originally removed in Enterprise COBOL 5.1, but was restored to COBOL 5.1 via service and is included in COBOL 5.2 and 6. • The ZONECHECK option is available in Enterprise COBOL 5.1 with the service PTFs and COBOL 5.2 with the service PTFs. ZONECHECK is deprecated in COBOL 6.1 with the PTF for APAR PI71625 installed, and is replaced by NUMCHECK. • The ZONEDATA options is available in Enterprise COBOL 5.1 with the service PTFs, COBOL 5.2 with the service PTFs, and COBOL 6.	X	X	X
Compiler options for Enterprise COBOL 4	The following compiler options are available to Enterprise COBOL 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 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 5.1, but was restored to COBOL 5.1 via service and is included in COBOL 5.2 and 6. • 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

Table 7. 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 3	The following compiler options are available to Enterprise COBOL 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
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	

Table 7. 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 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 2.2.				

Changes in the Enterprise COBOL for z/OS compilers and z/OS Language Environment runtime

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

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 9, “Upgrading OS/VS COBOL source programs,” on page 61
- Chapter 11, “Upgrading VS COBOL II source programs,” on page 105
- Chapter 13, “Upgrading IBM COBOL source programs,” on page 115

FLAGMIG compiler option

The FLAGMIG option helps identify source statements that need to be converted to compile under Enterprise COBOL. FLAGMIG is available in compilers prior to Enterprise COBOL that support the CMPR2 option. If you are already using Enterprise COBOL 4.2, it is recommended that you use the FLAGMIG4 option (available in Enterprise COBOL 4.2 with current service applied) to help you migrate to Enterprise COBOL 5 or 6.

To get similar migration flagging, use "COBOL and CICS Command Level Conversion Aid for z/OS (CCCA)" on page 303, this *Migration Guide*, or a compiler released prior to Enterprise COBOL to compile programs that use FLAGMIG.

For details about using the FLAGMIG and CMPR2 options to aid you with migration to Enterprise COBOL, see "Upgrading programs compiled with the CMPR2 compiler option" on page 120.

If you are already using Enterprise COBOL 4.2 and want to migrate to Enterprise COBOL 5 or 6, use the FLAGMIG4 option to flag source code syntax-related changes required to move to Enterprise COBOL 5 or 6. For details, see "FLAGMIG4 compiler option" on page 22.

FLAGMIG4 compiler option

The FLAGMIG4 option helps you migrate to Enterprise COBOL 5 or 6. FLAGMIG4 is available in Enterprise COBOL 4.2 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 4 programs that are not supported, or that are supported differently in Enterprise COBOL 5 or 6. The compiler generates a warning diagnostic message for all such language elements.

Note: The source code changes for COBOL 5 and 6 are rarely used COBOL language features and do not affect 99% of COBOL users.

SOM-based object-oriented COBOL

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 152.

Integrated Db2 coprocessor

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 25, "Db2 coprocessor conversion considerations," on page 255.

Integrated CICS translator

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 integrated CICS translator to process a COBOL source program that contains CICS statements.

For additional details and compatibility considerations, see Chapter 24, "CICS conversion considerations," on page 249.

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, and ARCH(12) with the vector decimal 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.

Starting with ARCH(13) in COBOL 6.3, the compiler uses the vector decimal Instruction Overflow Mask (IOM) to suppress decimal overflows at the instruction level independently of the program mask setting. Therefore, COBOL performance is unaffected by overflows, even in ILC applications.

General migration tasks

Depending on the programming environment of your enterprise, you will likely have to complete one or more migration tasks to move to the Enterprise COBOL for z/OS compiler and the z/OS Language Environment runtime.

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 *Chapter 3. Planning the move to Language Environment* in the *Enterprise COBOL 4.2 Compiler and Runtime Migration Guide*.

Your migration strategy might be to gradually recompile applications one program at a time as you make program changes, or you might recompile entire existing applications with Enterprise COBOL at once. You may also decide to use a bit of both strategies.

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.

Related references

Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3

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 69.

Related references
Chapter 1, "COBOL compiler versions, required runtimes, and support information," on page 3

VS COBOL II

From a conversion standpoint, VS COBOL II and Enterprise COBOL 5 or 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 "COBOL reserved word comparison" on page 276.

If upgrading from VS COBOL II 1.3, 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 11, "Upgrading VS COBOL II source programs," on page 105.

VS COBOL II 1.2 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 1.1 or 1.2 programs as well as any VS COBOL II 1.3 or 1.4 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 120.

For details about the conversion tools available to upgrade source programs, see "Conversion tools for source programs" on page 298.

Related references
Chapter 1, "COBOL compiler versions, required runtimes, and support information," on page 3

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 13, "Upgrading IBM COBOL source programs," on page 115.

Enterprise COBOL 3

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

For details, see Chapter 15, "Upgrading programs from Enterprise COBOL 3," on page 159.

Enterprise COBOL 4

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

For details, see Chapter 17, "Upgrading from Enterprise COBOL 4," on page 171.

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 steps have been completed:

1. Add Language Environment to the LNKLST/LPALST. This moves Language Environment into production, and all COBOL applications will run under Language Environment by default.
   - The only COBOL runtime library present should be SCEERUN. Remove any instances of COBLIB, VSCLLIB, or COB2LIB in JCL STEPLIB or JOBLIB statements or in CICS startup JCL.
   - **Note:** Only use one library for a given language in LNKLST/LPALST. For example, if you install Language Environment with the COBOL component in LNKLST/LPALST, do not have the OS/VS COBOL library or the VS COBOL II library installed in LNKLST/LPALST.

   Optional: Add Language Environment to the STEPLIB JCL. This is a more gradual approach where Language Environment is phased in one region (CICS or IMS) or user (TSO) at a time.

   Note: Programs run slower and use more virtual storage with this approach than using LNKLST/LPALST to access Language Environment.
2. For programs compiled with NORES, use REPLACE linkage-editor control statements to replace the existing runtime library routines compiled with Language Environment versions.
3. Ensure that SCEERUN is the only COBOL runtime library available in LNKLST/LPALST. Remove any other COBOL runtime libraries present, such as COBLIB, VSCLLIB, or COB2LIB.
4. For VS COBOL II programs IGZEBST bootstrap models compiled with RES, do one of the following tasks:
   - Link to a runtime version of IGZEBST with APAR PN74000 applied
   - REPLACE with IGZEBST from Language Environment

If these steps have not been completed, please first complete all runtime migration activities in *Chapter 3. Planning the move to Language Environment* of the *Enterprise COBOL 4.2 Compiler and Runtime Migration Guide* prior to following the steps here.

When running a mixture of VS COBOL II NORES programs and Enterprise COBOL 5 or 6 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 5 or 6 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 5 or 6 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 COBOL 5 or 6 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 5 or 6 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 5 and 6

For details, see Chapter 21, “Adding Enterprise COBOL 5 or 6 programs to existing COBOL applications,” on page 233.

Restriction: You cannot mix Enterprise COBOL 5 or 6 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 3. 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 for a supported version of z/OS). You can migrate programs gradually, in two stages:

- Stage 1: Runtime migration. See *Chapter 3. Planning the move to Language Environment* in the *Enterprise COBOL 4.2 Compiler and Runtime Migration Guide* 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).

Migration basics

The migration process involves compiler migration (recompiling source programs with the Enterprise COBOL for z/OS compiler) and might involve a runtime migration (moving your applications to z/OS Language Environment) 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 23.

Related references
Chapter 1, "COBOL compiler versions, required runtimes, and support information," on page 3

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 1.1 in 1991, all COBOL compilers default to the RES behavior.

Related references
Chapter 1, "COBOL compiler versions, required runtimes, and support information," on page 3

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.

For details about replacing OS/VS COBOL and VS COBOL II libraries with z/OS Language Environment, see the following information:

- *Replacing COBOL library routines in a COBOL load module* in the *z/OS Language Environment Programming Guide*
- *HLL compatibility considerations* in the *z/OS Language Environment Programming Guide*

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. For details, see *Chapter 3. Planning the move to Language Environment* in the *Enterprise COBOL 4.2 Compiler and Runtime Migration Guide*.

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 5 or 6. Although we recommend recompiling all programs in each application as you migrate to Enterprise COBOL 5 or 6, 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 5 or 6 programs. Enterprise COBOL 5 and 6 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 "Conversion tools for source programs" on page 298.

Related references
Chapter 1, "COBOL compiler versions, required runtimes, and support information," on page 3

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 1.2 and VS COBOL II 1.3 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 5 or 6 programs
- VS COBOL II programs compiled with the NORES option interoperating with Enterprise COBOL 5 or 6 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 5 or 6 programs.

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

Related references
Chapter 1, "COBOL compiler versions, required runtimes, and support information," on page 3

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 5 or 6 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 Command Level Conversion Aid (CCCA) and then compile using the Enterprise COBOL compiler.

For more information about CCCA, see "Conversion tools for source programs" on page 298.

Related references
Chapter 1, "COBOL compiler versions, required runtimes, and support information," on page 3

Interoperability with older levels of IBM COBOL programs

There are some restrictions for Enterprise COBOL 5 and 6 programs to call or be called by (interoperate with) programs compiled with earlier versions of COBOL.

Enterprise COBOL 5 and 6 programs interoperability

Enterprise COBOL 5 and 6 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 5 or 6 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 4 or earlier versions can interoperate with OS/VS COBOL and VS COBOL II NORES programs.

Programs compiled with Enterprise COBOL 5 or 6 can interoperate with programs compiled with VS COBOL II or later, based on the following conditions and CALL types:

- Static calls. Enterprise COBOL 5 or 6 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 3 or 4

  Note: Programs that were compiled with VS COBOL II with the NORES compiler option in effect cannot interoperate with programs compiled with Enterprise COBOL 5 or 6.
- 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 5 or 6 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 5 or 6 program objects by using DLL linkage.

How to find if you have OS/VS COBOL programs

To find if you have OS/VS COBOL programs, you can:

- Use COBOL Upgrade Advisor for z/OS to run an inventory scan to discover what compiler versions are used in your load libraries or applications.
- Enable Language Environment to put out a message whenever an OS/VS COBOL program is run. To enable this warning message, set up IGZEOPT.

  The following is an example of the embedded HLASM code inside the JCL:

```
IGZUOPT CSECT
IGZUOPT AMODE 31
IGZUOPT RMODE ANY
```

```
*
  IGZXOPT SUPP_OSV=ON * ON: Suppress warning
       * ONCE: Only issue 1 warning
       * OFF: issue warning
END
```

Part 2. Upgrade tasks

Chapter 4. Prerequisite upgrade tasks

Ensure the following tasks have been completed before upgrading to Enterprise COBOL for z/OS. These tasks include checking for COBOL interoperability problems, upgrading to the 85 COBOL Standard, moving PDS load libraries to PDSE, and upgrading to Language Environment.

Important:

- Do not try to switch from the Db2 precompiler to integrated Db2 coprocessor or migrate to CICS translator at the same time as your COBOL compiler migration.
- Do not migrate z/OS, Db2 or CICS at the same time as a COBOL compiler migration. COBOL migration is a significant migration on its own.

Check for COBOL interoperability problems

This task is often completed by a application architect.

Enterprise COBOL 5 and 6 programs cannot interoperate with OS/VS COBOL or VS COBOL II NORES programs in a single application.

To find out if you have OS/VS COBOL or VS COBOL II NORES programs:

- Use COBOL Upgrade Advisor for z/OS to run an inventory scan to discover what compiler versions are used in your load libraries or applications.
- Enable Language Environment to put out a message whenever an OS/VS COBOL program is run. To enable this warning message, set up IGZEOPT.

  The following is an example of the embedded HLASM code inside the JCL:

```
IGZUOPT CSECT
IGZUOPT AMODE 31
IGZUOPT RMODE ANY
*
  IGZXOPT SUPP_OSV=ON * ON: Suppress warning
        * ONCE: Only issue 1 warning
        * OFF: issue warning
END
```

Interoperability can be separated by three generations of compilers:

Table 8. Interoperability between generations of compilers within a single application

Generation A (Gen A)	**Generation B (Gen B)**	**Generation C (Gen C)**
• OS/VS COBOL • VS COBOL II NORES	• VS COBOL II RES • COBOL/370 and COBOL for MVS • COBOL for OS/390 • Enterprise COBOL 3 • Enterprise COBOL 4	• Enterprise COBOL 5 • Enterprise COBOL 6
Generations A and B can interoperate within a single application.		
	Generations B and C can interoperate within a single application.	

Scenario 1: If your application only consists of Generation A, you can either:

- Mass recompile: Upgrade all Gen A programs to Gen C at once. You cannot upgrade Gen A programs one by one to Gen C because Gen C programs cannot interoperate with Gen A programs in a single application.

- Gradually recompile in stages: Upgrade Gen A programs one by one to Gen B. Once upgraded to Gen B, upgrade the Gen B programs again one by one into Gen C.

  Note: In general, no intermediate 'stages' are required for your upgrade to Enterprise COBOL 6, this is an exception. This may only be needed if the mass recompile option is not suitable.

Scenario 2: If your application consists of Generation A and B, you can either:

- Mass recompile: Upgrade all the Gen A programs to Gen C at once, then follow by upgrading the Gen B programs to Gen C at once.
- Gradually recompile in stages: Upgrade Gen A programs one by one to Gen B. Once all programs are Gen B, upgrade the Gen B programs one by one into Gen C.

Scenario 3: If your application only consists of Generation B:

- No special considerations. You may upgrade programs one by one from Gen B to Gen C or all at once.

When running a mixture of VS COBOL II NORES programs and Enterprise COBOL 5 or 6 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 5 or 6 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 5 or 6 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 COBOL 5 or 6 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 5 or 6 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.

For more information, refer to "Interoperability with older levels of IBM COBOL programs" on page 29.

Update source code to the 85 COBOL language standard

This task is often completed by a COBOL application developer.

Any programs compiled with the 68 COBOL Standard, 74 COBOL Standard, or with the CMPR2 option need to be updated to the 85 COBOL Standard before they can be compiled in Enterprise COBOL.

This includes:

- All customers using OS/VS COBOL
- All customers using VS COBOL II 1.1 or VS COBOL II 1.2
- Customers using any of the following compilers with the CMPR2 option:
  - VS COBOL II 1.3
  - VS COBOL II 1.4
  - COBOL/370 1.1

- COBOL for MVS & VM 1.2
- COBOL for OS/390 2.1
- COBOL for OS/390 2.2

Note: This is a rare scenario but may cause issues if left unaddressed. COBOL Upgrade Advisor for z/OS checks if this is a task that needs to be completed for your programs.

Tasks may vary depending on which version of the compiler you are upgrading from. Refer to Part 3, "Upgrading programs," on page 59 for specific information about upgrading to the 85 COBOL Standard from each compiler version. IBM COBOL and CICS Command Level Conversion Aid for z/OS (CCCA) can help you complete this upgrade step. For more information, refer to "COBOL and CICS Command Level Conversion Aid for z/OS (CCCA)" on page 303.

Move PDS data sets to PDSE data sets

This task is often completed by a system programmer.

To upgrade to Enterprise COBOL 5 and later, executables must be in PDSE data sets/load libraries. Any COBOL executables (load modules or program objects) in PDS data sets/load libraries must be moved to PDSE datasets.

To move your PDS load libraries to PDSE 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 in the following example:

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

Upgrade to Language Environment

This task is often completed by a system programmer.

Earlier COBOL programs can run under several different runtime libraries, including Language Environment. If any of your programs are still using old runtime library routines such as the OS/VS COBOL runtime library or the VS COBOL II runtime library, you need to make sure that they are only using Language Environment. For more information on runtime libraries across IBM COBOL compilers, refer to the *Runtime libraries for COBOL programs* section of Chapter 1, "COBOL compiler versions, required runtimes, and support information," on page 3.

To check if your programs use Language Environment, ensure all of the following statements are true:

- 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.

Tip: The IBM COBOL Upgrade Advisor for z/OS application scan can check if your application uses Language Environment or not. If you have COBOL Upgrade Advisor for z/OS, skip this list and run an application scan.

If everything is verified, the program uses the Language Environment runtime library. If any of the statements are false, upgrade to Language Environment using the following steps:

1. Add Language Environment to the LNKLST/LPALST. This moves Language Environment into production, and all COBOL applications will run under Language Environment by default.
   - The only COBOL runtime library present should be SCEERUN. Remove any instances of COBLIB, VSCLLIB, or COB2LIB in JCL STEPLIB or JOBLIB statements or in CICS startup JCL.
   - **Note:** Only use one library for a given language in LNKLST/LPALST. For example, if you install Language Environment with the COBOL component in LNKLST/LPALST, do not have the OS/VS COBOL library or the VS COBOL II library installed in LNKLST/LPALST.

   Optional: Add Language Environment to the STEPLIB JCL. This is a more gradual approach where Language Environment is phased in one region (CICS or IMS) or user (TSO) at a time.

   Note: Programs run slower and use more virtual storage with this approach than using LNKLST/LPALST to access Language Environment.
2. For programs compiled with NORES, use REPLACE linkage-editor control statements to replace the existing runtime library routines compiled with Language Environment versions.
3. Ensure that SCEERUN is the only COBOL runtime library available in LNKLST/LPALST. Remove any other COBOL runtime libraries present, such as COBLIB, VSCLLIB, or COB2LIB.
4. For VS COBOL II programs IGZEBST bootstrap models compiled with RES, do one of the following tasks:
   - Link to a runtime version of IGZEBST with APAR PN74000 applied
   - REPLACE with IGZEBST from Language Environment

For more information, refer to *Chapter 3. Planning the move to Language Environment* in the *Enterprise COBOL 4.2 Compiler and Runtime Migration Guide* for help in completing your runtime library upgrade.

Chapter 5. Upgrade recommendations and best practices

Upgrading to Enterprise COBOL 5 and 6 is more difficult than earlier COBOL compiler migrations (except for the OS/VS COBOL to Enterprise COBOL upgrade), and it is recommended that you read this section before you upgrade to Enterprise COBOL 5 or 6.

Decide on the approach for the upgrade

A significant motivation toward upgrading COBOL programs is for continuous usage of supported software. Some earlier compilers have reached end of support, but you can run the COBOL applications while they run on a supported version of z/OS, with the z/OS Language Environment as your COBOL runtime. Find a list of compiler versions and runtime environments at Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3. z/OS Language Environment is a component of z/OS and follows the lifecycle of z/OS[1].

There are three main approaches to the upgrade:

- Upgrade as part of one large project: all programs or applications
- Upgrade as part of one or smaller projects: specific applications selected in each project
- Upgrade as part of a normal development process

After an approach is selected, there might be some programs that are out of scope. For programs out of scope for upgrade now, use IBM Automatic Binary Optimizer for z/OS. If you use IBM Automatic Binary Optimizer for z/OS 2.3 to optimize your Enterprise COBOL 4.2 applications, it delivers comparable performance to applications compiled with IBM Enterprise COBOL for z/OS 6.5 without the need to recompile or tune performance settings [2]. This provides an immediate path to the same performance gains until those programs are put into scope for upgrade.

In general, identify a team to upgrade each application completely, rather than upgrading one or two programs at a time. In this way, all programs in an application can be upgraded, so future updates or fixes do not involve an upgrade. You can save costs in the end because more programs can take advantage of the "million instructions per second (MIPS)" savings with Enterprise COBOL 5 and 6. Upgrading to COBOL 6 involves extensive testing effort. The same testing effort is required to complete the test run, whether you test all programs in an application together or you test one or two programs at a time. It might be more efficient to upgrade many programs together.

[1]Different z/OS versions and their releases have specific EOS dates. To check the EOS date for a specific z/OS release, visit the z/OS lifecycle website. You can also find this information in the "Support for COBOL programs after EOS" section of Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3.

[2]The performance improvements are based on the geometric mean of IBM internal measurements on IBM z17 running a z/OS 3.1 LPAR with 1 CP and 80 GB Central Storage. The COBOL 4.2 application optimized using IBM Automatic Binary Optimizer for z/OS 2.3 produced results within 2.4% of the same application compiled with IBM Enterprise COBOL for z/OS 6.5. All benchmarks optimized with IBM Automatic Binary Optimizer for z/OS 2.3 use the new ARCH(15) option and default settings for all other options. The input COBOL benchmarks modules optimized by IBM Automatic Binary Optimizer for z/OS were all compiled by Enterprise COBOL 4.2. All benchmarks compiled with IBM Enterprise COBOL for z/OS 4.2 use the options OPT(STD), LIB. For all benchmarks that are compiled with IBM Enterprise COBOL for z/OS 6.5, use the options ARCH(15), OPT(2), STGOPT, AFP(NOVOLATILE), HGPR(NOPRESERVE), and LIST. Performance results for customer applications vary depending on the source code, specified compiler options, and other factors.

Set ARCH for the hardware level

Check what ARCH setting that you are using. The default level might not be the optimal level. Set the correct ARCH level for your hardware level, or your programs might not run at all.

To set the ARCH level, explore the different levels of hardware where your COBOL applications might run on, including disaster recovery machines. Set ARCH to match the lowest level that you find, and set it in installation defaults only (IGYCDOPT). In particular, do not set ARCH in build tools or JCL or CBL/PROCESS. For TUNE, set it to match the hardware where performance is most important, such as production machines. Like ARCH, TUNE should only be set in installation defaults.

For more information on ARCH settings, refer to *ARCH* in the Enterprise COBOL for z/OS Programming Guide.

Ensure sufficient test coverage and set up automated testing

IBM Test Accelerator for Z is a test automation and test generation framework with support for on-demand virtual development and test z/OS environments. This tool was built specifically for z/OS developers and testers. Learn more about this product at the IBM Test Accelerator for Z product page or see the documentation at Overview of IBM Test Accelerator for Z.

Regression testing

For information on regression testing and invalid data, refer to “Regression testing and invalid data” on page 41.

Best practices for developers to write COBOL programs

To write better COBOL programs, use the RULES compiler option to provide more information about the following programs:

- **NOENDPERIOD**
  Flags conditional statements terminated with period
- **NOEVENPACK**
  Flags even number of packed decimal digits
- **NOLAXPERF**
  Flags opportunities for performance improvements
- **NOSLACKBYTES**
  Flags bytes added by compiler for SYNCHRONIZED data items
- **NOOMITODOMIN**
  Flags ODO clause with no minimum occurrences
- **NOUNREFALL**
  Flags all items that are not referenced, including COPY
- **NOUNREFSOURCE**
  Flags only items that are not referenced in the COBOL source.

Chapter 6. System programmer tasks

These upgrade tasks are typically completed by a system programmer. These tasks include upgrading hardware and software levels, installing prerequisite service updates, verifying region sizes, backing up the old COBOL compiler, installing the new COBOL compiler, and uninstalling the old COBOL compiler if applicable.

Upgrade hardware and software levels

Ensure that all of your hardware and software are up to the prerequisite levels, listed below are the requirements for Enterprise COBOL 6.5.

Hardware requirements	Software requirements
Any hardware environment supported by z/OS 2.5 or z/OS 3.1: • IBM z17 • IBM z16 • IBM z15 • IBM z14 • IBM z13 • IBM z13s	IBM Enterprise COBOL for z/OS 6.5 runs under the control of, or in conjunction with, the currently supported releases of the following programs and their subsequent releases or their equivalents. For more information on the following programs listed that require program temporary fixes (PTFs), refer to the Enterprise COBOL Program Directory. • z/OS 2.5 (5650-ZOS), or later is required. • For installation on z/OS, z/OS SMP/E is required. • For customization during or after installation, z/OS High Level Assembler is required. • Enterprise COBOL XML PARSE statements in programs, which are compiled with the XMLPARSE(XMLSS) compiler option, require z/OS XML System Services 2.5 (5650-ZOS), or later. • The new COBOL/Java interoperability feature available in COBOL 6.5 requires IBM SDK for z/OS, Java Technology Edition 8.0.6.36 (JVM), or IBM Semeru Certified Edition for z/OS 11.0.14.1, or later.

For hardware, software, and optional licensed program information for other versions of Enterprise COBOL for z/OS, refer to IBM Software Product Compatibility Reports for IBM Enterprise COBOL for z/OS. For more information on software requirements, refer to “Prerequisite software and service for Enterprise COBOL 5 and 6” on page 199.

Ensure that all systems on which COBOL will run, and all software that needs to work with COBOL (for example, IBM z/OS, IBM Debug for z/OS, IBM Fault Analyzer for z/OS, and IBM Db2 for z/OS), are ready for programs compiled with the new COBOL compiler. To make CSD setup and DFHRPL setup changes for CICS, see Chapter 24, “CICS conversion considerations,” on page 249.

Install prerequisite service updates

Service updates may be required for IBM products and z/OS components that Enterprise COBOL interoperates with. With Enterprise COBOL 5 or 6, you can use the FIXCAT feature of SMP/E 3.5 or later to find the required services, which are identified with a FIXCAT category name in HOLDDATA.

Category names:

- For COBOL 5.1: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V5R1`
- For COBOL 5.2: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V5R2`

- For COBOL 6.1: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R1`
- For COBOL 6.2: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R2`
- For COBOL 6.3: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R3`
- For COBOL 6.4: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R4`
- For COBOL 6.5: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R5`

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 5 or 6 on your current system, use the SMP/E REPORT MISSINGFIX command.

Here is a sample command using a wildcard that can be used to run against your z/OS CSI for Enterprise COBOL 6.5 (and earlier versions):

```
SET BDY(GLOBAL).
REPORT MISSINGFIX ZONES(ZOS13T)
FIXCAT(IBM.TargetSystem-RequiredService.Enterprise-COBOL*)
```

For more information on service requirements, refer to "Prerequisite software and service for Enterprise COBOL 5 and 6" on page 199.

Verify region sizes

Enterprise COBOL for z/OS 5 and 6 require more memory to run than previous COBOL compilers. TSO user IDs require 200 MB or more of memory.

In many environments, the maximum TSO user region size has to be raised to 200 MB or more. If users cannot get a large enough region size to compile their programs, they will get a compiler ABORT and will not be able to compile any programs.

For COBOL 6, the compiler always uses storage above the 2 GB BAR. This means that if your system MEMLIMIT is set to zero, the compiler will fail. Be sure to update your system MEMLIMIT if it is currently set to zero. The z/OS default is 2 GB, that is a good starting point. For very large programs, MEMLIMIT might need to be set to 3 GB or 4 GB or more.

Back up old COBOL compiler

For emergency purposes, save your current COBOL compilers.

Install new COBOL compiler

Learn how to purchase the latest IBM Enterprise COBOL for z/OS at How to obtain IBM Enterprise COBOL for z/OS from Shopz compiler and install it as well as the latest PTFs on all development systems where COBOL compiles are performed.

Once installed, follow the instructions Installation guide (Program Directories) for installation instructions.

Uninstall the old COBOL compiler

Check with your COBOL application developer to ensure all tasks are complete. After all programs have been compiled with the new compiler, uninstall the old compiler.

Chapter 7. COBOL application developer tasks

These upgrade tasks are typically completed by COBOL application developers. These tasks include setting default compiler options, regression testing, checking for invalid data, and fixing the problems.

Set default compiler options

Tip: IBM COBOL Upgrade Advisor for z/OS outlines compiler option recommendations to tell you exactly what options need to be added, changed, or removed for your compiler version. If you are using COBOL Upgrade Advisor for z/OS, follow the steps there to complete this task.

Set the default compiler options in IBM Enterprise COBOL for z/OS 6.5 to be compatible with previous COBOL compilers. This involves copying IGYCDOPT source from SIGYSAMP, setting the options, and then assembling the modified IGYCDOPT.

The most important options to set the same as previous compilers are:

- ADV
- AWO
- DYNAM
- NUMPROC (other than changing from NUMPROC(MIG) to NUMPROC(NOPFD))
- TRUNC

You should also:

1. Set up your source library control system compiler options for the new compiler to be compatible with the old compiler(s).
2. Document all customization and setups performed for future reference.

Regression testing and invalid data

You might see different results with IBM Enterprise COBOL for z/OS 6.5 compared to previous compilers if the programs process "invalid COBOL data" or you use "invalid COBOL programs", where the runtime data values or programs do not conform to the rules in the Enterprise COBOL Language Reference manual.

To determine whether the programs process invalid COBOL data at the run time or have mismatched parameters at the run time, compile the programs with the following compiler options and run regression tests:

- NUMCHECK
- PARMCHECK
- SSRANGE
- INITCHECK
- OPT(0)

If you do not find any SSRANGE, NUMCHECK, PARMCHECK, or INITCHECK errors, and you are sure that you get the same results with the new compiler as with earlier compilers, recompile with the following compiler options:

- NOSSRANGE
- NONUMCHECK
- NOPARMCHECK
- OPT(2)

When the compilation is complete, run a final test and move the application into production.

It is important to test with each of SSRANGE, NUMCHECK, and PARMCHECK because users sometimes find different invalid data results with Enterprise COBOL 6. INITCHECK is also important because it can find uninitialized data at compiler time that can also cause upgrade problems.

If you have not found any SSRANGE, NUMCHECK, PARMCHECK, or INITCHECK errors after a period of time, then you might consider skipping this step for future upgrades, as you might not have any invalid data usage. Additionally, this step is only recommended for the first time that a program is compiled with Enterprise COBOL 6. Once you have compiled a program with Enterprise COBOL 6, you can skip regression testing with SSRANGE, NUMCHECK, PARMCHECK, or INITCHECK for future compiles.

Another type of invalid data is zero addresses, wherein an instruction uses an address of zero to access memory. Programs with this issue might run fine for years, but when moving to a new level of z/OS, they might produce incorrect results. Such occurrences are seen when customers move to z/OS 2.5 from earlier z/OS levels. To identify and fix this problem, use the Zero Address Detection (ZAD) feature of z/OS.

SLIP Zero Address Detection (ZAD) is a z/OS feature that detects and documents execution of an instruction that accesses (stores or fetches) storage by using an operand address that was formed from a general register containing zero. This detection feature allows the owner of an application to identify programming errors where an assembler instruction is inadvertently accessing data within the Prefixed Save Area (PSA) control block, which resides at virtual address zero, due to incorrect register content of zero.

For details about how to generate and read a z/OS SLIP Zero Address Detection (ZAD) report, see the technote.

Compiler options to detect problems

This section describes compiler options that help to detect, correct, or tolerate problems due to migration and problems that are carried from the earlier versions.

Table 9. Compiler options to solve invalid data issues

Invalid data problem	Compiler options	Step at which error messages appear	Risk due to compiler upgrade	ABO considerations
Invalid **USAGE DISPLAY/PACKED** data (data format nonconformation to the USAGE clauses of that data - this is for **packed/zoned data**, similar to string)	Option that identifies and corrects problems: • `NUMCHECK` Option that tolerates problems: • `INVDATA` (Replaces the deprecated `ZONEDATA`, but `ZONEDATA` tolerates for compatibility) **Note:** Pay special attention to `NUMPROC` setting if you use `INVDATA`.	• Run time • Compile time **Note:** Use `NUMCHECK`, when the compiler detects the problem at the compile time.	Wrong results or different behavior	Not an issue with ABO

Table 9. Compiler options to solve invalid data issues (continued)

Invalid data problem	Compiler options	Step at which error messages appear	Risk due to compiler upgrade	ABO considerations
Overpopulated binary data [data format nonconformation to the **PICTURE** clauses of that data - this is for **binary** data, similar to bit/bytes]	NUMCHECK	• Run time • Compile time **Note:** Use NUMCHECK, when the compiler detects the problem at the compile time.	Wrong results or different behavior	Not an issue with ABO
Parameter passing size mismatch [data corruption beyond the end of WORKING-STORAGE]	PARMCHECK	Run time	Abends or wrong results	Not an issue with ABO
Data items used before set [usage of uninitialized data items]	INITCHECK	Compile time	Abends or wrong results	Not an issue with ABO

Table 10. Compiler options to solve carry-over issues

Problem description	Compiler options	Step at which error messages appear	Risk due to compiler upgrade	ABO considerations
• 'indexed by' data item issue • Invalid table processing • Out-of-range storage references	SSRANGE	Run time	The impact of out of range table access is more severe or very different with V5/V6 vs V4 SSRANGE also detects other problems that are common or present the same in COBOL 4,5,6	
To find any cases of ‘hidden’ loss of data when statements truncate numeric data items	DIAGTRUNC	Compile time	The impact of out of range table access is more severe or very different with V5/V6 vs V4 SSRANGE also detects other problems that are common or present the same in COBOL 4,5,6	

Chapter 8. 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 5 or 6. 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 3 or 4, no source changes will be necessary (in most cases) to compile with Enterprise COBOL 5 or 6. Go to the appropriate chapters in the "Part 3, “Upgrading programs,” on page 59" 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
- 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 customize the Enterprise COBOL default compiler options prior to using the new compiler, based on the default options of your prior compiler version. For instructions, see *Planning to customize Enterprise COBOL* in the *Enterprise COBOL for z/OS Customization Guide*.

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 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. CCCA also provides you with reports of the statements that were changed.

CCCA is bundled with IBM Debug for z/OS (IDz) 14.2 or earlier versions, and it is removed since IDz 15.0. After IDz 14.2 reached EOS on September 30, 2022, you can download CCCA from here at no charge.

For details about CCCA, see “COBOL and CICS Command Level Conversion Aid for z/OS (CCCA)” on page 303.

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 4.2 FLAGMIG4 compiler option
A new compiler option, FLAGMIG4, is available with APAR PM93450 for Enterprise COBOL 4.2 to help you migrate to Enterprise COBOL 5 or 6. 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 4 programs that are not supported, or that are supported differently in Enterprise COBOL 5 or 6. The compiler generates a warning diagnostic message for all such language elements.

Note: The source code changes for COBOL 5 and 6 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 “Conversion tools for source programs” on page 298.

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 Enterprise COBOL 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 46.

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.

IBM COBOL Upgrade Advisor for z/OS can provide assistance in taking an inventory of your existing program objects by reporting the compiler, compiler release, and compiler options used. It also provides recommendations for actions to take to complete the upgrade.

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/V/S COBOL program "program-name".

IBM watsonx Code Assistant for Z Understand can aid by analyzing the impact of a code change for an application.

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 4, OS/VS COBOL, VS COBOL II, IBM COBOL, Enterprise COBOL 3, Enterprise COBOL 4)
- 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 48.

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 11 on page 48 are defined as:

Complexity rating	Requirement
0	All code converted by CCCA without error; code compiles correctly under Enterprise COBOL
1-3	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 11 on page 48 shows estimated complexity ratings for conversions of specific program attributes.

Table 11. 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

Table 11. Complexity ratings for program attribute conversions (continued)

Program attribute	Description of attribute	Complexity rating		
74 COBOL Standard COPY library members		1	M	C
ANS COBOL 4 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 4 compiler (pre- compiler)		4		C
Compiled by OS/VS COBOL 1.2 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		
	Numeric USAGE DISPLAY	5		
Access methods used	ISAM[3]	10	M	C
	BDAM	10		C[4]
	TCAM	10		
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		

Table 11. Complexity ratings for program attribute conversions (continued)

Program attribute	Description of attribute	Complexity rating
SIMVRD		3
SOM-based OO		8
LABEL declaratives		3

1. For additional information, see "Preventing file status 39 for QSAM files" on page 342.
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 12 on page 50 shows one method of relating program complexity ratings to conversion priorities. (The highest priority is "1" and the lowest priority is "6".)

Table 12. 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
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

Table 12. Assigning program conversion priorities (continued)

Conversion priority	Complexity rating	Other considerations
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 21, “Adding Enterprise COBOL 5 or 6 programs to existing COBOL applications,” on page 233.

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.

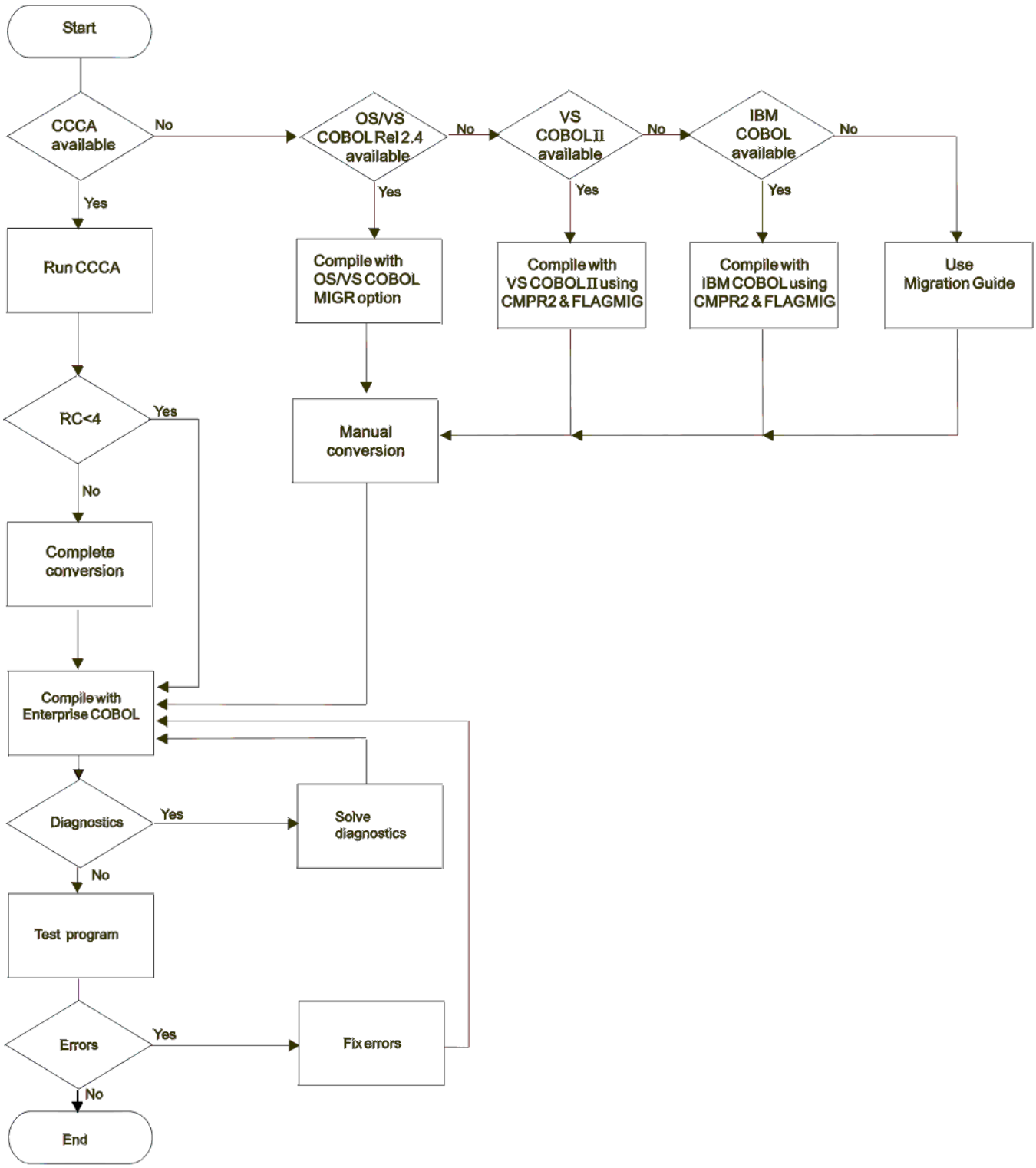


Figure 1. Steps for converting an OS/VS COBOL program to an Enterprise COBOL program

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.

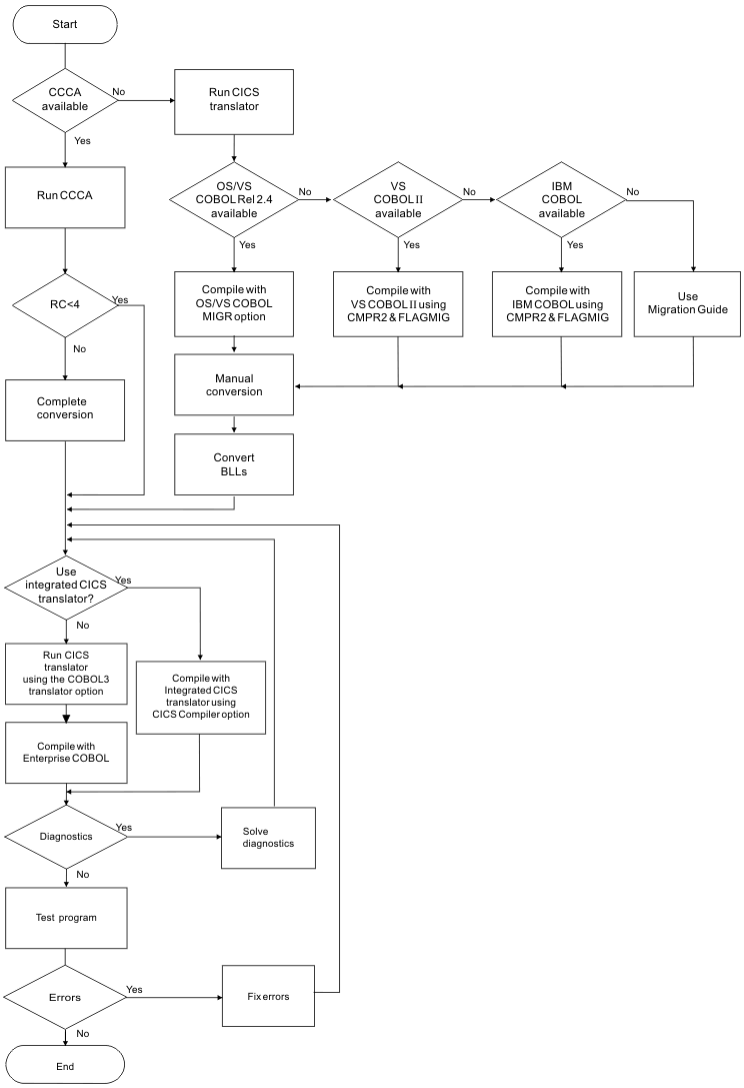


Figure 2. Steps for converting an OS/VS COBOL program containing CICS commands

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.

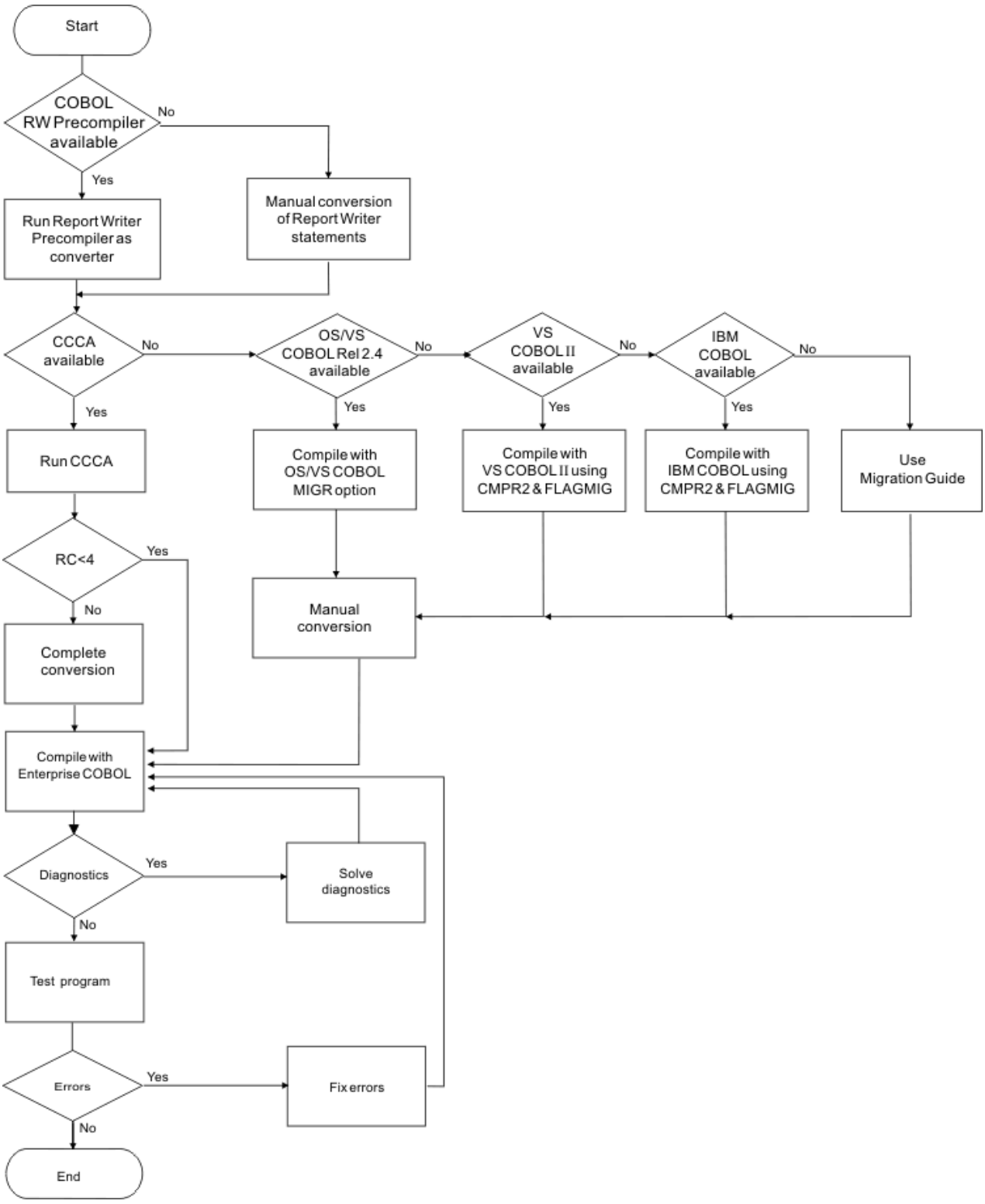


Figure 3. Steps for converting an OS/VS COBOL program and discarding Report Writer statements

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.

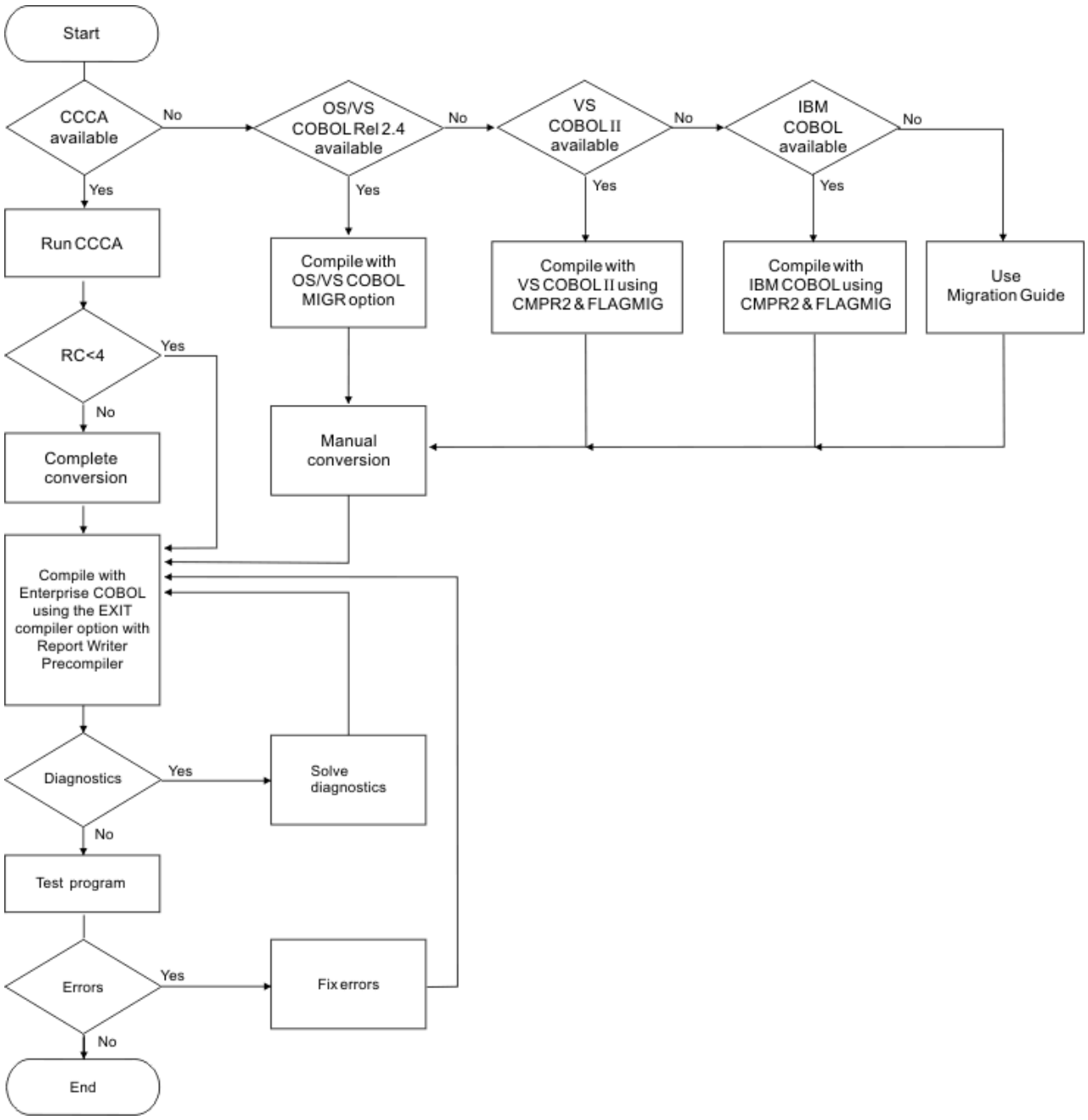


Figure 4. Steps for converting an OS/VS COBOL program and retaining Report Writer statements

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 “Conversion tools for source programs” on page 298. 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, PARMCHECK, INITCHECK, and OPT(0); and then after a successful test, recompile with NOSSRANGE, NONUMCHECK, NOPARMCHECK, and OPT(2), 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 5 or 6.

   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 5 or 6 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 “Preventing file status 39 for QSAM files” on page 342.
   - 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

Chapter 9. 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 5.

Also consider changes in reserved words as described in "COBOL reserved word comparison" on page 276.

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 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 1.2.4, with the latest service updates applied.

Related references
Chapter 1, "COBOL compiler versions, required runtimes, and support information," on page 3

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 13 on page 62 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

Table 13. 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 77
ACCEPT statement		"ACCEPT statement" on page 78
ALPHABETIC class changes	CCCA	"ALPHABETIC class changes" on page 85
ALPHABET clause changes—ALPHABET key word	CCCA	"ALPHABET-NAME clause changes: ALPHABET keyword " on page 85
Area A, periods in	CCCA	"Periods in Area A " on page 81
Arithmetic statement changes		"Arithmetic statement changes " on page 85
ASSIGN . . . OR	CCCA	"ASSIGN . . . OR" on page 72
ASSIGN TO *integer system-name*	CCCA	"ASSIGN . . . OR" on page 72
ASSIGN . . . FOR MULTIPLE REEL /UNIT	CCCA	"ASSIGN . . . FOR MULTIPLE REEL/ UNIT " on page 72
ASSIGN clause changes—*assignment-name* forms	CCCA	"ASSIGN clause changes" on page 85
B symbol in PICTURE clause—changes in evaluation		"B symbol in PICTURE clause: changes in evaluation " on page 85
BDAM file handling	CCCA*	"#unique_117/ unique_117_Connect_42_BDAMfile" on page 71
BLANK WHEN ZERO clause and asterisk (*) override		"BLANK WHEN ZERO clause and asterisk (*) override" on page 78
CALL identifier statement—B symbol in PICTURE clause		"B symbol in PICTURE clause: changes in evaluation " on page 85
CALL statement changes—procedure names and file names in USING phrase		"CALL statement changes " on page 86
CANCEL statement—B symbol in PICTURE clause		"B symbol in PICTURE clause: changes in evaluation " on page 85
CLOSE . . . FOR REMOVAL statement		"CLOSE . . . FOR REMOVAL statement" on page 78

Table 13. 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 72
Combined abbreviated relation condition changes	CCCA	"Combined abbreviated relation condition changes" on page 86
Comparing group to numeric packed-decimal item		"Comparing group to numeric packed-decimal item" on page 78
COPY statement with associated names	CCCA	"COPY statement with associated names " on page 88
Communication feature		"#unique_118/unique_118_Connect_42_comfeature" on page 71
CURRENCY-SIGN clause changes—'/', '=', and 'L' characters		"CURRENCY-SIGN clause changes: '/', '=', and 'L' characters" on page 88
CURRENT-DATE special register	CCCA	"CURRENT-DATE special register " on page 72
DIVIDE . . . ON SIZE ERROR—change in intermediate results		"ON SIZE ERROR phrase: changes in intermediate results " on page 93
Dynamic CALL statements to programs with alternate entry points without an intervening CANCEL		"Dynamic CALL statements to ENTRY points " on page 88
EXAMINE statement	CCCA	"EXAMINE statement " on page 73
EXHIBIT statement	CCCA	"Corrective action for EXHIBIT NAMED" on page 73
EXIT PROGRAM/GOBACK statement changes		"EXIT PROGRAM/GOBACK statement changes " on page 88
FILE STATUS clause changes	CCCA	"FILE STATUS clause changes " on page 88
FILE-LIMIT clause of the FILE-CONTROL paragraph	CCCA	"FILE-LIMIT clause of the FILE-CONTROL paragraph " on page 74
Flow of control, no terminating statement		"Flow of control, no terminating statement" on page 78
FOR MULTIPLE REEL/UNIT	CCCA	"ASSIGN . . . FOR MULTIPLE REEL/UNIT " on page 72

Table 13. 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 74
IF . . . OTHERWISE statement changes	CCCA	“IF . . . OTHERWISE statement changes ” on page 91
Index names—nonunique		“Index names” on page 79
INSPECT statement—PROGRAM COLLATING SEQUENCE clause		“PROGRAM COLLATING SEQUENCE clause changes ” on page 94
IS as an optional word		“Optional word IS ” on page 93
ISAM file handling	CCCA	“#unique_119/unique_119_Connect_42_isam” on page 71
JUSTIFIED clause changes	CCCA	“JUSTIFIED clause changes ” on page 91
LABEL declaratives		“LABEL declaratives” on page 74
LABEL RECORDS clause with TOTALING/TOTALED AREA	CCCA	“LABEL RECORDS clause with TOTALING/TOTALED AREA phrases ” on page 74
LABEL RECORD IS statement		“LABEL RECORD IS statement” on page 79
MOVE statement—binary value and DISPLAY value		“MOVE statement - binary value and DISPLAY value” on page 79
MOVE statements and comparisons—scaling changes		“MOVE statements and comparisons: scaling changes ” on page 91
MOVE CORRESPONDING statement	CCCA	“MOVE CORRESPONDING statement” on page 79
MOVE statement—multiple TO specification		“MOVE statement - multiple TO specification” on page 80
MOVE ALL—TO PIC 99		“MOVE ALL - TO PIC 99” on page 80
MOVE statement—warning message for numeric truncation		“MOVE statement - warning message for numeric truncation” on page 80
MULTIPLY ... ON SIZE ERROR—change in intermediate results		“ON SIZE ERROR phrase: changes in intermediate results ” on page 93

Table 13. 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 82
NOTE statement	CCCA	"NOTE statement " on page 74
Numeric class test on group items		"Numeric class test on group items" on page 92
Numeric data changes		"Numeric data changes" on page 92
Numeric-editing changes (PICTURE clause)		"PICTURE string " on page 81
OCCURS clause (order of phrases)		"OCCURS clause" on page 80
OCCURS DEPENDING ON— ASCENDING and DESCENDING KEY phrases		"OCCURS DEPENDING ON clause: ASCENDING and DESCENDING KEY phrase" on page 92
OCCURS DEPENDING ON—value for receiving items changed	CCCA	"OCCURS DEPENDING ON clause: value for receiving items changed " on page 92
ON statement	CCCA	"ON statement " on page 74
ON SIZE ERROR phrase—changes in intermediate results		"ON SIZE ERROR phrase: changes in intermediate results " on page 93
OPEN statement failing for QSAM files (file status 39)		"OPEN statement failing for VSAM files (file status 39)" on page 75
OPEN statement failing for VSAM files (file status 39)		"OPEN statement failing for QSAM files (file status 39)" on page 75
OPEN statement with LEAVE, REREAD, and DISP phrases	CCCA	"OPEN statement with the LEAVE, REREAD, and DISP phrases " on page 75
OPEN REVERSED statement		"OPEN REVERSED statement" on page 81
OTHERWISE clause changes		"IF . . . OTHERWISE statement changes " on page 91
Paragraph names not allowed as parameters		"CALL statement changes " on page 86
PERFORM statement—changes in the VARYING and AFTER phrases		"PERFORM statement: changes in the VARYING/ AFTER phrases " on page 94

Table 13. 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 81
Periods, consecutive in any division		"Periods, consecutive in any division " on page 81
Periods in Area A	CCCA	"Periods in Area A " on page 81
Periods missing on paragraphs	CCCA	"Periods missing on paragraphs " on page 81
Periods missing at the end of SD, FD, or RD		"Periods missing at the end of SD, FD, or RD " on page 81
PICTURE clause (numeric-editing changes)		"PICTURE string " on page 81
PROGRAM COLLATING SEQUENCE clause changes		"PROGRAM COLLATING SEQUENCE clause changes " on page 94
Program-ID names, nonunique	CCCA	"PROGRAM-ID names, nonunique " on page 82
Qualification - using the same phrase repeatedly		"Qualification - using the same phrase repeatedly " on page 82
READ statement - redefined record keys in the KEY phrase		"READ statement - redefined record keys in the KEY phrase" on page 82
READ and RETURN statement changes—INTO phrase		"READ and RETURN statement changes: INTO phrase " on page 94
READY TRACE and RESET TRACE statements	CCCA	"READY TRACE and RESET TRACE statements " on page 75
RECORD CONTAINS n CHARACTERS clause		"RECORD CONTAINS n CHARACTERS clause " on page 82
RECORD KEY phrase and ALTERNATE RECORD KEY phrase		"RECORD KEY phrase and ALTERNATE RECORD KEY phrase" on page 82
REDEFINES clause in SD or FD entries	CCCA	"REDEFINES clause in SD or FD entries" on page 82
REDEFINES clause with tables		"REDEFINES clause with tables" on page 83
Relation conditions	CCCA	"Relation conditions" on page 83

Table 13. Language element differences between OS/VS COBOL and Enterprise COBOL (continued)

Language element	Conversion tool	Page
REMARKS paragraph	CCCA	"REMARKS paragraph " on page 76
RENAMES clause—nonunique, nonqualified data names		"RENAMES clause - nonunique, nonqualified data names " on page 83
Report Writer statements	Report Writer Precompiler	"#unique_120/unique_120_Connect_42_reportwr" on page 69
RERUN clause changes		"RERUN clause changes " on page 94
RESERVE clause changes	CCCA	"RESERVE clause changes " on page 94
Reserved word list changes	CCCA	"Reserved word list changes" on page 95
SEARCH statement changes	CCCA	"SEARCH statement changes " on page 95
Segmentation changes—PERFORM statement in independent segments		"Segmentation changes: PERFORM statement in independent segments " on page 95
SELECT statement without a corresponding FD		"SELECT statement without a corresponding FD" on page 83
SELECT OPTIONAL clause changes	CCCA	"SELECT OPTIONAL clause changes " on page 95
SORT special registers		"SORT special registers " on page 96
SORT statement		"SORT statement" on page 83
SORT or MERGE		"SORT or MERGE" on page 84
Source language debugging changes		"Source language debugging changes " on page 96
START . . . USING KEY statement	CCCA	"START . . . USING KEY statement " on page 76
STRING statement—PROGRAM COLLATING SEQUENCE clause		"PROGRAM COLLATING SEQUENCE clause changes " on page 94
STRING statement—sending field identifier		"STRING statement - sending field identifier " on page 84
Subscripts out of range—flagged at compile-time		"Subscripts out of range flagged at compile time " on page 96

Table 13. 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 76
TIME-OF-DAY special register	CCCA	"TIME-OF-DAY special register " on page 76
TOTALING/TOTALED AREA phrases in LABEL RECORDS clause	CCCA	"LABEL RECORDS clause with TOTALING/TOTALED AREA phrases " on page 74
TRANSFORM statement	CCCA	"TRANSFORM statement " on page 77
UNSTRING statement—PROGRAM COLLATING SEQUENCE clause		"PROGRAM COLLATING SEQUENCE clause changes " on page 94
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 84
UNSTRING statement—multiple INTO phrases		"UNSTRING statement - multiple INTO phrases " on page 84
UNSTRING statements—subscript evaluation changes		"UNSTRING statements: subscript evaluation changes " on page 96
UPSI switches	CCCA	"UPSI switches " on page 97
USE AFTER STANDARD ERROR—GIVING phrase	CCCA	"GIVING phrase of USE AFTER STANDARD ERROR declarative " on page 74
USE BEFORE STANDARD LABEL statement	CCCA	"USE BEFORE STANDARD LABEL " on page 77
VALUE clause—signed value in relation to the PICTURE clause	CCCA	"VALUE clause - signed value in relation to the PICTURE clause " on page 84
VALUE clause—condition names	CCCA	"VALUE clause condition names " on page 98
WHEN-COMPILED special register	CCCA	"WHEN-COMPILED special register " on page 98
WRITE AFTER POSITIONING statement	CCCA	"WRITE AFTER POSITIONING statement" on page 98

* 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 "Conversion tools for source programs" on page 298.

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 Command Level Conversion Aid for z/OS (CCCA) is *not* for CICS only; it converts CICS and non-CICS COBOL source programs and copybooks from old 68 COBOL Standard and 74 COBOL Standard languages to the 85 COBOL Standard language. 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 Command Level Conversion Aid for z/OS (CCCA)" on page 303.

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 298 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 69
- "Convert existing Report Writer code using the Report Writer Precompiler" on page 70
- "Run existing OS/VS COBOL-compiled Report Writer programs under Language Environment" on page 70
- "Report Writer language items affected" on page 70

Note: Starting with Enterprise COBOL 5.1, COBOL Report Writer Precompiler 1.6.01 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.

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 5 or 6. If you want to mix Enterprise COBOL 5 or 6 programs with OS/VS COBOL Report Writer programs, you must convert all of the programs to use Enterprise COBOL 5 or 6, 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
Alphanumeric 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 “Conversion tools for source programs” on page 298

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 1.7 and later releases. You must convert ISAM files to VSAM/KSDS files before you move to z/OS 1.7 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 1.6 or earlier. You must migrate ISAM to VSAM/KSDS before moving to z/OS 1.7 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 “Conversion tools for source programs” on page 298.

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 “Conversion tools for source programs” on page 298.

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 5, 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 5 and 6.

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 "Preventing file status 39 for QSAM files" on page 342.

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 14. 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 115.

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 OS/VS COBOL 1.2.4 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 OS/VS COBOL 1.2.4 accepted paragraph names not followed by a period. OS/VS COBOL 1.2.4 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 for z/OS Language Reference*.

REDEFINES clause in SD or FD entries
Releases prior to OS/VS COBOL 1.2.4 accepted a REDEFINES clause in a level-01 SD or FD; Enterprise COBOL and OS/VS COBOL 1.2.4 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 1.2.4 accepted operators in relation conditions that are not valid. The following table lists the operators accepted by OS/VS COBOL 1.2.3 that are not accepted by Enterprise COBOL. It also shows the valid coding for Enterprise COBOL programs.

OS/VS COBOL 1.2.3	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 15 on page 89.

- For VSAM files, see Table 16 on page 90.

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 for z/OS Language Reference*.

Table 15. 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 16. 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
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

Table 16. Status key values: VSAM files (continued)

OS/VS	Enterprise COBOL	Meaning
95	95	Not valid or incomplete VSAM file information
96	96	No file identification (no DD statement for this VSAM file)
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 5.2, you can use the ZONEDATA(MIG) (replaced by INVDATA(FORCENUMCMP) in Enterprise COBOL 6.2 with PTFs for APAR PH31500 installed) to ease your migration to COBOL 5 or 6. When the INVDATA(FORCENUMCMP) 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 4 when a zoned decimal data item has invalid zone bits. For more information, see INVDATA.

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. "COBOL reserved word comparison" on page 276 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 and OS/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 17 on page 96. 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 17. 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 of OS/VS COBOL 2.4 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 10. 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.

Related references
Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3

Compiler options for converted programs

Table 18 on page 101 lists the compiler options that have special relevance to converted programs.

Table 18. 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 for z/OS 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.

Table 18. 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 19 on page 102 shows the OS/VS COBOL compiler options that are not supported by Enterprise COBOL.

For a complete list of Enterprise COBOL compiler options, see "Option comparison" on page 314.

Table 19. 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 for z/OS 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.
SYMDMP/ NOSYMDMP	ABEND dumps and dynamic dumps are available through Language Environment services. Symbolic dumps are available through using the TEST compiler option.

Table 19. OS/VS COBOL compiler options not supported by Enterprise COBOL (continued)

OS/VS COBOL option	Enterprise COBOL equivalent
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 11. 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 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 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 5

Related references
Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3

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 120.

For information about tools that will help with the CMPR2 to NOCMPR2 conversion, see “Conversion tools for source programs” on page 298.

85 COBOL Standard interpretation changes

Some language differences exist between programs compiled with NOCMPR2 on VS COBOL II 1.3 (including 1.3.0, 1.3.1, and 1.3.2) and programs compiled with NOCMPR2 on subsequent releases (including VS COBOL II 1.4, 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 1.3. 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 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 1.3.x.

Precedence of USE procedures

This difference affects the precedence of USE procedures relating to contained programs.

In VS COBOL II 1.3.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 1.4 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 1.3.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 1.3.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 1.3.x, VS COBOL II 1.4, 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 1.3.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 1.4 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 1.3.x.

ACCEPT statement

One additional difference between later releases and VS COBOL II 1.3.0 involves the system input devices for the mnemonic-name suboption of the ACCEPT statement.

For VS COBOL II 1.3.0 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 1.3.1 through 1.4.0, 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 5 or 6, change it to:

```
77 VOLATILE-85 PIC S9(9) BINARY.
Move 0 TO VOLATILE-85.
```

You can use CCCA to convert the reserved words automatically. For more information about the CCCA tool, see “Conversion tools for source programs” on page 298.

CCCA is updated for reserved word conversions for Enterprise COBOL 5.1 by the PTF for APAR PM86253. For Enterprise COBOL 5.2, CCCA is updated for reserved word conversions by the PTF for APAR PI32750. For Enterprise COBOL 6.1, 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 "COBOL reserved word comparison" on page 276.

Table 20. New reserved words by compilers

Compiler	Reserved word
COBOL/370 1.1	FUNCTION, PROCEDURE-POINTER
COBOL for MVS & VM 1.2	CLASS-ID, METACLASS, RECURSIVE, END-INVOKE, METHOD, REPOSITORY, INHERITS, METHOD-ID, RETURNING, INVOKE, OBJECT, SELF, SUPER, LOCAL-STORAGE, OVERRIDE
COBOL for OS/390 & VM 2.1	Same as COBOL for MVS & VM
COBOL for OS/390 & VM 2.2	COMP-5, COMPUTATIONAL-5, EXEC, END-EXEC, SQL, TYPE, FACTORY
COBOL for OS/390 & VM 2.2 with PQ49375	EXECUTE
Enterprise COBOL 3.1	JNIENVPTR, NATIONAL, XML, END-XML, XML-EVENT, XML-CODE, XML-TEXT, XML-NTEXT, FUNCTION-POINTER
Enterprise COBOL 3.4	NATIONAL-EDITED, GROUP-USAGE
Enterprise COBOL 4.1	XML-NAMESPACE, XML-NAMESPACE-PREFIX, XML-NNAMESPACE, XML-NNAMESPACE-PREFIX
Enterprise COBOL 4.2	XML-SCHEMA **Note:** XML-INFORMATION is added as a reserved word with APAR PM85035.
Enterprise COBOL 5.1	XML-INFORMATION
Enterprise COBOL 5.2	VOLATILE
Enterprise COBOL 6.1	ALLOCATE, DEFAULT, END-JSON, FREE, JSON, JSON-CODE
Enterprise COBOL 6.2	JSON-STATUS
Enterprise COBOL 6.3	BYTE-LENGTH, JAVA, LIMIT, POINTER-32, UTF-8
Enterprise COBOL 6.4	FUNCTION-ID

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 115.

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 4 or later. These files must be changed to VSAM RRDS files.

In COBOL compilers that supported the NOCMPR2 compiler option before Enterprise COBOL 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 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 21. 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 12. 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.

Related references
Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3

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 120. For information about other compiler options, see the *Enterprise COBOL for z/OS Programming Guide*.

Compiling with Enterprise COBOL

Table 22 on page 111 lists the Enterprise COBOL compiler options that have special relevance to converted programs.

Table 22. 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. • In Enterprise COBOL 5 and 6.1, The TEST option has suboptions of EJPD | NOEJPD and SOURCE | NOSOURCE. 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). • In Enterprise COBOL 6.2, new suboptions SEPARATE and NOSEPARATE are added to the TEST compiler option to control program object size on disk while retaining debugging capability. In addition, new combinations of suboptions are supported in both the TEST and NOTEST compiler options, including TEST(NODWARF), TEST(SEPARATE), and NOTEST(DWARF,SOURCE). For more information about the TEST option, see TEST in the *Enterprise COBOL for z/OS Programming Guide*.
LSACHECK	It is recommended to use LSACHECK=ON, starting from development.

Compiler options not supported in Enterprise COBOL

Table 23 on page 112 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 23. 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.
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 5 and 6 does not support the NUMPROC(MIG) option. If NUMPROC(MIG) is specified, Enterprise COBOL 5 or 6 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 that are compiled with NUMPROC(MIG) to Enterprise COBOL 6, use 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. For details, see *NUMCHECK* in the *Enterprise COBOL for z/OS 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 13. 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 120.

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 252.

Related references
Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3

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 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 COBOL 3.3 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 3.3 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 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 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 4 or later. These files must be changed to VSAM RRDS files.

In COBOL compilers that supported the NOCMPR2 compiler option before Enterprise COBOL 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 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 24. 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 24. 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: `***** STACK STORAGE 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 5 or 6, change it to:

```
77 VOLATILE-85 PIC S9(9) BINARY.
Move 0 TO VOLATILE-85.
```

You can use CCCA to convert the reserved words automatically. For more information about the CCCA tool, see “Conversion tools for source programs” on page 298.

CCCA is updated for reserved word conversions for Enterprise COBOL 5.1 by the PTF for APAR PM86253. For Enterprise COBOL 5.2, CCCA is updated for reserved word conversions by the PTF for APAR PI32750. For Enterprise COBOL 6.1, 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 “COBOL reserved word comparison” on page 276.

Table 25. New reserved words by compilers

Compiler	Reserved word
COBOL/370 1.1	FUNCTION, PROCEDURE-POINTER
COBOL for MVS & VM 1.2	CLASS-ID, METACLASS, RECURSIVE, END-INVOKE, METHOD, REPOSITORY, INHERITS, METHOD-ID, RETURNING, INVOKE, OBJECT, SELF, SUPER, LOCAL-STORAGE, OVERRIDE
COBOL for OS/390 & VM 2.1	Same as COBOL for MVS & VM
COBOL for OS/390 & VM 2.2	COMP-5, COMPUTATIONAL-5, EXEC, END-EXEC, SQL, TYPE, FACTORY
COBOL for OS/390 & VM 2.2 with PQ49375	EXECUTE
Enterprise COBOL 3.1	JNIENVPTR, NATIONAL, XML, END-XML, XML-EVENT, XML-CODE, XML-TEXT, XML-NTEXT, FUNCTION-POINTER
Enterprise COBOL 3.4	NATIONAL-EDITED, GROUP-USAGE
Enterprise COBOL 4.1	XML-NAMESPACE, XML-NAMESPACE-PREFIX, XML-NNAMESPACE, XML-NNAMESPACE-PREFIX
Enterprise COBOL 4.2	XML-SCHEMA **Note:** XML-INFORMATION is added as a reserved word with APAR PM85035.
Enterprise COBOL 5.1	XML-INFORMATION
Enterprise COBOL 5.2	VOLATILE

Table 25. New reserved words by compilers (continued)

Compiler	Reserved word
Enterprise COBOL 6.1	ALLOCATE, DEFAULT, END-JSON, FREE, JSON, JSON-CODE
Enterprise COBOL 6.2	JSON-STATUS
Enterprise COBOL 6.3	BYTE-LENGTH, JAVA, LIMIT, POINTER-32, UTF-8
Enterprise COBOL 6.4	FUNCTION-ID

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 115.

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 1.3.0, 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 1.2, as well as *nonstandard* VS COBOL II 1.2 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 1.2 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 1.2, 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 1.3 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 1.2
- VS COBOL II, 1.3 or 1.4 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, 1.3 or 1.4, 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 26. 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 122
ALPHABETIC class	“ALPHABETIC class” on page 123
CALL ... ON OVERFLOW	“CALL . . . ON OVERFLOW” on page 123
Comparisons between scaled integers and nonnumerics	“Comparisons between scaled integers and nonnumerics” on page 124
COPY...REPLACING statements using non-COBOL characters	“COPY ... REPLACING statements using non-COBOL characters” on page 125
COPY statement using national extension characters	“COPY statement using national extension characters” on page 127
File status codes	“File status codes” on page 128
Fixed filed attributes and DCB= parameters of JCL	“Fixed-file attributes and DCB= parameters of JCL” on page 130
Implicit EXIT PROGRAM	“Implicit EXIT PROGRAM” on page 131
OPEN statement failing for QSAM file (FILE STATUS 39)	“OPEN statement failing for QSAM files (FILE STATUS 39)” on page 132
OPEN statement failing for VSAM files (FILE STATUS 39)	“OPEN statement failing for VSAM files (FILE STATUS 39)” on page 132
PERFORM return mechanism	“PERFORM return mechanism” on page 133
PERFORM...VARYING...AFTER	“PERFORM ... VARYING ... AFTER” on page 135
PICTURE clause with "A"s and "B"s	“PICTURE clause with "A"s and "B"s” on page 137
PROGRAM COLLATING SEQUENCE	“PROGRAM COLLATING SEQUENCE” on page 139

Table 26. Language elements different between CMPR2 and NOCMPR2 (continued)

Language element	Page
READ INTO and RETURN INTO	"READ INTO and RETURN INTO" on page 140
RECORD CONTAINS n CHARACTERS	"RECORD CONTAINS n CHARACTERS" on page 141
SET...TO TRUE	"SET . . . TO TRUE" on page 142
SIZE ERROR on MULTIPLY and DIVIDE	"SIZE ERROR on MULTIPLY and DIVIDE" on page 144
UNSTRING operand evaluation	"UNSTRING operand evaluation" on page 145
UPSI switches	"UPSI switches" on page 150
Variable-length group moves	"Variable-length group moves" on page 151

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 an alphanumeric 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 27 on page 129 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 for z/OS Language Reference*.

Table 27. 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 27. 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 "Preventing file status 39 for QSAM files" on page 342 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 for z/OS 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 “Preventing file status 39 for QSAM files” on page 342.

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 28. 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 mentioned earlier would be classified as alphanumeric-edited. If ALPHA was defined in a group that was to be initialized, a message like the one mentioned earlier 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 for z/OS 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 here 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 following message.

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 152 and "SOM-based OO COBOL language elements that are changed" on page 153.

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 14. 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.

Related references
Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3

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 for z/OS Programming Guide*.

There are some new compiler options in Enterprise COBOL compared to compiler options in IBM COBOL. Table 29 on page 155 lists the options that affect compatibility between IBM COBOL and Enterprise COBOL.

Table 29. Compiler options for IBM COBOL programs

Compiler option	Comments
ARITH	Use ARITH(COMPAT) to get the same results as COBOL/370 1.1, thru COBOL for OS/390 & VM 2.1 for intermediate results in arithmetic statements.

Table 29. Compiler options for IBM COBOL programs (continued)

Compiler option	Comments
INTDATE	Use INTDATE(ANSI) to get the same results as COBOL/370 1.1 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 1.1 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, 1.1.
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 2.2, 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 2.2, 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 COBOL for OS/390 & VM 2.2 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 30. 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 COBOL 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 that are compiled with NUMPROC(MIG) to Enterprise COBOL 6, use 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. For details, see *NUMCHECK* in the *Enterprise COBOL for z/OS 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 15. Upgrading programs from Enterprise COBOL 3

To compile with Enterprise COBOL 5 or 6, Enterprise COBOL 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 107.
- 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 5.
- Programs using DATE FORMAT and windowed date functions. For details, see “Changes in millennium language extensions in IBM Enterprise COBOL for z/OS 5 and 6” on page 175.

Related references
Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3

SEARCH ALL statements

Refer to this information if you have programs that contain SEARCH ALL statements and that were compiled with COBOL 3.4 before the installation of the PTF for APAR PK16765 or with Enterprise COBOL 3.1 through 3.3.

Tip: You can tell if your Enterprise COBOL 3.4 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 COBOL 3.3 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 3.3 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 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 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 3 programs that have XML PARSE statements

Refer to this information for upgrading Enterprise COBOL 3 programs that have XML PARSE statements.

Enterprise COBOL 4 introduced new XML PARSE support compared to Enterprise COBOL 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 5 and 6, you can choose between the COBOL runtime library parser and the XML System Services parsers.

Originally, Enterprise COBOL 5.1 did not have an XMLPARSE compiler option and required the XMLSS parser. However, with current service applied, COBOL 5.1 is the same as COBOL 5.2 in this area, and both have the XMLPARSE compiler option so that you can choose the same parser in 5 and 6 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 3 programs that have XML PARSE statements to upgrade to Enterprise COBOL 5 or 6. You can have the compatible behavior by specifying the XMLPARSE(COMPAT) compiler option. However, the COMPAT XML parser implementation in Enterprise COBOL 5.2 and later is different in rare cases from that in COBOL 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 162.

- XMLPARSE(XMLSS) specifies that the compiled code will use the z/OS System Services XML parser.

  You must change your Enterprise COBOL 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 3 programs to use XMLPARSE(XMLSS) with Enterprise COBOL 5 or 6, change the programs to reflect the new, changed, and discontinued XML parsing events. For details, see "Migrating from XMLPARSE(COMPAT) to XMLPARSE(XMLSS)" on page 346.

COMPAT XML parser considerations

User modifications to the XML document during execution of the XML PARSE statement

In versions earlier than Enterprise COBOL 5, the COMPAT XML parser was actively in progress when the XML processing procedure was executing. In COBOL 5, 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 COBOL 5 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 5, 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 COBOL 5 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 COBOL 5 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 COBOL 5, 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 5, but it causes runtime errors IGZ0227S or IGZ0228S on Enterprise COBOL 5. 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      ***
***  COBOL 3/4 and COBOL 5 (or XMLSS on any version).         ***
***                                                           ***
***  In COBOL 3/4, the logical branch out of the XML          ***
***  processing procedure by CEEMRCE terminates the           ***
***  XML PARSE. In COBOL 5, 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 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 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 5 or 6, 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
- JSON-STATUS
- 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 5.1, or if you have the PTF for APAR PI32750 installed for Enterprise COBOL 5.2, or if you have the PTF for APAR PI55980 installed for Enterprise COBOL 6.1.

CCCA is bundled with IBM Debug for z/OS (IDz) 14.2 or earlier versions, and it is removed since IDz 15.0. After IDz 14.2 reached EOS on September 30, 2022, you can download CCCA from here at no charge.

For details about CCCA, see "COBOL and CICS Command Level Conversion Aid for z/OS (CCCA)" on page 303.

For a table comparing reserved words for all of the different COBOL compilers, see Table 55 on page 277.

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 4 or later. These files must be changed to VSAM RRDS files.

In COBOL compilers that supported the NOCMPR2 compiler option before Enterprise COBOL 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 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 31. 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 31. 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.

Chapter 16. Compiling Enterprise COBOL 3 programs

There have been a number of changes to compiler options and debug behavior since Enterprise COBOL 3.

After reading these topics, see also Chapter 20, “Changes with Enterprise COBOL 5 and 6,” on page 199.

Related references
Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3

Compiler option changes from IBM Enterprise COBOL for z/OS 3

There have been a number of changes to compiler options.

The following options have been removed.

Table 32. Compiler options not available in Enterprise COBOL 5

Compiler option	Comments
DATEPROC	Support for Year 2000 extensions has been removed.
LIB	The compiler behaves as though COPY, BASIS, or REPLACE statements are included in a program and searches for the specified library or libraries to retrieve the copied code referenced in those statements. For details about how to define the source libraries, see *Specifying source libraries (SYSLIB)* in the *Enterprise COBOL for z/OS Programming Guide*.
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 5 or 6 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 that are compiled with NUMPROC(MIG) to Enterprise COBOL 6, use 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. For details, see *NUMCHECK* in the *Enterprise COBOL for z/OS Programming Guide*.

Table 33. Compiler option not available in Enterprise COBOL 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 CHECK(OFF) runtime option.

For descriptions of new and modified options for Enterprise COBOL 5 and 6, see “Compiler option changes in Enterprise COBOL 5 and 6” on page 204.

For a detailed list of options supported for the various compiler versions, see “Option comparison” on page 314.

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 5 and 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 34. The removed TEST suboptions

Removed suboption	**Behavior if specified with compiler**	**Diagnostic message level or category**
ALL	Diagnostic message is issued. No hooks are generated in object.	Error (`Invalid option diagnostic, option discarded`)
BLOCK	Diagnostic message is issued. No hooks are generated in object.	Error (`Invalid option diagnostic, option discarded`)
PATH	Diagnostic message is issued. No hooks are generated in object.	Error (`Invalid option diagnostic, option discarded`)
STMT	Diagnostic message is issued. No hooks are generated in object.	Error (`Invalid option diagnostic, option discarded`)
NONE	Diagnostic message is issued. No hooks are generated in object.	Error (`Invalid option diagnostic, option discarded`)
SYM	Diagnostic message is issued. Symbolic debugging information is always generated.	Error (`Invalid option diagnostic, option discarded`)
NOSYM	Diagnostic message is issued. Symbolic debugging information is always generated.	Error (`Invalid option diagnostic, option discarded`)
HOOK	Diagnostic message is issued. No hooks are generated in object.	Informational message about NOHOOK behavior always in effect (`Suboption tolerated, TEST in effect`)
NOHOOK	Diagnostic message is issued. No hooks are generated in object.	Informational message about NOHOOK behavior always in effect (`Suboption tolerated, TEST in effect`)

Table 34. The removed TEST suboptions (continued)		
Removed suboption	**Behavior if specified with compiler**	**Diagnostic message level or category**
SEPARATE	**In Enterprise COBOL 5 and 6.1:** Diagnostic message is issued. Debug information is always generated in the object program. **In Enterprise COBOL 6.2:** TEST(SEPARATE) causes the generated DWARF debugging information to be written to the SYSDEBUG data set instead of to the object program.	**In Enterprise COBOL 5 and 6.1:** Informational message about NOSEPARATE behavior always in effect (`Suboption tolerated, TEST in effect`) **In Enterprise COBOL 6.2:** No diagnostic messages will be issued.
NOSEPARATE	**In Enterprise COBOL 5 and 6.1:** Diagnostic message is issued. Debug information is always generated in the object program. **In Enterprise COBOL 6.2:** TEST(NOSEPARATE) causes the generated DWARF debugging information to be written to the object program.	**In Enterprise COBOL 5 and 6.1:** Informational message about NOSEPARATE behavior always in effect (`Suboption tolerated, TEST in effect`) **In Enterprise COBOL 6.2:** No diagnostic messages will be issued.

Note: None of the old TEST suboptions are recognized when specified in IGYCDOPT for setting installation default options.

For details about choosing the appropriate TEST suboptions to meet your debugging needs, see "Debug information changes with Enterprise COBOL 5 and 6" on page 169.

Debug information changes with Enterprise COBOL 5 and 6

Programs compiled with Enterprise COBOL 5 or 6 will have different debug information than that of programs compiled with previous versions of the compiler.

IBM Enterprise COBOL 5 and 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.

TEST option changes

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 z/OS Debugger. When the TEST(`NOSOURCE`) compiler option is specified, the generated DWARF debug information does not include the expanded source code.

Tip: If you are using IBM z/OS Debugger, it is recommended that you specify TEST(SOURCE) (for COBOL 5 or 6.1) or TEST(SEPARATE,SOURCE) (for COBOL 6.2 and later) to get the most debugging functionality while controlling module size:

- With TEST(SOURCE), the debug information is saved in a NOLOAD debug segment in the program object.
- With TEST(SEPARATE,SOURCE), the debug information is saved in a separate debug file.

- You can use the NOTEST(DWARF) compiler option to include basic DWARF debugging information in the program object. You cannot debug such programs with z/OS Debugger, 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.

For details about the TEST option, see *TEST* in the *Enterprise COBOL for z/OS Programming Guide*.

For details about debugging COBOL programs using IBM z/OS Debugger, see *Choosing TEST or NOTEST compiler suboptions for COBOL programs* in the *IBM z/OS Debugger User's Guide*.

Listing information changes

With Enterprise COBOL 5 and 6.1, 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.

With Enterprise COBOL 6.2, the diagnostic messages are again at the bottom of the listing, as with Enterprise COBOL 4 and earlier compilers.

Changes that apply to Enterprise COBOL 6 only

- The allocation and management of WORKING-STORAGE SECTION have been changed since Enterprise COBOL 5. 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 192.
- Enterprise COBOL 6 uses interprocess communication (IPC) message queues within the compiler. 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.
- PPA1 changes in Enterprise COBOL 6.3

  Starting in Enterprise COBOL 6.3, bit 30 of flag3 (offset X'1C') of PPA1 may be set to indicate that the Extended Flag field is present. If this bit is set, the extended flag will have bit 0 set to indicate that Vector Registers Area is in the optional area. This should not affect tools or program code that are accessing PPA1 according to the Language Environment interface. Refer to the *z/OS Language Environment Vendor Interfaces* for details about PPA1.

When debugging your COBOL programs, you will find that there have been a large number of improvements and behavior changes introduced with Enterprise COBOL 5 and 6. For details about changes in debugging with IBM z/OS Debugger, see "z/OS Debugger changes with Enterprise COBOL 5 and 6" on page 241.

Chapter 17. Upgrading from Enterprise COBOL 4

To compile with Enterprise COBOL 5 or 6, Enterprise COBOL 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 using DATE FORMAT and windowed date functions. For details, see "Changes in millennium language extensions in IBM Enterprise COBOL for z/OS 5 and 6" on page 175.
- Label declaratives. To compile programs with Enterprise COBOL 5 or 6, 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 5.
- Programs that use new reserved words as user words. For details, see "New reserved words" on page 107.

There is a new compiler option, FLAGMIG4, available with PTF for APAR PM93450 for Enterprise COBOL 4.2 to help you migrate to Enterprise COBOL 5 or 6. 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 4 programs that are not supported, or that are supported differently in Enterprise COBOL 5 or 6. The compiler will generate a warning diagnostic message for all such language elements.

Note: The source code changes for COBOL 5 and 6 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 4 PTFs to support the migration to Enterprise COBOL 5 or 6. For details, see http://www.ibm.com/support/docview.wss?uid=swg21982146.

Related references
Chapter 1, "COBOL compiler versions, required runtimes, and support information," on page 3

Upgrading Enterprise COBOL 4 programs that have XML PARSE statements

You can refer to the following guidelines for upgrading Enterprise COBOL 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 5 or 6.

If you were using the z/OS System Services XML parser with Enterprise COBOL 4.2, you do not need to make any code changes for COBOL 5.2 and 6. Originally, Enterprise COBOL 5.1 did not have an XMLPARSE compiler option and required the XMLSS parser. However, with current service applied, COBOL 5.1 is the same as COBOL 5.2 in this area, and both have the XMLPARSE compiler option so that you can choose the same parser in 5 and 6 that you used with earlier versions of Enterprise COBOL.

If you were using the z/OS System Services XML parser with Enterprise COBOL 4.1, consider information in "Upgrading Enterprise COBOL 4.1 programs that have XML PARSE statements and that use the XMLPARSE(XMLSS) compiler option" on page 174.

If you use the COMPAT XML parser that is part of the COBOL runtime library with COBOL 4 and COBOL 3, you most likely do not have to change your code. The COMPAT XML parser implementation in Enterprise COBOL 5 and 6 has two minor differences in special cases compared to COBOL 3 and COBOL 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 162.

COMPAT XML parser considerations

User modifications to the XML document during execution of the XML PARSE statement

In versions earlier than Enterprise COBOL 5, the COMPAT XML parser was actively in progress when the XML processing procedure was executing. In COBOL 5, 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 COBOL 5 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 5, 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 COBOL 5 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 COBOL 5 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 COBOL 5, 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 5, but it causes runtime errors IGZ0227S or IGZ0228S on Enterprise COBOL 5. 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      ***
***  COBOL 3/4 and COBOL 5 (or XMLSS on any version).         ***
***                                                           ***
***  In COBOL 3/4, the logical branch out of the XML          ***
***  processing procedure by CEEMRCE terminates the           ***
***  XML PARSE. In COBOL 5, 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 4.1 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 4.1 and Enterprise COBOL 4.2 or later. In Enterprise COBOL 4.1 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 4.1 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 4.2 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 4.2 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 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 5 or 6, 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
- JSON-STATUS
- 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 5.1, or if you have the PTF for APAR PI32750 installed for Enterprise COBOL 5.2, or if you have the PTF for APAR PI55980 installed for Enterprise COBOL 6.1.

CCCA is bundled with IBM Debug for z/OS (IDz) 14.2 or earlier versions, and it is removed since IDz 15.0. After IDz 14.2 reached EOS on September 30, 2022, you can download CCCA from here at no charge.

For details about CCCA, see "COBOL and CICS Command Level Conversion Aid for z/OS (CCCA)" on page 303.

For a table comparing reserved words for all of the different COBOL compilers, see Table 55 on page 277.

Changes in millennium language extensions in IBM Enterprise COBOL for z/OS 5 and 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 5 or 6.

Chapter 18. Compiling Enterprise COBOL 4 programs

There have been a number of changes to compiler options and debug behavior for Enterprise COBOL 4 programs.

After reading these topics, see also Chapter 20, “Changes with Enterprise COBOL 5 and 6,” on page 199.

Compiler option changes from IBM Enterprise COBOL for z/OS 4

There have been a number of changes to compiler options.

The following options have been removed.

Table 35. Compiler options not available in Enterprise COBOL 5

Compiler option	Comments
DATEPROC	Support for Year 2000 extensions has been removed.
LIB	The compiler behaves as though COPY, BASIS, or REPLACE statements are included in a program and searches for the specified library or libraries to retrieve the copied code referenced in those statements. For details about how to define the source libraries, see *Specifying source libraries (SYSLIB)* in the *Enterprise COBOL for z/OS Programming Guide*.
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 5 or 6 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 that are compiled with NUMPROC(MIG) to Enterprise COBOL 6, use 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. For details, see *NUMCHECK* in the *Enterprise COBOL for z/OS Programming Guide*.

Table 36. Compiler option not available in Enterprise COBOL 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 CHECK(OFF) runtime option.

For descriptions of new and modified options for Enterprise COBOL 5 and 6, see "Compiler option changes in Enterprise COBOL 5 and 6" on page 204.

For a detailed list of options supported for the various compiler versions, see "Option comparison" on page 314.

For detailed descriptions of all options, see the *Enterprise COBOL Programming Guide*.

Debug information changes with Enterprise COBOL 5 and 6

Programs compiled with Enterprise COBOL 5 or 6 will have different debug information than that of programs compiled with previous versions of the compiler.

IBM Enterprise COBOL 5 and 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.

TEST option changes

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 z/OS Debugger. When the TEST(NOSOURCE) compiler option is specified, the generated DWARF debug information does not include the expanded source code.

  Tip: If you are using IBM z/OS Debugger, it is recommended that you specify TEST(SOURCE) (for COBOL 5 or 6.1) or TEST(SEPARATE,SOURCE) (for COBOL 6.2 and later) to get the most debugging functionality while controlling module size:

  – With TEST(SOURCE), the debug information is saved in a NOLOAD debug segment in the program object.
  – With TEST(SEPARATE,SOURCE), the debug information is saved in a separate debug file.
- You can use the NOTEST(DWARF) compiler option to include basic DWARF debugging information in the program object. You cannot debug such programs with z/OS Debugger, 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.

For details about the TEST option, see *TEST* in the *Enterprise COBOL for z/OS Programming Guide*.

For details about debugging COBOL programs using IBM z/OS Debugger, see *Choosing TEST or NOTEST compiler suboptions for COBOL programs* in the *IBM z/OS Debugger User's Guide*.

Listing information changes

With Enterprise COBOL 5 and 6.1, 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.

With Enterprise COBOL 6.2, the diagnostic messages are again at the bottom of the listing, as with Enterprise COBOL 4 and earlier compilers.

Changes that apply to Enterprise COBOL 6 only

- The allocation and management of WORKING-STORAGE SECTION have been changed since Enterprise COBOL 5. 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 192.
- Enterprise COBOL 6 uses interprocess communication (IPC) message queues within the compiler. 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.
- PPA1 changes in Enterprise COBOL 6.3

  Starting in Enterprise COBOL 6.3, bit 30 of flag3 (offset X'1C') of PPA1 may be set to indicate that the `Extended Flag field` is present. If this bit is set, the extended flag will have bit 0 set to indicate that `Vector Registers Area` is in the optional area. This should not affect tools or program code that are accessing PPA1 according to the Language Environment interface. Refer to the *z/OS Language Environment Vendor Interfaces* for details about PPA1.

When debugging your COBOL programs, you will find that there have been a large number of improvements and behavior changes introduced with Enterprise COBOL 5 and 6. For details about changes in debugging with IBM z/OS Debugger, see "z/OS Debugger changes with Enterprise COBOL 5 and 6" on page 241.

Part 4. What is new and changed in Enterprise COBOL 5 and 6?

There are many changes to the compiler and runtime library with Enterprise COBOL 5 and 6. There are changes in compiling, binding (link-editing), execution, and even changed Debug Tool behavior.

- To find out changes with COBOL 6 specifically, see Chapter 19, “Changes with Enterprise COBOL 6,” on page 183.
- To find out changes with COBOL 5 and 6, see Chapter 20, “Changes with Enterprise COBOL 5 and 6,” on page 199.

Related references
Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3

Chapter 19. Changes with Enterprise COBOL 6

For more information about changes with Enterprise COBOL 6 specifically, read this section.

The COBOL 6 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 6

Enterprise COBOL for z/OS 6 runs under the control of, or in conjunction with, the currently supported releases of the following programs and their subsequent releases or their equivalents. For more information, see the *Program Directory* and the preventive service planning (PSP) bucket for each COBOL release.

For COBOL 6.5:

- z/OS 2.5 (5650-ZOS), or later, is required with various APARs applied for COBOL runtime support. Check the *Program Directory* for APARs needed depending on your z/OS version.
- For installation on z/OS, z/OS SMP/E is required.
- For customization during or after installation, z/OS High Level Assembler is required.
- Enterprise COBOL XML PARSE statements in programs, which are compiled with the XMLPARSE(XMLSS) compiler option, require z/OS XML System Services 2.5 (5650-ZOS), or later.
- The new COBOL/Java interoperability feature available in Enterprise COBOL for z/OS 6.5 requires IBM SDK for z/OS, Java Technology Edition 8.0.6.36 (JVM), or IBM Semeru Certified Edition for z/OS 11.0.14.1, or later.

For COBOL 6.4:

- z/OS 2.3 (5650-ZOS), or later, is required with various z/OS Language Environment APARs applied for mixed AMODE 31 (31-bit)/AMODE 64 (64-bit) and COBOL runtime support. Check the *Program Directory* for APARs needed depending on your z/OS version.
- For installation on z/OS, z/OS SMP/E is required.
- For customization during or after installation, z/OS High Level Assembler is required.
- Enterprise COBOL XML PARSE statements in programs, which are compiled with the XMLPARSE(XMLSS) compiler option, require z/OS XML System Services 2.3 (5650-ZOS), or later.
- The new COBOL/Java interoperability feature available in Enterprise COBOL for z/OS 6.4 requires IBM SDK for z/OS, Java Technology Edition 8.0.6.36 (JVM), or IBM Semeru Certified Edition for z/OS 11.0.14.1, or later.

For COBOL 6.3:

- z/OS 2.2 (5650-ZOS), or later, is required.

  Note: To run 64-bit (AMODE 64) COBOL applications, z/OS 2.3 (5650-ZOS) or later is required.
- For installation on z/OS, z/OS SMP/E is required.
- For customization during or after installation, z/OS High Level Assembler is required.
- Enterprise COBOL XML PARSE statements in programs, which are compiled with the XMLPARSE(XMLSS) compiler option, require z/OS XML System Services 2.2 (5650-ZOS), or later.

For COBOL 6.2:

- z/OS 2.1 (5650-ZOS), or later, is required.
- For installation on z/OS, z/OS SMP/E is required.
- For customization during or after installation, z/OS High Level Assembler is required.
- Enterprise COBOL XML PARSE statements in programs, which are compiled with the XMLPARSE(XMLSS) compiler option, require z/OS XML System Services 2.1 (5650-ZOS), or later.

For COBOL 6.1:

- z/OS 2.1 (5650-ZOS), or later, is required.
- For installation on z/OS, z/OS SMP/E is required.
- For customization during or after installation, z/OS High Level Assembler is required.
- Enterprise COBOL XML PARSE statements in programs, which are compiled with the XMLPARSE(XMLSS) compiler option, require z/OS XML System Services 2.1 (5650-ZOS), or later.

Depending on the functions used, you might require other software products such as CICS, Db2, or IMS. For a list of compatible software, see the Software Product Compatibility Reports (SPCR) website. From the SPCR website, in the **In-depth reports** section, under **Detailed system requirements**, click **Create a report**. Search for *Enterprise COBOL for z/OS*, choose the COBOL version and then click **Submit**.

Note: Prerequisite software levels were valid as of the General Availability of the Enterprise COBOL 6 releases. Over time, some of the products will announce end of support plans. Check the product lifecycle website for versions currently supported.

COBOL source code differences in Enterprise COBOL 6

The following differences apply to Enterprise COBOL 6 specifically.

Reserved words

Starting in Enterprise COBOL 6.1, ALLOCATE, DEFAULT, END-JSON, FREE, JSON, and JSON-CODE are new reserved words. Existing programs that use these words as user-defined words (for example, as data names or paragraph names) will get S-level diagnostic messages with Enterprise COBOL 6. You must change instances of these reserved words to other words such as ALLOCATE-X or JSON-Y, or you can use the CCCA utility to do it for you.

Starting in Enterprise COBOL 6.2, JSON-STATUS is a new reserved word. Existing programs that use JSON-STATUS as a user-defined word (for example, as a data name or paragraph name) will get S-level diagnostic messages with Enterprise COBOL 6.2. You must change these instances of JSON-STATUS to other words such as JSON-STATUS-X, or you can use the CCCA utility to do it for you.

Starting in Enterprise COBOL 6.3, BYTE-LENGTH, JAVA, LIMIT, POINTER-32, and UTF-8 are new reserved words. Existing programs that use these words as user-defined words (for example, as data names or paragraph names) will get S-level diagnostic messages with Enterprise COBOL 6.3. You must change instances of these reserved words to other words such as BYTE-LENGTH-X or BYTE-LENGTH-Y, or you can use the CCCA utility to do it for you.

Starting in Enterprise COBOL 6.4, FUNCTION-ID is a new reserved word. Existing programs that use FUNCTION-ID as a user-defined word (for example, as a data name or paragraph name) will get S-level diagnostic messages with Enterprise COBOL 6.4. You must change these instances of FUNCTION-ID to other words such as FUNCTION-ID-X, or you can use the CCCA utility to do it for you.

CURRENCY SIGN clause

Starting in Enterprise COBOL 6.3, in the CURRENCY SIGN clause of the SPECIAL-NAMES paragraph:

- If the PICTURE SYMBOL phrase is not specified, then operand *literal-6* can no longer be the character 'U' or the character 'u'.

- If the PICTURE SYMBOL phrase is specified, then operand *literal-7* can no longer be the character 'U' or the character 'u'.

VALUE clause

In Enterprise COBOL 5 and earlier versions, a non-88 level VALUE clause in the LINKAGE SECTION or the FILE SECTION was treated as a comment and ignored.

For example, with Enterprise COBOL 5 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.
```

However, starting in Enterprise COBOL 6.1, the VALUE clause for the LINKAGE SECTION and the FILE SECTION items is now syntax checked and has meaning.

With Enterprise COBOL 6:

```
  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.
```

In COBOL 6:

- If the data VALUE literal is incompatible with the PICTURE clause, as shown in the example above, the IGYGR1080-S error message will be issued.
- If the data VALUE literal is compatible with the PICTURE clause, it will be used to initialize the data item in the LINKAGE SECTION when the data item is used in an INITIALIZE...TO VALUE statement.

In summary, a COBOL 5 program with a non-88 level VALUE clause in the LINKAGE SECTION that is compiled with an RC=0 could get an RC=12 with COBOL 6 or have the LINKAGE data item be initialized when the data item is used in an INITIALIZE...TO VALUE statement, depending on the validity of the VALUE clause literal.

CALL...USING *file-name* statement

The use of passing a *file-name* to a subprogram with the USING phrase of the CALL statement was removed in Enterprise COBOL 6.3, but is restored in Enterprise COBOL 6.3 with PTF for APAR PH20724 installed.

Compiler option changes in Enterprise COBOL 6

The following options are added:

Table 37. Compiler options new with Enterprise COBOL 6

Compiler option	Comments
CONDCOMP	New option in Enterprise COBOL V6.3 with the service PTFs. It affects the behavior of conditional compilation directives and controls how conditional code will be displayed in the listing.
COPYLOC	New option in Enterprise COBOL 6.1 with the service PTFs, 6.2 with the service PTFs, and from 6.3. 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.

Table 37. Compiler options new with Enterprise COBOL 6 (continued)

Compiler option	Comments
DEFINE	New option from Enterprise COBOL 6.2. It assigns a literal value to a compilation variable that is defined in the program by using the DEFINE directive with the PARAMETER phrase.
INITCHECK	New option in Enterprise COBOL 6.1 with the service PTFs and from 6.2. It controls whether to check for uninitialized data items and issue warning messages when they are used without being initialized.
INITIAL	New option in Enterprise COBOL 6.2 with the service PTFs and from 6.3. It causes a program and all of its nested programs to behave as if the IS INITIAL clause was specified on the PROGRAM-ID paragraph.
INLINE	New option in Enterprise COBOL 6.1 with the service PTFs and from 6.2 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 5.)
INVDATA	New option in Enterprise COBOL 6.2 with the service PTFs and from 6.3. The option supercedes the deprecated ZONEDATA option. 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. To ease your migration to COBOL 5 or 6: • If your digits, sign code, and zone bits are valid, use NOINVDATA and the same NUMPROC setting that you used with COBOL 4 when using COBOL 5 or 6. **Note:** If you used NUMPROC(MIG) in 4, it is no longer available in COBOL 5 or 6 and you should use NUMPROC(NOPFD) in this scenario instead. • If you have invalid digits, invalid sign code, or invalid zone bits: – If you used NUMPROC(MIG) with COBOL 4, use INVDATA(FORCENUMCMP,NOCLEANSIGN) and NUMPROC(NOPFD) with COBOL 5 or 6. – If you used NUMPROC(NOPFD) with COBOL 4, use INVDATA(NOFORCENUMCMP,CLEANSIGN) (or simply INVDATA) with COBOL 5 or 6. – If you used NUMPROC(PFD) with COBOL 4, use INVDATA(NOFORCENUMCMP,CLEANSIGN) (or simply INVDATA) with COBOL 5 or 6.
JAVAIOP	New option from Enterprise COBOL 6.4. It controls the behavior of COBOL programs that interoperate with Java though the JAVA-CALLABLE or JAVA-SHAREABLE directives or by calling Java static methods using the CALL statement.
LP	New option from Enterprise COBOL 6.3. It can be used to indicate whether an AMODE 31 (31-bit) or AMODE 64 (64-bit) program should be generated with the related language features enabled.
LSACHECK	New option in Enterprise COBOL 6.3 and 6.4 with service PTFs. It prevents inadvertent use of LINKAGE-SECTION data items prior to establishing addressability.
NUMCHECK	New option in Enterprise COBOL 6.1 with the service PTFs and from 6.2. 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 ERR0R checking for binary data items.

Table 37. Compiler options new with Enterprise COBOL 6 (continued)

Compiler option	Comments
PARMCHECK	New option in Enterprise COBOL 6.1 with the service PTFs and from 6.2. 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.
SMARTBIN	New option from Enterprise COBOL 6.4. It instructs the compiler to generate modules containing additional binary metadata that enables them to be optimized by IBM Automatic Binary Optimizer (ABO) for z/OS 2.2. For details, see "SMARTBIN changes" on page 191.
SUPPRESS	New option from Enterprise COBOL 6.1. It controls whether to ignore the SUPPRESS phrase of COPY statements.
TUNE	New option from Enterprise COBOL 6.3 with the service PTFs. It specifies the architecture for which the executable program will be optimized. • In Enterprise COBOL 6.4, TUNE(8) and TUNE(9) are removed, and a new higher level of TUNE(14) is accepted. • In Enterprise COBOL 6.5, TUNE(10) is removed and a new higher level of TUNE(15) is accepted. The default TUNE level matches the ARCH level if ARCH is specified. If ARCH is not specified, both ARCH and TUNE default to 11.
VSAMOPENFS	New option from Enterprise COBOL 6.1. It affects the user file status reported from successful VSAM OPEN statements that require verified file integrity check.
VLR	New option in Enterprise COBOL 6. It affects the READ statement processing of variable length records that have length conflicts. VLR(STANDARD) is the default. VLR(COMPAT) is compatible with older COBOL compilers. For details, see "Variable length records - wrong length READ" on page 221.

The following options are modified:

Table 38. Compiler option changed with Enterprise COBOL 6

Compiler option	Comments
AFP	It controls the compiler usage of the Additional Floating Point (AFP) registers that are provided by IBM z/Architecture processors. • In Enterprise COBOL 6.1, AFP(VOLATILE) is the default. • From Enterprise COBOL 6.2, AFP(NOVOLATILE) is the default.
ARCH	It specifies the machine architecture for which the executable program instructions are to be generated. • In Enterprise COBOL 6.1, ARCH(7) is the default. • In Enterprise COBOL 6.2, a new higher level of ARCH(12) is accepted, and ARCH(7) is still the default. • In Enterprise COBOL 6.3, ARCH(7) is removed, and a new higher level of ARCH(13) is accepted. ARCH(8) is the default. • In Enterprise COBOL 6.4, ARCH(8) and ARCH(9) are removed, and a new higher level of ARCH(14) is accepted. ARCH(10) is the default. • In Enterprise COBOL 6.5, ARCH(10) is removed, and a new higher level of ARCH(15) is accepted. ARCH(11) is the default.

Table 38. Compiler option changed with Enterprise COBOL 6 (continued)

Compiler option	Comments
CURRENCY	From Enterprise COBOL 6.3, the literal argument to the CURRENCY option can no longer be the character 'U' or the character 'u'.
INITCHECK	In Enterprise COBOL 6.1 with the service PTFs, 6.2 with the service PTFs, and from 6.3 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 6, 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)`
	`/*`

MAXPCF	New option. It instructs the compiler not to optimize code if the program contains a complexity factor greater than *n*. • In Enterprise COBOL 6.1, MAXPCF(60000) is the default. • From Enterprise COBOL 6.2, MAXPCF(100000) is the default.
NOSTGOPT	In Enterprise COBOL 6.1, data items can get optimized with OPT(2) even when NOSTGOPT was in effect. In Enterprise COBOL 6.1 with the service PTFs and from 6.2, NOSTGOPT was changed so that no optimization of storage or data items occurs even with OPT(2). This is especially helpful for WORKING-STORAGE eye-catchers.
NUMCHECK	From Enterprise COBOL 6.3, when invalid data is found at compile time, regardless of whether NUMCHECK(MSG) or NUMCHECK(ABD) is in effect, an error-level message is produced and the check is removed.
RULES	In Enterprise COBOL 6.2 with the service PTFs and from 6.3, the following new suboptions are added to the RULES compiler option: • OMITODOMIN | NOOMITODOMIN tells the compiler whether to issue warning messages for any OCCURS DEPENDING ON clauses that are specified without *integer-1* (the minimum number of occurrences). • UNREF | NOUNREFALL | NOUNREFSOURCE tells the compiler whether to issue warning messages for unreferenced data items, and to control whether the reporting is done only for data items not declared in a copy member (NOUNREFSOURCE) or all data items (NOUNREFALL). • LAXREDEF | NOLAXREDEF tells the compiler whether to issue warning messages when a data item is redefined to a smaller item on any level. From Enterprise COBOL 6.4, if there are multiple RULES specifications for a compilation, the suboptions are additive, which means they are accumulated.

Table 38. Compiler option changed with Enterprise COBOL 6 (continued)

Compiler option	Comments
SOURCE	From Enterprise COBOL 6.3 with the service PTFs, new suboptions DEC | HEX are added to SOURCE compiler option. If SOURCE(DEC) is in effect, the line numbers for the listing of the source will be in decimal format. If SOURCE(HEX) is in effect, the line numbers for the listing of the source will be in hexadecimal format.
SSRANGE	In Enterprise COBOL 6.1 with the service PTFs and from 6.2, 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.
TEST	From Enterprise COBOL 6.2, new suboptions SEPARATE | NOSEPARATE are added to the TEST compiler option to control program object size on disk while retaining debugging capability. In addition, new combinations of suboptions are supported in both the TEST and NOTEST compiler options, including TEST(NODWARF), TEST(SEPARATE), and NOTEST(DWARF,SOURCE).

The following options are removed:

Table 39. Compiler option not available in Enterprise COBOL 6

Compiler option	Comments
LVLINFO	From Enterprise COBOL 6.1, 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.
ZONECHECK	In Enterprise COBOL 6.1 with the service PTFs and from 6.2, ZONECHECK is deprecated but is tolerated for compatibility, and it is replaced by NUMCHECK(ZON).

For a detailed list of options supported for the various compiler versions, see “Option comparison” on page 314.

For a detailed list of compiler options that can affect performance, see *How to tune compiler options to get the most out of COBOL 6* 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 6

Non-OO COBOL/Java interop DLL name changes

In Enterprise COBOL 6.5, when the user directs the cjbuild utility to output the DLL for their program to a data set, the specified name is no longer automatically prefixed with the 3 characters "LIB", as it was in Enterprise COBOL 6.4. This allows users to use the full 8 characters of a member name for the name of their DLL, which makes it easier to match the DLL name to the COBOL program name when desired. Users will need to update the link step of their JCL to refer to the name of the DLL side deck without the LIB prefix in their INCLUDE statements when linking. The characters "lib" are still prefixed to the DLL when it is output to the z/OS UNIX file system, as is the convention.

z/OS MEMLIMIT changes

In Enterprise COBOL 6, the compiler starts using storage above the 2 GB BAR to compile programs, even those that are not large. 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 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. If you encounter this error message, set REGION=0M and MEMLIMIT=3G on the job card and recompile your programs. If it is successful, consider changing the system MEMLIMIT default that was set in IEFUSI, SMFPRMxx, or SMFLIMxx to no less than 2 GB.

Note: The SMFLIMxx PARMLIB member is only available in z/OS 2.2 and later versions.

Listing changes

- Starting in Enterprise COBOL 6.1, 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 6.5.0 PXXXXXX
  ```

  In Enterprise COBOL 5 and 6.1, the diagnostic messages are in the middle of the listing. In Enterprise COBOL 6.2 and later versions, the diagnostic messages are at the bottom of the listing as with Enterprise COBOL 4 and earlier compilers.
- Starting in Enterprise COBOL 6.3, listing terminologies change as follows:
  - STATIC MAP in Enterprise COBOL 6.2 and earlier versions is changed to INITIAL HEAP STORAGE MAP.
  - Writeable static area (WSA) in Enterprise COBOL 6.2 and earlier versions is changed to storage.
  - WSA24 in Enterprise COBOL 6.2 and earlier versions is changed to BELOW THE LINE STORAGE.
  - AUTOMATIC MAP in Enterprise COBOL 6.2 and earlier versions is changed to STACK STORAGE MAP.

JCL changes

To change to uppercase English or Japanese compiler messages in COBOL 6, 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)
/*
```

Starting in Enterprise COBOL 6.3, new cataloged procedures for doing compilation have been provided to help developing COBOL AMODE 64 (64-bit) programs. The AMODE 64 support is a new feature introduced to Enterprise COBOL 6.3. See Developing AMODE 64 programs (*Enterprise COBOL for z/OS Programming Guide*) for details about AMODE 64 support.

Compiler phases in shared storage changes

Starting in Enterprise COBOL 6.3, 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.

Use of *file-name* in CALL ... USING statement

The use of passing a *file-name* to a subprogram with the USING phrase of the CALL statement was removed in Enterprise COBOL 6.3, but is restored in Enterprise COBOL 6.3 with PTF for APAR PH20724 installed.

SMARTBIN changes

Starting in Enterprise COBOL 6.4, the SMARTBIN option is on by default when LP(32) is in effect. SMARTBIN instructs the compiler to generate modules containing additional binary metadata that enables them to be optimized by IBM Automatic Binary Optimizer (ABO) for z/OS (ABO) 2.2. When SMARTBIN is in effect, the additional binary metadata is placed in a NOLOAD segment of the module. To generate the SMARTBIN metadata, compile times may increase by up to 21% at OPT(0) and 2-3% at OPT(1) and OPT(2) on an IBM z15® (or later) machine with zEnterprise Data Compression (zEDC) enabled (hardware compression turned on). This is in comparison to an increase of up to 33% at OPT(0) and 10% at OPT(1) and OPT(2) on an IBM z15™ (or later) machine without zEDC enabled (hardware compression turned off). The additional metadata will also increase the size of the module on disk, requiring larger load libraries, but will not increase the size in memory when the program is running since it is not loaded. The size increase on disk will be approximately 2 times to 3 times the size of the original binary.

You can change the option to NOSMARTBIN, however, without the additional binary metadata, COBOL modules built with Enterprise COBOL 6.4 will be ineligible for ABO optimization and you would need to recompile and test your modules in the future to maximize benefit from IBM Z hardware improvements. If you use ABO or plan to in the future, the SMARTBIN option is recommended.

Refer to the IBM Automatic Binary Optimizer for z/OS product page for additional information on ABO benefits.

Related references
SMARTBIN
(*Enterprise COBOL for z/OS Programming Guide*)

Changes at run time with Enterprise COBOL 6

- In some cases, the STORAGE runtime option cannot be used to initialize WORKING-STORAGE to a chosen value at startup. These cases are:
  - COBOL 6 programs with spanned (RECORDING MODE S) files
  - Non-CICS COBOL 5 programs compiled with DATA(31)
- File status changes in 6:
  - 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 6 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 6, 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 in Enterprise COBOL 6 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.
- Starting from Enterprise COBOL 6.3, when using the LP(64) option, the compilation process includes a component that runs in POSIX(ON) mode. This implies that there must be an OMVS Segment established in RACF® (or equivalent in RACF alternatives) for each user executing the compiler with this option.

Changes with Enterprise COBOL 6 that might affect vendor tools

- The allocation and management of WORKING-STORAGE SECTION have been changed since Enterprise COBOL 5. 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 192.
- Enterprise COBOL 6 uses interprocess communication (IPC) message queues within the compiler. 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.
- PPA1 changes in Enterprise COBOL 6.3

  Starting in Enterprise COBOL 6.3, bit 30 of flag3 (offset X'1C') of PPA1 may be set to indicate that the `Extended Flag field` is present. If this bit is set, the extended flag will have bit 0 set to indicate that `Vector Registers Area` is in the optional area. This should not affect tools or program code that are accessing PPA1 according to the Language Environment interface. Refer to the *z/OS Language Environment Vendor Interfaces* for details about PPA1.

WORKING-STORAGE SECTION changes

The allocation and management of WORKING-STORAGE SECTION have been changed since Enterprise COBOL 5. 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 5 and 6 programs at run time.

To find the start of WORKING-STORAGE in COBOL 5 and 6, you need to know how to locate the PPA4 (Program Prologue Area 4) in a dump.

A: For AMODE 31

The following description applies when the program is compiled with LP(32):

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 5 or 6 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.

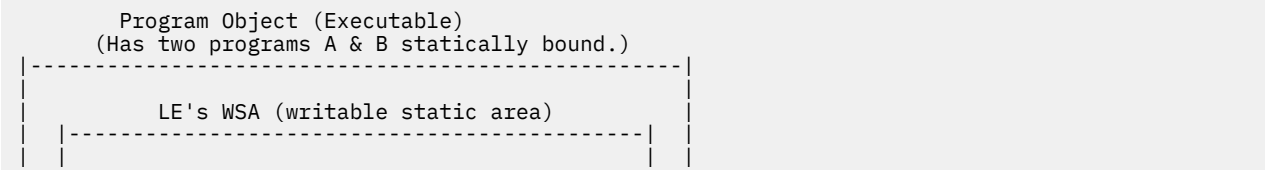
Explanation of the areas where WORKING-STORAGE can reside

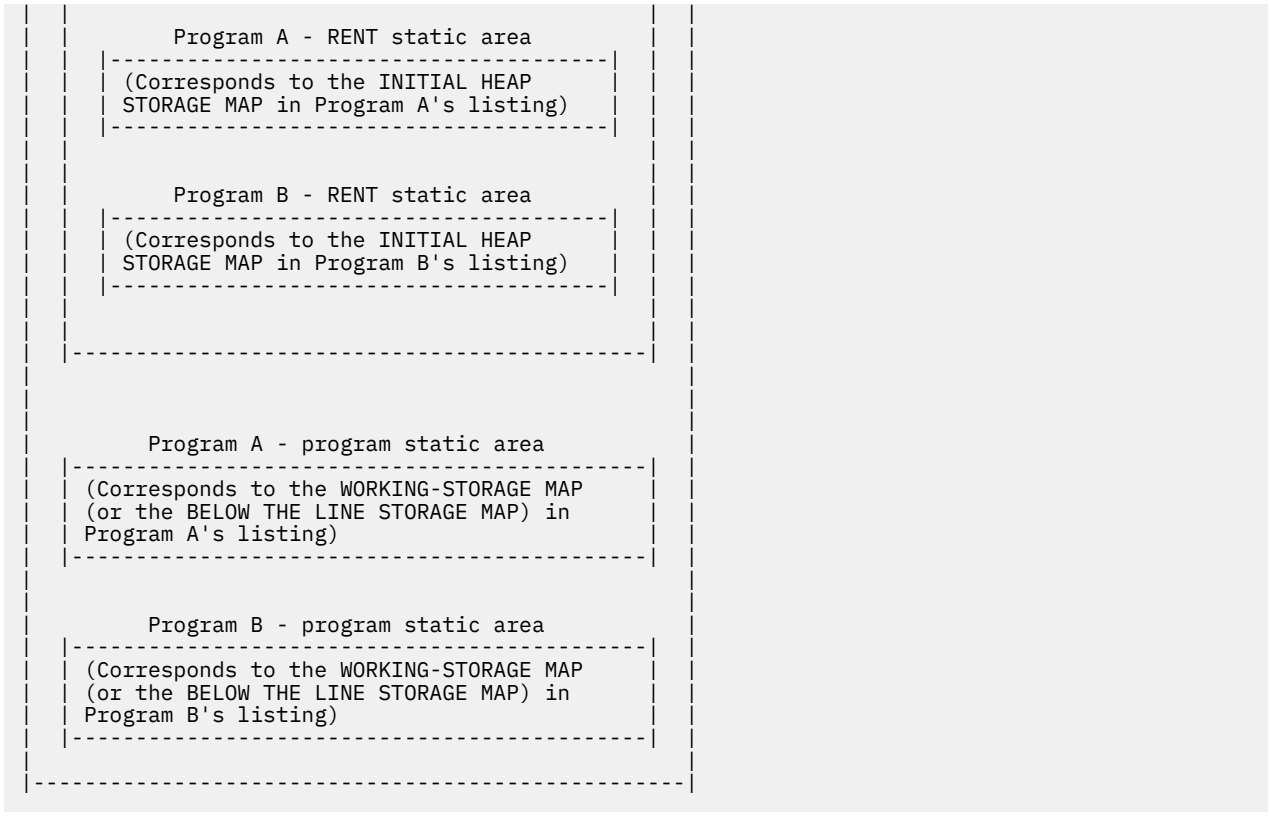
There are three different locations where WORKING-STORAGE can reside:

- 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 5 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 40. Area where WORKING-STORAGE is located

COBOL versions	**Compiler options**	**Where is WORKING-STORAGE located?**
COBOL 5	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 6 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

Table 40. Area where WORKING-STORAGE is located (continued)

COBOL versions	Compiler options	Where is WORKING-STORAGE located?

Notes:

1. In COBOL 5, there is a WSOPT compiler option. In COBOL 6, 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 41. 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 INITIAL HEAP STORAGE MAP shows the layout of the RENT static area or the NORENT static area.
- The WORKING-STORAGE MAP or the BELOW THE LINE STORAGE MAP shows the layout of the program static area.

B: For AMODE 64

The following information applies when the program is compiled with LP(64):

Information about the WORKING-STORAGE SECTION can be found in the PPA4 of the program together with the Heap Storage Address Table. Follow the steps below to locate them.

1. Find the entry point address of the program in the dump from the traceback. In the LE CEEDUMP traceback, this is the address under the "E Addr" column corresponding to the row of the program.

   In the example below, HELLO is the COBOL program. Its entry point address is X'260000A8'. This address should contain the first executable instruction of the program, that is, an STMG instruction.

```
Traceback:
  DSA     Entry        E  Offset    …
  1       CEEHDSP      +00003F3C
  2       CELQHROD     +00000266
  3       HELLO        +00000224
  4       CELQINIT     +00001D0C

  DSA     DSA Addr           E  Addr
  1       00000050082FBC60   0000000026B0A3D0
  2       00000050082FEDA0   0000000026B1DD18
  3       00000050082FEFA0   00000000260000A8
  4       00000050082FF220   0000000026903010
```

2. At program entry point offset -x'08', that is, before the entry point, there is an integer value. This value is the offset from the entry point address to PPA1.
3. At PPA1+x'04', there is an offset value. This is the offset from the entry point address to PPA2.
4. At PPA2+x'08', there is an offset value. This is the offset from PPA2 to PPA4.
5. At PPA4+x'7C', there is an offset value. This is the offset from the *environment* of the program to the Heap Storage Address Table.

Environment here refers to the XPLINK environment of the program. This is the address in register R5 on entry into the program. The first instruction of the program, the STMG, stores the register to the stack. The contents of R5 can be found in the dump.

Heap Storage Address Table

Offset of this table from the *environment* of the program is in PPA4+X'7C'.

Data items in WORKING-STORAGE SECTION in LP(64) are by default allocated above the bar. They are in COBOL's ABOVE THE BAR HEAP. Its starting address is in the first field of the Heap Storage Address Table (at offset X'00' of this table). Note that this address corresponds also to the ABOVE THE BAR HEAP MAP section in the compilation listing, which provides information about level 77 and 01 data items in the WORKING-STORAGE SECTION.

There are also COBOL control areas and compiler internal variables allocated in the ABOVE THE BAR HEAP. The first WORKING-STORAGE data item in the program might not reside right at the beginning. The offset of the first data item in the program's WORKING-STORAGE SECTION can be found in PPA4 offset +X'40'.

Table 42. Heap Storage Address Table

	Length	**Description**
X'00'	8	Starting Address of COBOL's ABOVE THE BAR HEAP (64-bit storage area)
X'08'	8	Reserved
X'10'	8	Reserved

Information relating to WOKRING-STORAGE SECTION can be summarized below:

Table 43. WORKING-STORAGE SECTION summary	
Description	**Can be found in:**
Offset of Heap Storage Address Table from R5	PPA4+x'7C'
Starting address of WORKING-STORAGE	Heap Storage Address Table + x'00'
Offset of first user 64-bit data item from WORKING-STORAGE	PPA4+x'40'
Length of the area containing all user WORKING-STORAGE 64-bit data items	PPA4+x'48'

For information about the layout of PPA4 and each PPA4 offset, length, and description, see COBOL 64-bit PPA4 layout in the *z/OS Language Environment Vendor Interfaces*.

C: 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 6.1, 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 INITIAL HEAP STORAGE 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 for z/OS Programming Guide*)

Related references
Example: Program prolog areas (*Enterprise COBOL for z/OS Programming Guide*)
Common interfaces and conventions (*z/OS Language Environment Vendor Interfaces*)

Chapter 20. Changes with Enterprise COBOL 5 and 6

There are a few differences from all previous compilers to consider when using Enterprise COBOL 5 or 6. 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 5 and 6 mainly fall into the following categories:

- Prerequisite software and service changes
- COBOL source code differences
- Compiler option changes
- Compiling behavior differences
- Binding (link-editing) changes
- Changes at run time
- Debug information and Debug Tool behavior changes

Migrating to COBOL 5 or 6 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 5 or 6. 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 5.1 is equivalent to Enterprise COBOL 5.2 for migration purposes.

The performance characteristics of COBOL 5 of the compiler are similar to those of COBOL 6. Except where otherwise noted, the changes and migration recommendations in this section are applicable to both 5 and 6.

Prerequisite software and service for Enterprise COBOL 5 and 6

Updates are required for other products to compile programs with Enterprise COBOL 5 and 6 and also to bind, run and debug those programs. Now, with Enterprise COBOL 5 and 6, you can use FIXCAT to find required service.

Prerequisite levels of related software products

Enterprise COBOL for z/OS 6 runs under the control of, or in conjunction with, the currently supported releases of the following programs and their subsequent releases or their equivalents. For more information, see the *Program Directory* and the preventive service planning (PSP) bucket for each COBOL release.

For COBOL 6.5:

- z/OS 2.5 (5650-ZOS), or later, is required with various APARs applied for COBOL runtime support. Check the *Program Directory* for APARs needed depending on your z/OS version.
- For installation on z/OS, z/OS SMP/E is required.
- For customization during or after installation, z/OS High Level Assembler is required.
- Enterprise COBOL XML PARSE statements in programs, which are compiled with the XMLPARSE(XMLSS) compiler option, require z/OS XML System Services 2.5 (5650-ZOS), or later.
- The new COBOL/Java interoperability feature available in Enterprise COBOL for z/OS 6.5 requires IBM SDK for z/OS, Java Technology Edition 8.0.6.36 (JVM), or IBM Semeru Certified Edition for z/OS 11.0.14.1, or later.

For COBOL 6.4:

- z/OS 2.3 (5650-ZOS), or later, is required with various z/OS Language Environment APARs applied for mixed AMODE 31 (31-bit)/AMODE 64 (64-bit) and COBOL runtime support. Check the *Program Directory* for APARs needed depending on your z/OS version.
- For installation on z/OS, z/OS SMP/E is required.
- For customization during or after installation, z/OS High Level Assembler is required.
- Enterprise COBOL XML PARSE statements in programs, which are compiled with the XMLPARSE(XMLSS) compiler option, require z/OS XML System Services 2.3 (5650-ZOS), or later.
- The new COBOL/Java interoperability feature available in Enterprise COBOL for z/OS 6.4 requires IBM SDK for z/OS, Java Technology Edition 8.0.6.36 (JVM), or IBM Semeru Certified Edition for z/OS 11.0.14.1, or later.

For COBOL 6.3:

- z/OS 2.2 (5650-ZOS), or later, is required.

  Note: To run 64-bit (AMODE 64) COBOL applications, z/OS 2.3 (5650-ZOS) or later is required.
- For installation on z/OS, z/OS SMP/E is required.
- For customization during or after installation, z/OS High Level Assembler is required.
- Enterprise COBOL XML PARSE statements in programs, which are compiled with the XMLPARSE(XMLSS) compiler option, require z/OS XML System Services 2.2 (5650-ZOS), or later.

For COBOL 6.2:

- z/OS 2.1 (5650-ZOS), or later, is required.
- For installation on z/OS, z/OS SMP/E is required.
- For customization during or after installation, z/OS High Level Assembler is required.
- Enterprise COBOL XML PARSE statements in programs, which are compiled with the XMLPARSE(XMLSS) compiler option, require z/OS XML System Services 2.1 (5650-ZOS), or later.

For COBOL 6.1:

- z/OS 2.1 (5650-ZOS), or later, is required.
- For installation on z/OS, z/OS SMP/E is required.
- For customization during or after installation, z/OS High Level Assembler is required.
- Enterprise COBOL XML PARSE statements in programs, which are compiled with the XMLPARSE(XMLSS) compiler option, require z/OS XML System Services 2.1 (5650-ZOS), or later.

Depending on the functions used, you might require other software products such as CICS, Db2, or IMS. For a list of compatible software, see the Software Product Compatibility Reports (SPCR) website. From the SPCR website, in the **In-depth reports** section, under **Detailed system requirements**, click **Create a report**. Search for *Enterprise COBOL for z/OS*, choose the COBOL version and then click **Submit**.

Note: Prerequisite software levels were valid as of the General Availability of the Enterprise COBOL 6 releases. Over time, some of the products will announce end of support plans. Check the product lifecycle website for versions currently supported.

Determining service required

You no longer need to find lists of APARs and PTFs in PSP buckets. As of Enterprise COBOL for z/OS 5, you must use SMP/E FIXCATs to identify the required PTFs on other products to work with Enterprise COBOL 5 and 6. The required service PTFs for COBOL for z/OS 5 and 6 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 5 and 6 required service. It is the easiest way to quickly determine if you have all the necessary required service PTFs installed. For Enterprise COBOL 5 and 6, you should use SMP/E 3.5 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 6 for COBOL.

- For COBOL 5.1: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V5R1`
- For COBOL 5.2: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V5R2`
- For COBOL 6.1: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R1`
- For COBOL 6.2: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R2`
- For COBOL 6.3: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R3`
- For COBOL 6.4: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R4`
- For COBOL 6.5: `IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R5`

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 5 or 6 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 6.5 (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,
       IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R2,
       IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R3,
       IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R4,
       IBM.TargetSystem-RequiredService.Enterprise-COBOL.V6R5)
```

For complete information about the **REPORT MISSINGFIX** command, see *SMP/E Commands*.

Enterprise COBOL 4.2 aids for migration to Enterprise COBOL 5 or 6

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 4.2 to Enterprise COBOL 5 or 6.

- PM93450 - FLAGMIG4. This one helps you identify if you have COBOL statements that are unsupported in 5 or 6. 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 5 and 6 are rarely used COBOL language features and do not affect 99% of COBOL users.
- PM85035 - new function to support the XML-INFORMATION special register. This was helpful for migrating to XMLPARSE(XMLSS), which was required for migrating to COBOL 5.1 before XMLPARSE was added. In COBOL 5.1 with service applied and COBOL 5.2 and later compilers, the XMLPARSE compiler option is added so that you do not need to migrate to XMLPARSE(XMLSS).
- 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 5 or 6 compared to previous COBOL compiler releases.
- Language Environment 1.13 PM87347 for XML-INFORMATION support at run time if you have installed the related Enterprise COBOL 4 APAR, PM85035.

COBOL source code differences in Enterprise COBOL 5 and 6

Several language elements have been removed or modified in Enterprise COBOL 5 and 6 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 5 or 6:

- 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 5 or 6:

- 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 5.2, 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 5.2 and 6. 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 5 and later versions no longer do this zone normalization. Having `INSPECT` without a `REPLACING` clause update the inspected item was unexpected, and COBOL 5 and later versions do not do this.

There is no way to have COBOL 5 and later versions behave in the same unexpected way as COBOL 4. Adding or removing REPLACING will not replicate COBOL 4 and earlier behavior, which we consider to be in error. To avoid the unexpected behavior in COBOL 4, 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 5 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 6 programs:

```
INSPECT NUM-DISP REPLACING ALL SPACES BY '0'
```

This is effectively what COBOL 4 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 4.2 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 5 and 6 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 4.2.

Changes that apply to Enterprise COBOL 6 only

The following differences apply to Enterprise COBOL 6 specifically.

Reserved words

Starting in Enterprise COBOL 6.1, ALLOCATE, DEFAULT, END-JSON, FREE, JSON, and JSON-CODE are new reserved words. Existing programs that use these words as user-defined words (for example, as data names or paragraph names) will get S-level diagnostic messages with Enterprise COBOL 6. You must change instances of these reserved words to other words such as ALLOCATE-X or JSON-Y, or you can use the CCCA utility to do it for you.

Starting in Enterprise COBOL 6.2, JSON-STATUS is a new reserved word. Existing programs that use JSON-STATUS as a user-defined word (for example, as a data name or paragraph name) will get S-level diagnostic messages with Enterprise COBOL 6.2. You must change these instances of JSON-STATUS to other words such as JSON-STATUS-X, or you can use the CCCA utility to do it for you.

Starting in Enterprise COBOL 6.3, BYTE-LENGTH, JAVA, LIMIT, POINTER-32, and UTF-8 are new reserved words. Existing programs that use these words as user-defined words (for example, as data names or paragraph names) will get S-level diagnostic messages with Enterprise COBOL 6.3. You must change instances of these reserved words to other words such as BYTE-LENGTH-X or BYTE-LENGTH-Y, or you can use the CCCA utility to do it for you.

Starting in Enterprise COBOL 6.4, FUNCTION-ID is a new reserved word. Existing programs that use FUNCTION-ID as a user-defined word (for example, as a data name or paragraph name) will get S-level diagnostic messages with Enterprise COBOL 6.4. You must change these instances of FUNCTION-ID to other words such as FUNCTION-ID-X, or you can use the CCCA utility to do it for you.

CURRENCY SIGN clause

Starting in Enterprise COBOL 6.3, in the CURRENCY SIGN clause of the SPECIAL-NAMES paragraph:

- If the PICTURE SYMBOL phrase is not specified, then operand *literal-6* can no longer be the character 'U' or the character 'u'.
- If the PICTURE SYMBOL phrase is specified, then operand *literal-7* can no longer be the character 'U' or the character 'u'.

VALUE clause

In Enterprise COBOL 5 and earlier versions, a non-88 level VALUE clause in the LINKAGE SECTION or the FILE SECTION was treated as a comment and ignored.

For example, with Enterprise COBOL 5 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.
```

However, starting in Enterprise COBOL 6.1, the VALUE clause for the LINKAGE SECTION and the FILE SECTION items is now syntax checked and has meaning.

With Enterprise COBOL 6:

```
   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.
```

In COBOL 6:

- If the data VALUE literal is incompatible with the PICTURE clause, as shown in the example above, the IGYGR1080-S error message will be issued.
- If the data VALUE literal is compatible with the PICTURE clause, it will be used to initialize the data item in the LINKAGE SECTION when the data item is used in an INITIALIZE...TO VALUE statement.

In summary, a COBOL 5 program with a non-88 level VALUE clause in the LINKAGE SECTION that is compiled with an RC=0 could get an RC=12 with COBOL 6 or have the LINKAGE data item be initialized when the data item is used in an INITIALIZE...TO VALUE statement, depending on the validity of the VALUE clause literal.

CALL...USING *file-name* statement

The use of passing a *file-name* to a subprogram with the USING phrase of the CALL statement was removed in Enterprise COBOL 6.3, but is restored in Enterprise COBOL 6.3 with PTF for APAR PH20724 installed.

Compiler option changes in Enterprise COBOL 5 and 6

Various changes are made to compiler options in Enterprise COBOL 5 and 6.

The following options are new:

Table 44. Compiler options new with Enterprise COBOL 5 and 6

Compiler option	Comments
AFP	New option. It controls the compiler usage of the Additional Floating Point (AFP) registers that are provided by IBM z/Architecture processors. • From Enterprise COBOL 5.1, AFP(VOLATILE) is the default. • From Enterprise COBOL 6.2, AFP(NOVOLATILE) is the default.
ARCH	New option. It specifies the machine architecture for which the executable program instructions are to be generated. • In Enterprise COBOL 5.1, ARCH(6) is the default. • In Enterprise COBOL 5.2 and 6.1, ARCH(6) is no longer accepted, and ARCH(7) is the default. • In Enterprise COBOL 6.2, a new higher level of ARCH(12) is accepted. ARCH(7) is still the default. • In Enterprise COBOL 6.3, ARCH(7) is removed, and a new higher level of ARCH(13) is accepted. ARCH(8) is the default. • In Enterprise COBOL 6.4, ARCH(8) and ARCH(9) are removed, and a new higher level of ARCH(14) is accepted. ARCH(10) is the default. • In Enterprise COBOL 6.5, ARCH(10) is removed, and a new higher level of ARCH(15) is accepted. ARCH(11) is the default.
CONDCOMP	New option in Enterprise COBOL V6.3 with the service PTFs. It affects the behavior of conditional compilation directives and controls how conditional code is displayed in the listing.
COPYLOC	New option in Enterprise COBOL 6.1 with the service PTFs, 6.2 with the service PTFs, and from 6.3. 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.

Table 44. Compiler options new with Enterprise COBOL 5 and 6 (continued)

Compiler option	Comments
COPYRIGHT	New option from Enterprise COBOL 5.2. It places a string in the object module if the object module is generated.
DEFINE	New option from Enterprise COBOL 6.2. It assigns a literal value to a compilation variable that is defined in the program by using the DEFINE directive with the PARAMETER phrase.
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 that are provided by IBM z/Architecture processors. HGPR(PRESERVE) is the default.
INITCHECK	New option in Enterprise COBOL 5.2 with the service PTFs, 6.1 with the service PTFs, and from 6.2. It controls whether to check for uninitialized data items and issue warning messages when they are used without being initialized.
INITIAL	New option in Enterprise COBOL 6.2 with the service PTFs and from 6.3. It causes a program and all of its nested programs to behave as if the IS INITIAL clause was specified on the PROGRAM-ID paragraph.
INLINE	New option in Enterprise COBOL 6.1 with the service PTFs and from 6.2 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. INLINE was always in effect in COBOL 5.
INVDATA	New option in Enterprise COBOL 6.2 with the service PTFs and from 6.3. The option supersedes the deprecated ZONEDATA option. 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 is. To ease your migration to COBOL 5 or 6: • If your digits, sign code, and zone bits are valid, use NOINVDATA and the same NUMPROC setting that you used with COBOL 4 when using COBOL 5 or 6. **Note:** If you used NUMPROC(MIG) in 4, it is no longer available in COBOL 5 or 6, use NUMPROC(NOPFD) in this scenario instead. • If you have invalid digits, invalid sign code, or invalid zone bits: – If you used NUMPROC(MIG) with COBOL 4, use INVDATA(FORCENUMCMP,NOCLEANSIGN) and NUMPROC(NOPFD) with COBOL 5 or 6. – If you used NUMPROC(NOPFD) with COBOL 4, use INVDATA(NOFORCENUMCMP,CLEANSIGN) (or simply INVDATA) with COBOL 5 or 6. – If you used NUMPROC(PFD) with COBOL 4, use INVDATA(NOFORCENUMCMP,CLEANSIGN) (or simply INVDATA) with COBOL 5 or 6.
JAVAIOP	New option from Enterprise COBOL 6.4. It controls the behavior of COBOL programs that interoperate with Java though the JAVA-CALLABLE or JAVA-SHAREABLE directives or by calling Java static methods by using the CALL statement.
LP	New option from Enterprise COBOL 6.3. It indicates whether an AMODE 31 (31 bit) or AMODE 64 (64-bit) program is generated with the related language features enabled. LP(32) is the default.

Table 44. Compiler options new with Enterprise COBOL 5 and 6 (continued)

Compiler option	Comments
LSACHECK	New option in Enterprise COBOL 6.3 and 6.4 with service PTFs. It prevents inadvertent use of LINKAGE-SECTION data items prior to establishing addressability.
MAXPCF	New option. It instructs the compiler not to optimize code if the program contains a complexity factor greater than *n*. • From Enterprise COBOL 5.1, MAXPCF(60000) is the default. • From Enterprise COBOL 6.2, MAXPCF(100000) is the default.
NUMCHECK	New option in Enterprise COBOL 5.2 with the service PTFs, 6.1 with the service PTFs, and from 6.2. 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 ERR0R checking for binary data items.
PARMCHECK	New option in Enterprise COBOL 6.1 with the service PTFs and from 6.2. 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 5.2. 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 5.2. 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 5.2. It places a string in the object module if the object module is generated.
SMARTBIN	New option from Enterprise COBOL 6.4. It instructs the compiler to generate modules containing additional binary metadata that enables them to be optimized by IBM Automatic Binary Optimizer (ABO) for z/OS 2.2. For details, see “SMARTBIN changes” on page 191.
SQLIMS	New option in Enterprise COBOL 5.1 with the service PTFs, and from 5.2. 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. In Enterprise COBOL 5.1, 5.2, and 6.1, data items can get optimized with OPT(2) even when NOSTGOPT was in effect. NOSTGOPT was changed in Enterprise COBOL 6.1 with the service PTFs and from 6.2, so that no optimization of storage or data items occurs even with OPT(2). This is especially helpful for WORKING-STORAGE eye-catchers.
SUPPRESS	New option from Enterprise COBOL 6.1. It controls whether to ignore the SUPPRESS phrase of COPY statements.

Table 44. Compiler options new with Enterprise COBOL 5 and 6 (continued)

Compiler option	Comments
TUNE	New option from Enterprise COBOL 6.3 with the service PTFs. It specifies the architecture for which the executable program is optimized. • In Enterprise COBOL 6.4, TUNE(8) and TUNE(9) are removed, and a new higher level of TUNE(14) is accepted. • In Enterprise COBOL 6.5, ARCH(10) is removed, and a new higher level of ARCH(15) is accepted. The default TUNE level matches the ARCH level if ARCH is specified. If ARCH is not specified, both ARCH and TUNE default to 11.
VLR	New option in Enterprise COBOL 5.1 with the service PTFs and from 5.2. 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 221.
VSAMOPENFS	New option from Enterprise COBOL 6.1. It affects the user file status reported from successful VSAM OPEN statements that require verified file integrity check.
XMLPARSE	New option in Enterprise COBOL 5.1 with the service PTFs and from 5.2. 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 COBOL 5 or 6 compilers. XMLPARSE(XMLSS) is the default.
ZONECHECK	New option in Enterprise COBOL 5.2 with the service PTFs and 6.1. It tells the compiler to generate IF NUMERIC class tests for zoned decimal data items that are used as sending data items. In Enterprise COBOL 6.1 with the service PTFs and from 6.2, ZONECHECK is deprecated but is tolerated for compatibility. Use NUMCHECK(ZON) instead. For details, see *NUMCHECK* in the *Enterprise COBOL for z/OS Programming Guide*.

Table 44. Compiler options new with Enterprise COBOL 5 and 6 (continued)

Compiler option	Comments
ZONEDATA	New option from Enterprise COBOL 5.2. 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 is. Originally, Enterprise COBOL 5.2 at base level did not have the NOPFD suboption. In 5.2 with the service PTFs and from 6.1, the NOPFD suboption is added to let the compiler generate code that performs comparisons of zoned decimal data in the same manner as COBOL 4 does when you use NUMPROC(NOPFD|PFD) in COBOL 4. To ease your migration to COBOL 5 or 6: • If your digits, sign code, and zone bits are valid, use ZONEDATA(PFD) and the same NUMPROC setting that you used with COBOL 4 when using COBOL 5 or 6. • If you have invalid digits, invalid sign code, or invalid zone bits: – If you used NUMPROC(MIG) with COBOL 4, use ZONEDATA(MIG) and NUMPROC(NOPFD) with COBOL 5 or 6. – If you used NUMPROC(NOPFD) with COBOL 4, use ZONEDATA(NOPFD) and NUMPROC(NOPFD) with COBOL 5 or 6. – If you used NUMPROC(PFD) with COBOL 4, use ZONEDATA(NOPFD) and NUMPROC(PFD) with COBOL 5 or 6. **Note:** In Enterprise COBOL 6.2 and 6.3 with the service PTFs, ZONEDATA is deprecated but is tolerated for compatibility. Use INVDATA instead. For more details, see INVDATA in the *Enterprise COBOL for z/OS Programming Guide*.

For new compiler options in Enterprise COBOL 6, see Compiler options new with Enterprise COBOL 6.

The following options are modified:

Table 45. Compiler options changed with Enterprise COBOL 5 and 6

Compiler option	Comments
CURRENCY	From Enterprise COBOL 6.3, the literal argument to the CURRENCY option can no longer be the character 'U' or the character 'u'.
EXIT	The EXIT compiler option is no longer mutually exclusive with the DUMP compiler option, and the compiler exits rules are updated.
INITCHECK	In Enterprise COBOL 6.1 with the service PTFs, 6.2 with the service PTFs, and from 6.3 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.

Table 45. Compiler options changed with Enterprise COBOL 5 and 6 (continued)

Compiler option	Comments

LANGUAGE	To change to uppercase English or Japanese compiler messages in COBOL 6, in addition to using the LANGUAGE compiler option, you must also set the Language Environment runtime option NATLANG at compile time. Use 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 5.1 with the service PTFs and from 5.2, 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 5.1 at base level originally showed decimal offsets for MAP output. From Enterprise COBOL 5.1 with the service PTFs, new suboptions HEX and DEC are added to the MAP option. If MAP is specified with no suboption, it is accepted as MAP(HEX). This gives you the same behavior in Enterprise COBOL 5 or 6 as in earlier COBOL compilers. Thus, it can ease your migration to Enterprise COBOL 5 or 6 compilers.
MDECK	The MDECK option no longer has a dependency on the LIB option, as the LIB option is removed. For details, see LIB.
NORENT	NORENT can no longer be used with RMODE(ANY). Execution of NORENT programs above the 16 MB line is not supported.
NOSTGOPT	• From Enterprise COBOL 5.1, data items can get optimized with OPT(2) even when NOSTGOPT was in effect. • In Enterprise COBOL 6.1 with the service PTFs and from 6.2, NOSTGOPT was changed so that no optimization of storage or data items occurs even with OPT(2). This is especially helpful for WORKING-STORAGE eye-catchers.
NUMCHECK	From Enterprise COBOL 6.3, when invalid data is found at compile time and regardless of whether `NUMCHECK(MSG)` or `NUMCHECK(ABD)` is in effect, an error-level message is produced and the check is removed.
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 that is 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 45. Compiler options changed with Enterprise COBOL 5 and 6 (continued)

Compiler option	Comments
RULES	In Enterprise COBOL 6.2 with the service PTFs and from 6.3, the following new suboptions are added to the RULES compiler option: • OMITODOMIN | NOOMITODOMIN tells the compiler whether to issue warning messages for any OCCURS DEPENDING ON clauses that are specified without *integer-1* (the minimum number of occurrences). • UNREF | NOUNREFALL | NOUNREFSOURCE tells the compiler whether to issue warning messages for unreferenced data items, and to control whether the reporting is done only for data items not declared in a copy member (NOUNREFSOURCE) or all data items (NOUNREFALL). • LAXREDEF | NOLAXREDEF tells the compiler whether to issue warning messages when a data item is redefined to a smaller item on any level. From Enterprise COBOL 6.4, if there are multiple RULES specifications for a compilation, the suboptions are additive, which means they are accumulated.
SOURCE	From Enterprise COBOL 6.3 with the service PTFs, new suboptions DEC | HEX are added to SOURCE compiler option. If SOURCE(DEC) is in effect, the line numbers for the listing of the source is in decimal format. If SOURCE(HEX) is in effect, the line numbers for the listing of the source is in hexadecimal format.
SSRANGE	The compiled-in range checks cannot be disabled at run time by using the CHECK(OFF) runtime option. In Enterprise COBOL 5.2 with the service PTFs and from 6.1, new suboptions ZLEN | NOZLEN are added to the SSRANGE compiler option to control how the compiler checks reference modification lengths. In Enterprise COBOL 6.1 with the service PTFs and from 6.2, 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.

Table 45. Compiler options changed with Enterprise COBOL 5 and 6 (continued)

Compiler option	Comments
TEST	• From Enterprise COBOL 5.1, 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 information 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 suboptions are still supported. With Debug Tool 12 with APAR PM75819 or Debug Tool 13 or later, you can do JUMPTO or GOTO even if you compile with the TEST(NOEJPD) option and a nonzero OPTIMIZE level. However, you must use the Debug Tool command SET WARNING OFF and you might get unpredictable results. The NOTEST option is enhanced to include the suboptions DWARF | 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 run time, unless Debug Tool, CEEDUMP, Fault Analyzer, Application Performance Analyzer or a 3rd-party vendor tool that uses DWARF debugging data is used • From Enterprise COBOL 6.2, new suboptions SEPARATE | NOSEPARATE are added to the TEST compiler option to control program object size on disk while retaining debugging capability. In addition, new combinations of suboptions are supported in both the TEST and NOTEST compiler options, including TEST(NODWARF), TEST(SEPARATE), and NOTEST(DWARF,SOURCE).

For modified compiler options in Enterprise COBOL 6, see Compiler option changed with Enterprise COBOL 6.

The following options are removed:

Table 46. Compiler options not available in Enterprise COBOL 5 and 6

Compiler option	Comments
DATEPROC	Support for Year 2000 extensions is removed.
LVLINFO	From Enterprise COBOL 6.1, 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.
LIB	The compiler behaves as though COPY, BASIS, or REPLACE statements are included in a program and searches for the specified library or libraries to retrieve the copied code referenced in those statements. For details about how to define the source libraries, see *Specifying source libraries (SYSLIB)* in the *Enterprise COBOL for z/OS Programming Guide*.

Table 46. Compiler options not available in Enterprise COBOL 5 and 6 (continued)

Compiler option	Comments
NUMPROC(MIG)	NUMPROC(PFD) and NUMPROC(NOPFD) are still available. If NUMPROC(MIG) is specified, Enterprise COBOL 5 or 6 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 that are compiled with NUMPROC(MIG) to Enterprise COBOL 6, use 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. For details, see *NUMCHECK* in the *Enterprise COBOL for z/OS Programming Guide*.
SIZE	• In Enterprise COBOL 5.1, the SIZE option value is no longer an upper-limit for the total storage that is 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 5 and 6" on page 213. • From Enterprise COBOL 5.2, the SIZE option is removed.
YEARWINDOW	Support for Year 2000 extensions has been removed.
ZONECHECK	In Enterprise COBOL 6.1 with the service PTFs and from 6.2, ZONECHECK is deprecated but is tolerated for compatibility, and it is replaced by NUMCHECK(ZON).

For removed compiler options in Enterprise COBOL 6, see Compiler option not available in Enterprise COBOL 6.

The following options were obsolete in Enterprise COBOL 4, but were tolerated with informational or warning messages to ease migration from 3 or prior versions. With Enterprise COBOL 5 and 6, these options are no longer tolerated, and specifying any of them results in an error message.

- CMPR2
- EVENTS
- FDUMP
- FLAGSAA
- PFDSIGN
- RES

For a detailed list of options supported for the various compiler versions, see "Option comparison" on page 314.

For a detailed list of compiler options that can affect performance, see *How to tune compiler options to get the most out of COBOL 6* 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 5 and 6

There are a number of changes to Enterprise COBOL 5 and 6 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 5 or 6 and for running programs that were compiled with Enterprise COBOL 5 or 6. For details about prerequisite software levels and required maintenance, see "Prerequisite software and service for Enterprise COBOL 5 and 6" on page 199.

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 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 5.1.

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 5.2 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 6, the compiler starts using storage above the 2 GB BAR to compile programs, even those that are not large. 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 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`. If you encounter this error message, set `REGION=0M` and `MEMLIMIT=3G` on the job card and recompile your programs. If it is successful, consider changing the system MEMLIMIT default that was set in IEFUSI, SMFPRMxx, or SMFLIMxx to no less than 2 GB.

Note: The SMFLIMxx PARMLIB member is only available in z/OS 2.2 and later versions.

Consider also the following changes:

- The Language Environment member ID for Enterprise COBOL 5.1 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 6.1, 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 6.5.0 PXXXXXX
```

- In Enterprise COBOL 5 and 6.1, the diagnostic messages are in the middle of the listing. In Enterprise COBOL 6.2 and later versions, the diagnostic messages are at the bottom of the listing as with Enterprise COBOL 4 and earlier compilers.
- Several compiler limits are increased with Enterprise COBOL 5 and 6. For details, see "Compiler limit comparison" on page 336.
- Starting in Enterprise COBOL 6.3, listing terminologies change as follows:
  - `STATIC MAP` in Enterprise COBOL 6.2 and earlier versions is changed to `INITIAL HEAP STORAGE MAP`.
  - Writeable static area (WSA) in Enterprise COBOL 6.2 and earlier versions is changed to `storage`.
  - `WSA24` in Enterprise COBOL 6.2 and earlier versions is changed to `BELOW THE LINE STORAGE`.
  - `AUTOMATIC MAP` in Enterprise COBOL 6.2 and earlier versions is changed to `STACK STORAGE MAP`.
- Starting in Enterprise COBOL 6.3, 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.
- The use of passing a *file-name* to a subprogram with the USING phrase of the CALL statement was removed in Enterprise COBOL 6.3, but is restored in Enterprise COBOL 6.3 with PTF for APAR PH20724 installed.

If you are using IBM Enterprise COBOL Value Unit Edition (VUE) for z/OS 5.2 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 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 5 and 6.

For example, with Enterprise COBOL 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 5 and 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 5 and 6.

For example, with Enterprise COBOL 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 5 and 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 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 5 and 6

There have been a number of changes to the packaging, installation and JCL with Enterprise COBOL 5 and 6.

Changes that apply to Enterprise COBOL 5 and 6

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

Enterprise COBOL 5 and 6 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 5 and 6. Because they all use the Language Environment Prelinker or the DFSMS Loader, which are no longer supported for use with Enterprise COBOL 5 and 6.

- IGYWCG
- IGYWCPG
- IGYWCPL

- IGYWCPLG
- IGYWPL

The catalogued procedures that ship with Enterprise COBOL 5 and 6 have been modified.

- IGYWC
- IGYWCL
- IGYWCLG

Changes that apply to Enterprise COBOL 6

To change to uppercase English or Japanese compiler messages in COBOL 6, 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)
/*
```

Starting in Enterprise COBOL 6.3, new cataloged procedures for doing compilation have been provided to help developing COBOL AMODE 64 (64-bit) programs. The AMODE 64 support is a new feature introduced to Enterprise COBOL 6.3. See Developing AMODE 64 programs (*Enterprise COBOL for z/OS Programming Guide*) for details about AMODE 64 support.

Compilation restrictions for user-written condition handlers with Enterprise COBOL 5 and 6

Refer to the restrictions for user-written condition handlers with Enterprise COBOL 5 and 6, and the differences between COBOL 5.1 and 5.2.

User-written condition handlers with Enterprise COBOL 5.1

With Enterprise COBOL 5.1, 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 5.2 and 6

With Enterprise COBOL 5.2 and 6, 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 5.2 and 6. 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 for z/OS Language Reference*.

Binding (link-editing) changes with Enterprise COBOL 5 and 6

There have been a number of changes to binding (link-editing) Enterprise COBOL 5 or 6 programs.

- The DFSMS Program Management Binder must be used to bind (link-edit) Enterprise COBOL 5 or 6 applications.
- The Language Environment Prelinker can no longer be used, because it doesn't understand the GOFF object format. The transformations that the Prelinker does on prior object module formats are incompatible with program object features. Using the Language Environment Prelinker for any component of an executable which involves Enterprise COBOL 5 or 6 applications will yield the undefined behavior.
- Executables are program objects, not load modules. The batch loader (`IEWBLDGO`) cannot be used to produce a program module in a partitioned data set or a PDSE, because it doesn't understand the GOFF object format or program object formats. Alternatively, the Program Management Loader can support programs in PDSE data sets.
- 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 COBOL 5 that run with AMODE 24 and statically call a COBOL program compiled with COBOL 5 or later.

Changes at run time with Enterprise COBOL 5 and 6

There are a number of changes to runtime behavior with Enterprise COBOL 5 and 6.

If a z/OS system does not have Language Environment PTFs installed to support Enterprise COBOL 5 or 6 programs, you cannot run Enterprise COBOL 5 or 6 programs on that system.

- Runtime option changes. For details, see “Language Environment option changes” on page 219.
- Interoperability. Enterprise COBOL 5 and 6 has some restrictions with interoperability with older versions of COBOL. For details, see “Interoperability with older levels of IBM COBOL programs” on page 29.
- Invalid data might get different results with COBOL 5 and 6 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 SSRANGE, NUMCHECK, PARMCHECK, INITCHECK, and OPT(0), and then run regression tests.
2. Check whether there are any problems:
   - If no problems found, recompile with NOSSRANGE, NONUMCHECK, NOPARMCHECK, and OPT(2); 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 INVDATA compiler option to tolerate the invalid data.

Both INITCHECK and NUMCHECK options are available in Enterprise COBOL 6.2, 6.1, and 5.2 with current service applied.

Note: You do not have to do this additional testing for programs that have already been compiled with Enterprise COBOL 5 and 6

- All of the AMODE and RMODE scenarios supported by Enterprise COBOL 4 are now supported with 5 and 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 220.
- For applications compiled with Enterprise COBOL 5 or 6, the compiled-in range checks cannot be disabled at run time using the CHECK(OFF) runtime option.
- The ILBOABN0 interface for requesting an ABEND in a COBOL environment can be called dynamically with Enterprise COBOL 5 and later versions. When called by a program compiled with the Enterprise COBOL compiler, it will have the same result as calling CEE3ABD using ACTION code 1.

  You 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 suggestions below:
  - Migrate to CEE3ABD.
  - Relink your application with REPLACE ILBOABN and resolve the reference against the LE SCEELKED library. (ILBOABN0 is an alias of ILBOABN.)
  - 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 5 or 6.
- The IGZBRDGE macro, for converting static calls to dynamic calls, is not supported for programs compiled with Enterprise COBOL 5 or 6.
- 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 221.
- 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 5 and 6 runtime modules. For details, see "CSD setup differences with Enterprise COBOL 5 and 6" on page 249.
- 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 224.

For COBOL 5 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 for z/OS Programming Guide*).

For COBOL 5 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.

Changes that apply to Enterprise COBOL 6 only

- In some cases, the STORAGE runtime option cannot be used to initialize WORKING-STORAGE to a chosen value at startup. These cases are:
  - COBOL 6 programs with spanned (RECORDING MODE S) files
  - Non-CICS COBOL 5 programs compiled with DATA(31)
- File status changes in 6:
  - 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 6 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 6, 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 6 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.
    - Starting from Enterprise COBOL 6.3, when using the LP(64) option, the compilation process includes a component that runs in POSIX(ON) mode. This implies that there must be an OMVS Segment established in RACF (or equivalent in RACF alternatives) for each user executing the compiler with this option.

Language Environment option changes

There have been a number of changes to runtime options for Enterprise COBOL 5 and 6 programs.

The following options have different behavior for programs compiled with Enterprise COBOL 5 or 6.

Table 47. Runtime option changes with Enterprise COBOL 5 and 6

Option	Comments
HEAP	• With COBOL 5, 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 5 program is statically linked to a C, C++ or PL/I program and the main entry point of the program object is not COBOL 5. • With COBOL 6 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 5 or 6 programs compiled with SSRANGE.
STORAGE	In a few special cases with COBOL 5, 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 3 and 4.

- 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 5.1.1, or later versions; or Enterprise COBOL 4.2 or earlier versions. If any component of a program object is compiled with Enterprise COBOL 5.1.0, 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 5.1 changed the behavior for wrong length READ compared to previous COBOL compilers; but for Enterprise COBOL 5.1 with current service applied, 5.2, 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 5.1 without service applied, or the behavior that is compatible with earlier COBOL compilers. It eases your migration from earlier versions to Enterprise COBOL 5 and 6, 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 5.1 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 1.3 with PTFs for APAR PN34704 installed
- VS COBOL II 1.4 with PTFs for APAR PN38730 installed
- COBOL/370 1.1 or 1.2 with PTFs for APAR PN36445 installed
- COBOL for OS/390 & VM 2.1 or 2.2
- Enterprise COBOL 3 or 4

The inconsistent behavior could have inhibited the migration to Enterprise COBOL 5 and 6. Thus, in Enterprise COBOL 5.1 with current service applied, 5.2, 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 4 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 5 and 6 than with prior versions. You must consider more vigorous testing for migrating to Enterprise COBOL 5 or 6 than you did for migrating to Enterprise COBOL 4.

- 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 5 and 6 than with prior versions. The information such as PROGRAM-ID, COMPILED TIME, and COMPILED DATE included in the initialization code of Enterprise COBOL 4 or earlier is not included in the initialization code of Enterprise COBOL 5 or later, so the program it depends on might behave differently with Enterprise COBOL 5 and 6.
- 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 COBOL 2, 3, and 4: 128 bytes of 'C' were moved
  - For COBOL 5 and 6: 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 COBOL 2, 3 and 4: 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 COBOL 5 and 6: 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 COBOL 4 with NUMPROC(MIG) and COBOL 5.1 with OPT(0), the program displays "EQUAL TO ZERO"
  - For COBOL 4 with NUMPROC(PFD) or NUMPROC(NOPFD), and COBOL 5.1 with OPT(1) or OPT(2), the program displays "NOT EQUAL TO ZERO"

  If you have invalid digits, invalid sign codes, or invalid zone bits in your data, change your programs or systems so that your programs do not have invalid data in numeric data items at run time.

  When you have corrected your programs or systems, you can use the preferred NOINVDATA option. Only if you cannot contain this work and must continue to run with invalid data, consider the following choices for the INVDATA option:

  - If you used NUMPROC(MIG) with COBOL 4, use INVDATA(FORCENUMCMP, NOCLEANSIGN) and NUMPROC(NOPFD) with COBOL 6.
  - If you used NUMPROC(NOPFD) with COBOL 4, use INVDATA(NOFORCENUMCMP,CLEANSIGN) (or simply INVDATA) and NUMPROC(NOPFD) with COBOL 6.
  - If you used NUMPROC(PFD) with COBOL 4, use INVDATA(NOFORCENUMCMP,CLEANSIGN) (or simply INVDATA) and NUMPROC(PFD) with COBOL 6.

  Notes:

  - If you completed migration from COBOL 4 or earlier versions to COBOL 5 or 6 in the past and used the deprecated ZONEDATA(MIG) option in COBOL 5 or 6 and are satisfied with the behavior, use INVDATA(FORCENUMCMP, CLEANSIGN) instead of ZONEDATA(MIG).
  - IBM recommends that you correct your programs and/or data and use the NOINVDATA option.

  If your data doesn't always have the correct zone bits in zoned decimal data items, compile with the INVDATA(FORCENUMCMP) compiler option so that the zone bits will always be ignored.

- For programs using zoned decimal data with invalid zone bits, the SEARCH ALL statement may produce different results between Enterprise COBOL 4 and later versions (COBOL 5 and 6.1). In Enterprise COBOL 6.2, the SEARCH ALL statement behaves according to the INVDATA option as described in the previous bullet. Use any legal form of the INVDATA option to produce the same behaviour as Enterprise COBOL 4 or earlier versions.

  When the COBOL 6.2 runtime library enablement PTF is applied to the Language Environment, SEARCH ALL statement will behave according to the INVDATA option as described in the previous bullet. This is available for all COBOL 5 and 6 programs without recompilation. Use any legal form of the INVDATA option to produce the same behaviour as Enterprise COBOL 4 or earlier versions.

  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.

  This only affects programs with invalid zoned decimal data. If there are no invalid zone bits, the SEARCH ALL statement produces the same result regardless of the setting of the INVDATA option.

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 5 and later versions. When called by a program compiled with the Enterprise COBOL compiler, it will have the same result as calling `CEE3ABD` using ACTION code 1.

You 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 suggestions below:

- Migrate to `CEE3ABD`.
- Relink your application with `REPLACE ILBOABN` and resolve the reference against the LE `SCEELKED` library. (`ILBOABN0` is an alias of `ILBOABN`.)
- 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 4.2 or earlier versions. It is strongly recommended that programs upgrading to COBOL 5 or later versions take the opportunity to migrate away from the conventional technique of DFSORT.

To provide compatibility with COBOL 4.2 and earlier versions and to tolerate this usage in COBOL 5 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 5 and 6

Programs compiled with Enterprise COBOL 5 or 6 will have different debug information than that of programs compiled with previous versions of the compiler.

IBM Enterprise COBOL 5 and 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.

TEST option changes

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 z/OS Debugger. When the TEST(NOSOURCE) compiler option is specified, the generated DWARF debug information does not include the expanded source code.

  Tip: If you are using IBM z/OS Debugger, it is recommended that you specify TEST(SOURCE) (for COBOL 5 or 6.1) or TEST(SEPARATE,SOURCE) (for COBOL 6.2 and later) to get the most debugging functionality while controlling module size:

  – With TEST(SOURCE), the debug information is saved in a NOLOAD debug segment in the program object.

  – With TEST(SEPARATE,SOURCE), the debug information is saved in a separate debug file.
- You can use the NOTEST(DWARF) compiler option to include basic DWARF debugging information in the program object. You cannot debug such programs with z/OS Debugger, 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.

For details about the TEST option, see *TEST* in the *Enterprise COBOL for z/OS Programming Guide*.

For details about debugging COBOL programs using IBM z/OS Debugger, see *Choosing TEST or NOTEST compiler suboptions for COBOL programs* in the *IBM z/OS Debugger User's Guide*.

Listing information changes

With Enterprise COBOL 5 and 6.1, 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.

With Enterprise COBOL 6.2, the diagnostic messages are again at the bottom of the listing, as with Enterprise COBOL 4 and earlier compilers.

Changes that apply to Enterprise COBOL 6 only

- The allocation and management of WORKING-STORAGE SECTION have been changed since Enterprise COBOL 5. 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 192.

- Enterprise COBOL 6 uses interprocess communication (IPC) message queues within the compiler. 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.

- PPA1 changes in Enterprise COBOL 6.3

  Starting in Enterprise COBOL 6.3, bit 30 of flag3 (offset X'1C') of PPA1 may be set to indicate that the `Extended Flag field` is present. If this bit is set, the extended flag will have bit 0 set to indicate that `Vector Registers Area` is in the optional area. This should not affect tools or program code that are accessing PPA1 according to the Language Environment interface. Refer to the *z/OS Language Environment Vendor Interfaces* for details about PPA1.

When debugging your COBOL programs, you will find that there have been a large number of improvements and behavior changes introduced with Enterprise COBOL 5 and 6. For details about changes in debugging with IBM z/OS Debugger, see "z/OS Debugger changes with Enterprise COBOL 5 and 6" on page 241.

WORKING-STORAGE SECTION changes

The allocation and management of WORKING-STORAGE SECTION have been changed since Enterprise COBOL 5. 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 5 and 6 programs at run time.

To find the start of WORKING-STORAGE in COBOL 5 and 6, you need to know how to locate the PPA4 (Program Prologue Area 4) in a dump.

A: For AMODE 31

The following description applies when the program is compiled with LP(32):

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 5 or 6 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.

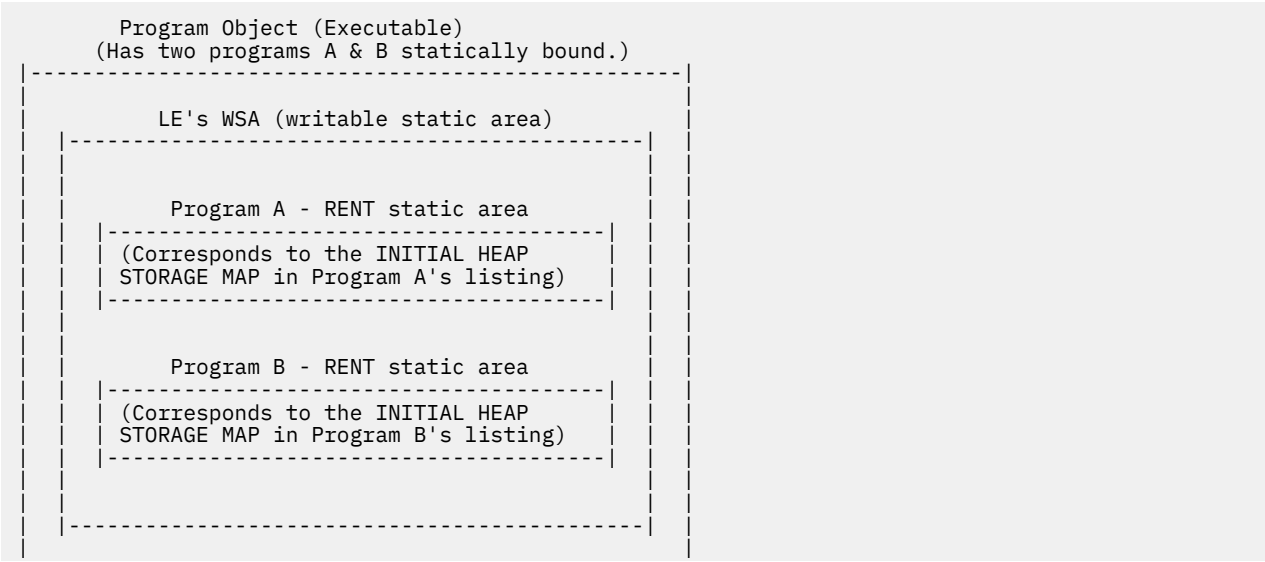
Explanation of the areas where WORKING-STORAGE can reside

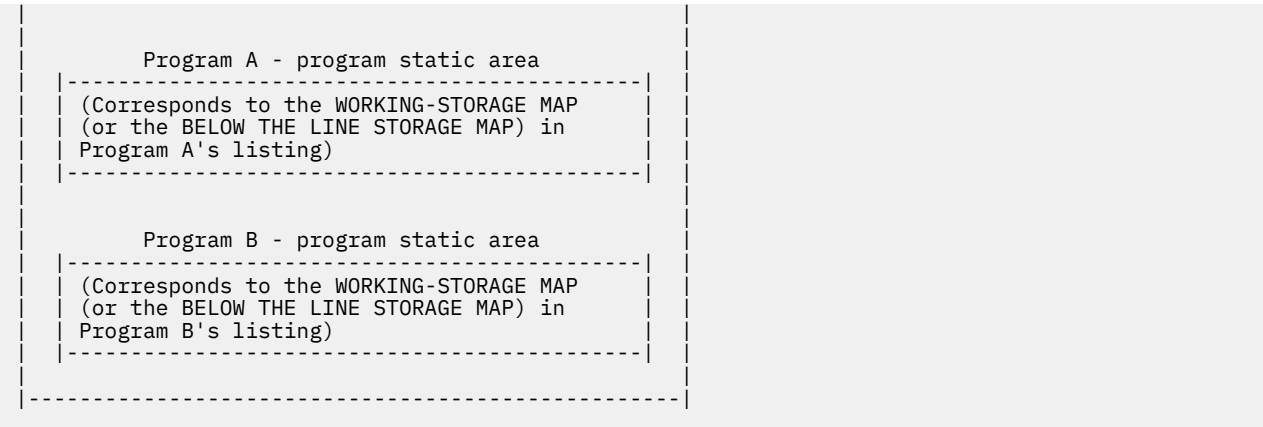
There are three different locations where WORKING-STORAGE can reside:

- 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 5 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 48. Area where WORKING-STORAGE is located

COBOL versions	**Compiler options**	**Where is WORKING-STORAGE located?**
COBOL 5	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 6 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

Table 48. Area where WORKING-STORAGE is located (continued)

COBOL versions	Compiler options	Where is WORKING-STORAGE located?

Notes:

1. In COBOL 5, there is a WSOPT compiler option. In COBOL 6, 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 49. 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 INITIAL HEAP STORAGE MAP shows the layout of the RENT static area or the NORENT static area.
- The WORKING-STORAGE MAP or the BELOW THE LINE STORAGE MAP shows the layout of the program static area.

B: For AMODE 64

The following information applies when the program is compiled with LP(64):

Information about the WORKING-STORAGE SECTION can be found in the PPA4 of the program together with the Heap Storage Address Table. Follow the steps below to locate them.

1. Find the entry point address of the program in the dump from the traceback. In the LE CEEDUMP traceback, this is the address under the "E Addr" column corresponding to the row of the program.

   In the example below, HELLO is the COBOL program. Its entry point address is X'260000A8'. This address should contain the first executable instruction of the program, that is, an STMG instruction.

```
Traceback:
  DSA     Entry        E  Offset    …
  1       CEEHDSP      +00003F3C
  2       CELQHROD     +00000266
  3       HELLO        +00000224
  4       CELQINIT     +00001D0C

  DSA     DSA Addr           E  Addr
  1       00000050082FBC60   0000000026B0A3D0
  2       00000050082FEDA0   0000000026B1DD18
  3       00000050082FEFA0   00000000260000A8
  4       00000050082FF220   0000000026903010
```

2. At program entry point offset -x'08', that is, before the entry point, there is an integer value. This value is the offset from the entry point address to PPA1.
3. At PPA1+x'04', there is an offset value. This is the offset from the entry point address to PPA2.
4. At PPA2+x'08', there is an offset value. This is the offset from PPA2 to PPA4.
5. At PPA4+x'7C', there is an offset value. This is the offset from the *environment* of the program to the Heap Storage Address Table.

Environment here refers to the XPLINK environment of the program. This is the address in register R5 on entry into the program. The first instruction of the program, the STMG, stores the register to the stack. The contents of R5 can be found in the dump.

Heap Storage Address Table

Offset of this table from the *environment* of the program is in PPA4+X'7C'.

Data items in WORKING-STORAGE SECTION in LP(64) are by default allocated above the bar. They are in COBOL's ABOVE THE BAR HEAP. Its starting address is in the first field of the Heap Storage Address Table (at offset X'00' of this table). Note that this address corresponds also to the ABOVE THE BAR HEAP MAP section in the compilation listing, which provides information about level 77 and 01 data items in the WORKING-STORAGE SECTION.

There are also COBOL control areas and compiler internal variables allocated in the ABOVE THE BAR HEAP. The first WORKING-STORAGE data item in the program might not reside right at the beginning. The offset of the first data item in the program's WORKING-STORAGE SECTION can be found in PPA4 offset +X'40'.

Table 50. Heap Storage Address Table

	Length	**Description**
X'00'	8	Starting Address of COBOL's ABOVE THE BAR HEAP (64-bit storage area)
X'08'	8	Reserved
X'10'	8	Reserved

Information relating to WOKRING-STORAGE SECTION can be summarized below:

Table 51. WORKING-STORAGE SECTION summary	
Description	**Can be found in:**
Offset of Heap Storage Address Table from R5	PPA4+x'7C'
Starting address of WORKING-STORAGE	Heap Storage Address Table + x'00'
Offset of first user 64-bit data item from WORKING-STORAGE	PPA4+x'40'
Length of the area containing all user WORKING-STORAGE 64-bit data items	PPA4+x'48'

For information about the layout of PPA4 and each PPA4 offset, length, and description, see COBOL 64-bit PPA4 layout in the *z/OS Language Environment Vendor Interfaces*.

C: 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 6.1, 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 INITIAL HEAP STORAGE 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 for z/OS Programming Guide*)

Related references
Example: Program prolog areas (*Enterprise COBOL for z/OS Programming Guide*)
Common interfaces and conventions (*z/OS Language Environment Vendor Interfaces*)

Chapter 21. Adding Enterprise COBOL 5 or 6 programs to existing COBOL applications

When you add an Enterprise COBOL 5 or 6 program to an existing application, you are either recompiling an existing program with Enterprise COBOL 5 or 6 or including a newly written Enterprise COBOL 5 or 6 program.

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

1. Add Language Environment to the LNKLST/LPALST. This moves Language Environment into production, and all COBOL applications will run under Language Environment by default.
   - The only COBOL runtime library present should be SCEERUN. Remove any instances of COBLIB, VSCLLIB, or COB2LIB in JCL STEPLIB or JOBLIB statements or in CICS startup JCL.
   - **Note:** Only use one library for a given language in LNKLST/LPALST. For example, if you install Language Environment with the COBOL component in LNKLST/LPALST, do not have the OS/VS COBOL library or the VS COBOL II library installed in LNKLST/LPALST.

   Optional: Add Language Environment to the STEPLIB JCL. This is a more gradual approach where Language Environment is phased in one region (CICS or IMS) or user (TSO) at a time.

   Note: Programs run slower and use more virtual storage with this approach than using LNKLST/LPALST to access Language Environment.
2. For programs compiled with NORES, use REPLACE linkage-editor control statements to replace the existing runtime library routines compiled with Language Environment versions.
3. Ensure that SCEERUN is the only COBOL runtime library available in LNKLST/LPALST. Remove any other COBOL runtime libraries present, such as COBLIB, VSCLLIB, or COB2LIB.
4. For VS COBOL II programs IGZEBST bootstrap models compiled with RES, do one of the following tasks:
   - Link to a runtime version of IGZEBST with APAR PN74000 applied
   - REPLACE with IGZEBST from Language Environment

If these steps have not been completed, please first complete all runtime migration activities in *Chapter 3. Planning the move to Language Environment* of the *Enterprise COBOL 4.2 Compiler and Runtime Migration Guide* prior to following the steps here.

When you add Enterprise COBOL 5 or 6 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 5 or 6. 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 5 or 6 and VS COBOL II programs

When running a mixture of VS COBOL II NORES programs and Enterprise COBOL 5 or 6 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 5 or 6 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 5 or 6 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 COBOL 5 or 6 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 5 or 6 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 5 or 6 programs

AMODE 24 execution of Enterprise COBOL 5.2 or 6 programs is supported in all the same cases as in earlier Enterprise COBOL compilers.

Note: To run COBOL 5 or 6 programs with AMODE 24, you must compile all COBOL programs with Enterprise COBOL 5.1.1 or later versions; or Enterprise COBOL 4.2 or earlier versions. If any component of a program object is compiled with Enterprise COBOL 5.1.0, 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 5 or 6 programs

You cannot mix Enterprise COBOL 5 or 6 programs with:

- OS/VS COBOL programs. You must migrate to Enterprise COBOL. To find any OS/VS COBOL programs, you can:
  - Use COBOL Upgrade Advisor for z/OS to run an inventory scan to discover what compiler versions are used in your load libraries or applications.
  - Enable Language Environment to put out a message whenever an OS/VS COBOL program is run. To enable this warning message, set up IGZEOPT.

    The following is an example of the embedded HLASM code inside the JCL:

```
IGZUOPT CSECT
IGZUOPT AMODE 31
IGZUOPT RMODE ANY
*
  IGZXOPT SUPP_OSV=ON * ON: Suppress warning
       * ONCE: Only issue 1 warning
       * OFF: issue warning
END
```

- 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 5 and later versions. When called by a program compiled with the 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 REPLACE ILBOABN and resolve the reference against the LE SCEELKED library. (ILBOABN0 is an alias of ILBOABN.)
- Change the COBOL program to use dynamic call for ILBOABN0.

RMODE restrictions with Enterprise COBOL 5 or 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 5.1.0 programs. Static calls between AMODE 24 programs and Enterprise COBOL 4.2 and earlier programs are supported for the cases where AMODE 24 is supported for Enterprise COBOL 4.2 and earlier programs.

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.

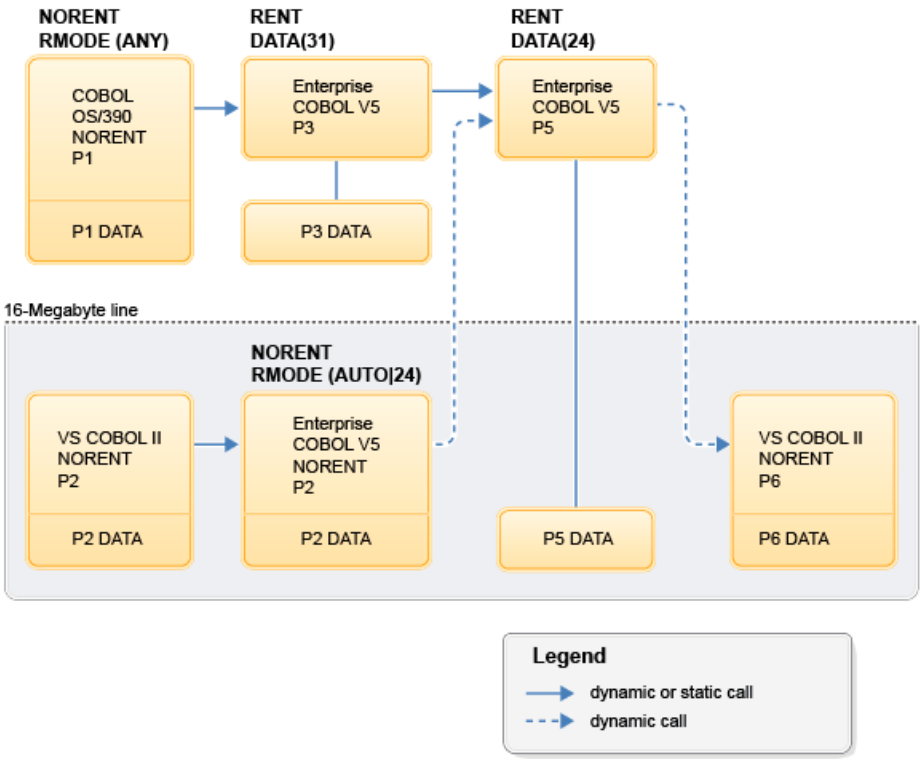


Figure 5. Examples of valid dynamic and static calls between different AMODE and RMODE COBOL programs

Note: For other AMODE 24 programs, no calls are allowed between Enterprise COBOL 5 or 6 programs and either OS/VS COBOL or VS COBOL II NORES programs.

Part 5. Enterprise COBOL migration and other IBM products

Enterprise COBOL 5 and 6 gives you access to CICS, Db2, IMS and other data and transactional systems. It can also be used with z/OS Debugger.

Chapter 22. IBM z/OS Debugger

IBM z/OS Debugger runs within Language Environment and supports a number of high-level languages, including Enterprise COBOL.

z/OS Debugger provides support for VS COBOL II 1.3 and all subsequent COBOL compilers.

Initiating z/OS Debugger

When you use z/OS Debugger, the application program starts first and the Language Environment TEST runtime option controls the invocation of z/OS Debugger.

You can also invoke z/OS Debugger 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 z/OS Debugger 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 z/OS Debugger 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 z/OS Debugger 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 z/OS Debugger to gain control, and to specify a string of commands to be passed to z/OS Debugger. Calling this service, causes Debug Tool to be initialized and invoked. (If z/OS Debugger is already initialized, then this re-entry is similar to a breakpoint.)

When using CEETEST to invoke z/OS Debugger, the string parameter containing a command list is optional. If you do use a command list, the commands are passed to z/OS Debugger 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), z/OS Debugger 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 5 and 6

Programs compiled with Enterprise COBOL 5 or 6 will have different debug information than that of programs compiled with previous versions of the compiler.

IBM Enterprise COBOL 5 and 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.

TEST option changes

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 z/OS Debugger. When the TEST(NOSOURCE) compiler option is specified, the generated DWARF debug information does not include the expanded source code.

  Tip: If you are using IBM z/OS Debugger, it is recommended that you specify TEST(SOURCE) (for COBOL 5 or 6.1) or TEST(SEPARATE,SOURCE) (for COBOL 6.2 and later) to get the most debugging functionality while controlling module size:

  – With TEST(SOURCE), the debug information is saved in a NOLOAD debug segment in the program object.
  – With TEST(SEPARATE,SOURCE), the debug information is saved in a separate debug file.
- You can use the NOTEST(DWARF) compiler option to include basic DWARF debugging information in the program object. You cannot debug such programs with z/OS Debugger, 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.

For details about the TEST option, see *TEST* in the *Enterprise COBOL for z/OS Programming Guide*.

For details about debugging COBOL programs using IBM z/OS Debugger, see *Choosing TEST or NOTEST compiler suboptions for COBOL programs* in the *IBM z/OS Debugger User's Guide*.

Listing information changes

With Enterprise COBOL 5 and 6.1, 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.

With Enterprise COBOL 6.2, the diagnostic messages are again at the bottom of the listing, as with Enterprise COBOL 4 and earlier compilers.

Changes that apply to Enterprise COBOL 6 only

- The allocation and management of WORKING-STORAGE SECTION have been changed since Enterprise COBOL 5. 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 192.
- Enterprise COBOL 6 uses interprocess communication (IPC) message queues within the compiler. 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.
- PPA1 changes in Enterprise COBOL 6.3

Starting in Enterprise COBOL 6.3, bit 30 of flag3 (offset X'1C') of PPA1 may be set to indicate that the `Extended Flag field` is present. If this bit is set, the extended flag will have bit 0 set to indicate that `Vector Registers Area` is in the optional area. This should not affect tools or program code that are accessing PPA1 according to the Language Environment interface. Refer to the *z/OS Language Environment Vendor Interfaces* for details about PPA1.

When debugging your COBOL programs, you will find that there have been a large number of improvements and behavior changes introduced with Enterprise COBOL 5 and 6. For details about changes in debugging with IBM z/OS Debugger, see "z/OS Debugger changes with Enterprise COBOL 5 and 6" on page 241.

z/OS Debugger changes with Enterprise COBOL 5 and 6

Programs compiled with Enterprise COBOL 5 and 6 will have many debugging advantages over programs compiled with previous versions of COBOL when debugged with z/OS Debugger.

For details about z/OS Debugger interfaces with COBOL applications, see the documentation available at: https://www.ibm.com/docs/en/debug-for-zos/latest?topic=overview-zos-debugger.

Most of these differences apply to all debugging modes: full screen, batch, and remote. Complete details of Debug Tool commands are described in *IBM z/OS Debugger References and Messages*.

DESCRIBE ATTRIBUTES commands

The `PIC` string shown in z/OS Debugger appears as it is specified in the source and not normalized as it was prior to Enterprise COBOL 5.

Level members are shown as written in the source code and not normalized as they were prior to Enterprise COBOL 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 5 and 6. 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.

z/OS Debugger 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 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.

z/OS Debugger 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. z/OS Debugger 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 5 and 6 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 5 and 6. The allowable comparison for relational conditions (involving data items, literals, and figurative constants) are implemented according to the Enterprise COBOL for z/OS Language Reference.

Index changes also improve the use of these commands:

- There is relative subscripting of index names with Enterprise COBOL 5 and 6.
- 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

z/OS Debugger 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 5 and 6, 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 5 and 6, 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 5 and 6, 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 5 and 6 supports an increment (+) or decrement (-) operator as part of the INDEX of an array. Enterprise COBOL 4 did not support this.

With Enterprise COBOL 5 and 6 programs, z/OS Debugger defaults to 1 if you do not specify the index of an array. With previous versions, z/OS Debugger listed all members of the array. If the array is declared as shown below, and you issue `LIST X`, z/OS Debugger 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 5 and 6, 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 5 and 6.

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 5 and 6. 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 5 and 6, the LIB|NOLIB option has been removed. The compiler behaves as though COPY, BASIS, or REPLACE statements are included in a program and searches for the specified library or libraries, 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 5 and 6. 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 5 and 6. The number of digits resulting from arithmetic operations are defined in the Enterprise COBOL for z/OS Programming Guide.

Sign is handled differently with Enterprise COBOL 5 and 6. 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 z/OS Debugger consistent with the compiler when it comes to resolving data item references.

z/OS Debugger 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 5 and 6

These changes apply to the Full-screen mode commands and functions.

The following commands are different between Enterprise COBOL 5 and 6 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 5 and 6 programs.
- `SET DYNDEBUG OFF`. COBOL 5 and 6 compiler does not support compiled-in hooks. You must have `SET DYNDEBUG ON` if you want to step or set breakpoints in a COBOL 5 or 6 program.
- `SET LIST BY SUBSCRIPT`. With COBOL 5 and 6 programs, z/OS Debugger displays arrays as if `LIST BY SUBSCRIPT ON` is always enabled. With Enterprise COBOL 4 programs, the default display on an array was `SET LIST BY SUBSCRIPT OFF`.
- `SET PROGRAMMING LANGUAGE`. The programming language for COBOL 5 and 6 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 5 or 6 program.

Remote mode changes with Enterprise COBOL 5 and 6

This section lists changes that apply to the remote debugger interfaces.

The changes are:

- With Enterprise COBOL 5 and 6, nodes in the tree of a monitored expression show the level number, for example, `05 VAR1`. With Enterprise COBOL 4, it showed `VAR1`.
- With Enterprise COBOL 5 and 6, `PIC` is shown as part of the type information, for example, `05 SBIN1 PIC 99 COMP`.
- With Enterprise COBOL 4, array type was shown as ARRAY. With Enterprise COBOL 5 and 6, 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 5 and 6, record types are shown as known to the language. For example, `ALPHANUMERIC GROUP` or `NATIONAL GROUP`. With Enterprise COBOL 4, record types were shown as CHARACTER, STRUCT, or ARRAY
- With programs compiled by Enterprise COBOL 5 and 6, array subscripts can be separated by a semicolon. This was not allowed for programs compiled with Enterprise COBOL 4 and is not allowed in full screen mode.

- With programs compiled by Enterprise COBOL 5 and 6, nested programs will now show in the Debug View.
- COBOL language provides a DECLARATIVES section to handle exceptional conditions. With Enterprise COBOL 5 and 6, when a DECLARATIVES section gets control in a z/OS Debugger session, the debug view shows a separate frame for it.

Chapter 23. Moving COBOL programs to newer levels of z/OS

IBM has received several reports of COBOL programs behaving differently when moving to z/OS 2.5 or later, for example, failing, wrong results, etc.

When moving COBOL programs from z/OS 2.4 or earlier to z/OS 2.5 or later, it can expose programs that have coding mistakes regarding setting addressability to LINKAGE SECTION data items. If addressability is not set, a reference to a LINKAGE SECTION data item will be a reference to a zero address, often called "low core". For many releases of z/OS the data in low core did not change, but there were changes in z/OS 2.5, resulting in some COBOL programs behaving differently when run in z/OS 2.5 or later compared to when they were run in z/OS 2.4 or earlier.

These invalid references to LINKAGE SECTION items with no addressability can be prevented by using the new LSACHECK compiler option. By using LSACHECK, references to LINKAGE SECTION data items will result in 0C4 ABENDs, instead of other behavior resulting from referring to random data.

IBM recommends that developers of COBOL programs use LSACHECK in development at all times, and maybe using LSACHECK in production as well. It is never a good idea to reference data items that have not had addressability set, and LSACHECK can prevent this from happening.

Chapter 24. CICS conversion considerations

To run COBOL 5 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:

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.

CSD setup differences with Enterprise COBOL 5 and 6

With the following CICS TS versions, CICS uses *system autoinstall* to install the modules required Enterprise COBOL 5 and 6 runtime so you do not need to update the CICS System Definition (CSD) file:

- CICS TS 5.4 and later
- CICS TS 5.3 with the PTF for APAR PI60389 applied
- CICS TS 5.1 and 5.2 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 5 and 6 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::

```
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 contained 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
Suppressing information in CEEDUMP processing (IGZ1OPT) (*Enterprise COBOL for z/OS Programming Guide*)
Controlling suppress of OS/VS COBOL warning messages (IGZ2OPT)
Requesting QSAM buffer above the line (IGZ3OPT)
Controlling initiation of QSAM buffer (IGZ4OPT)

DFHRPL setup differences with Enterprise COBOL 5 and 6

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 5.1 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.
```

Compiler options for programs that run under CICS

Table 52 on page 251 lists the compiler options for Enterprise COBOL programs that run under CICS.

Table 52. 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 52. 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 JSON PARSE, 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 5.2 and later versions support the EXCI translator option with the integrated CICS translator. In earlier versions than CICS 5.2, 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 53 on page 253 lists compiler options for Enterprise COBOL programs that use the integrated CICS translator.

Table 53. 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 5 or 6 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 5 or 6 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 25. 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 behavior between the Db2 precompiler and the integrated Db2 coprocessor and in code-page conversions.

Consider the following topics:

- Db2 coprocessor integration
- Language elements
- Code-page conversion

Starting with Db2 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=*
//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)
```

Differences between the Db2 precompiler and the integrated Db2 coprocessor

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.

Host variables defined in the FILE SECTION

Precompiler: Only gives a warning message for a host variable defined in the File Section, even though the Db2 Application Programming and SQL Guide clearly states that this is not allowed. Here is the message that the Db2 precompiler issues:

```
DSNH310I W csectname LINE nnnn COL cc language HOST VARIABLE name WAS DECLARED IN FILE
SECTION.
```

Coprocessor: Gives a severe error message for a host variable defined in the File Section. Here is the message that the Db2 coprocessor issues:

```
IGYPS0231-S SQL HOST VARIABLE name WAS DEFINED IN THE "FILE SECTION".
```

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 3.4.
  - 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 26. Moving IMS programs to Enterprise COBOL 5 or 6

If you use COBOL for IMS exit routines, pay attention to some restrictions with COBOL 5 and 6.

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 5 or 6. The exception is when the actual exit is an assembler program in a PDS data set that LOADs and calls a COBOL 5 or 6 program in a PDSE. To handle the cases with COBOL 5 or 6 and these users exits, you have the following choices:

- If the exit routine is COBOL, do not recompile with COBOL 5 or 6, but keep using the older COBOL version.
- If the exit routine is COBOL, change to use an assembler program that LOADs COBOL 5 or 6, or an older COBOL program that does a dynamic CALL to COBOL 5 or 6 for exit logic.
- If the exit routine is assembler that loads a COBOL program, recompile the COBOL program with COBOL 5 or 6, 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:

Table 54. 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 5 or 6 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 5 or 6 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 *Other product related factors that affect runtime performance* in the *Enterprise COBOL for z/OS Performance Tuning Guide*, for considerations on using LLA when the program object contains RMODE 24 CSECTs.

Appendix A. Appendixes

Frequently asked questions (FAQ)

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:

- Before migration
- 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?

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 6.

From a development perspective, migration means migrating an application: recompiling programs with the newer compiler to get the performance benefits and access to new features of COBOL.

Is migrating from COBOL 4 and earlier to COBOL 6 different than migrating from COBOL 3 to 4?

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.

Which COBOL 6 version should I choose to migrate to?

It is recommended that you migrate to the latest COBOL version (COBOL 6.5 that was released in June 2025) to benefit from the latest features and performance enhancements. To discover the latest features, see What's new in Enterprise COBOL for z/OS 6.5.

For a list of compatible hardware and software levels for the COBOL 6.5 compiler, see the Software Product Compatibility Reports (SPCR) website. To generate a product report from the SPCR website, search for "Enterprise COBOL for z/OS" under the **Product Reports** tab and choose version 6.5.

Why do I need to migrate?

The necessity is that EOS (End of Service) is announced for Enterprise COBOL 4 and 5. See IBM Software lifecycle website for more information.

The advantages of COBOL 6 are as follows:

- Fully exploiting IBM z/Architecture: Enterprise COBOL 6 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 6 from COBOL 4 and earlier compilers.

For improved application building and releasing, the DevOps tools are as follows:

- IBM Dependency Based Build
- IBM UrbanCode Deploy

For improved editing and debugging, the DevOps tools are as follows:

- IBM Developer for z/OS
- IBM Z and Cloud Modernization Stack

For automated testing and testing efficiency, the DevOps tools are as follows:

- IBM Z Virtual Test Platform

For efficient analyzing, the DevOps tools are as follows:

- IBM Application Discovery and Delivery Intelligence

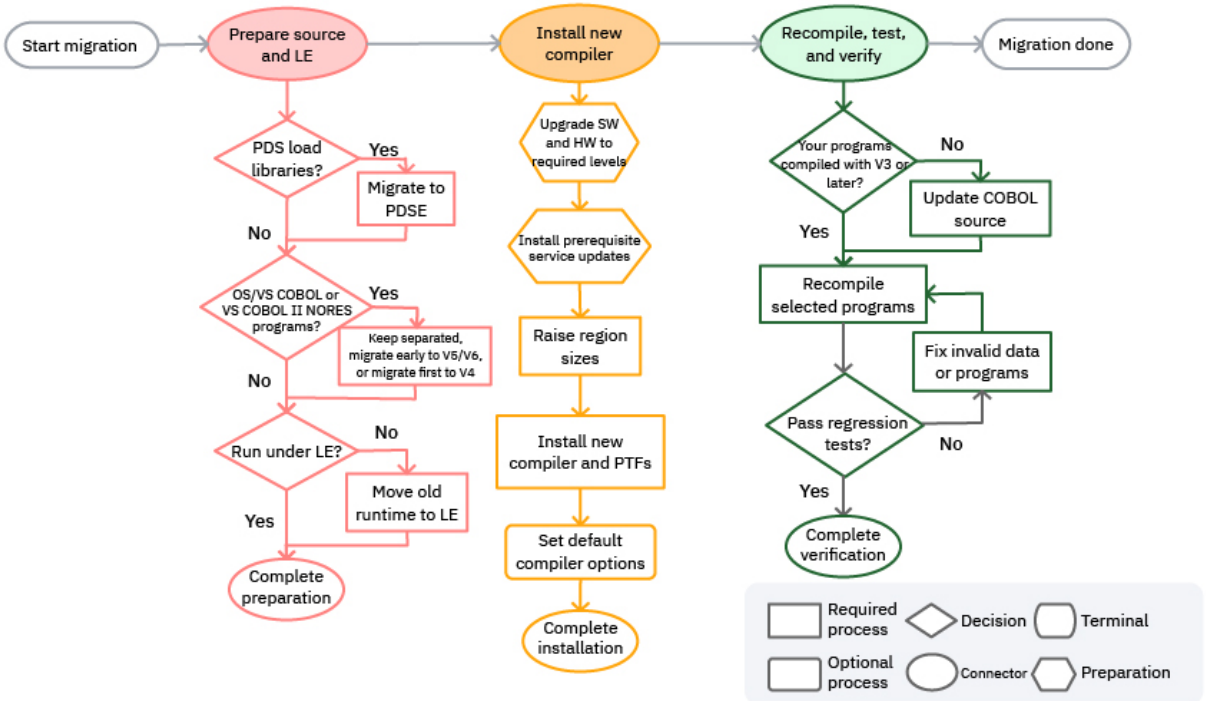
Do I need to recompile everything for the migration?

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 6.

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 can use IBM Automatic Binary Optimizer for z/OS (ABO) to improve the performance. For details about ABO, see the ABO product page.

Where can I get an overview of the complete migration process?

The following migration process diagram illustrates the whole migration process and Part 2, “Upgrade tasks,” on page 31 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?

It is recommended that you watch the recorded videos for the IBM Enterprise COBOL for z/OS 6 Migration Webinar and Performance Tuning Webinar on COBOL Migration and Performance Tuning Webinars.
The Migration Webinar helps you understand the migration process, tips, and tricks to avoid common pitfalls, and the Performance Tuning Webinar helps you understand how to take advantage of advanced optimization technology in the Enterprise COBOL 6 compiler to increase performance of your business-critical applications and reduce CPU usage.

If you still have questions after watching the webinar videos, contact the COBOL experts by filling out the questionnaire.

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 5 or 6, 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 behavior 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 6.1 without testing invalid data, when they moved up to COBOL 6.2 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 or an application 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 4 modules and COBOL 6 modules 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.

- “Is Enterprise COBOL 6 compatible with earlier versions of IBM COBOL?” on page 267
- “Does my IBM COBOL or Enterprise COBOL compiler support the latest IBM hardware and operating systems?” on page 267
- “Can OS/VS COBOL and VS COBOL II programs call Enterprise COBOL programs?” on page 268
- “Can programs compiled with Enterprise COBOL 3 or 4 call programs compiled with Enterprise COBOL 6?” on page 268
- “Can you convert programs selectively to Enterprise COBOL?” on page 268

Is Enterprise COBOL 6 compatible with earlier versions of IBM COBOL?

Enterprise COBOL 6 provides a high level of source compatibility, object compatibility, and runtime compatibility with earlier versions of IBM COBOL.

- **Enterprise COBOL 6 is source compatible with earlier versions of IBM COBOL. This means that the compiler will compile correct COBOL source programs that were developed using Enterprise COBOL 5, Enterprise COBOL 4, or earlier, with the exception of obsolete functions that were removed and the addition of new reserved words.** The removed functions include obsolete COBOL language syntax and obsolete compiler options. IBM does not expect that many applications will be affected by the removed functions, which in practice are no longer heavily used.

  It is recommended that you plan your source program upgrading by following the steps in Chapter 8, "Planning to upgrade source programs," on page 45. For details about source updating and recompiling, see appropriate topics in Part 3, "Upgrading programs," on page 59.
- **Enterprise COBOL 6 is object compatible with earlier versions of IBM COBOL. This means that applications can be constructed by using a mixture of object modules that are compiled with COBOL 6 and those compiled with earlier versions.** Both static calls (calls within a link-edited module) and dynamic calls (calls between programs link-edited as separate modules) can be used. The following are exceptions:
  - Interoperation with object modules that are compiled with OS/VS COBOL (5740-CB1) is not supported.
  - Interoperation with object modules that are compiled with VS COBOL II (5688-958) is limited to programs compiled with the RES compiler option. Interoperation with VS COBOL II programs that are compiled with the NORES option is not supported.

  For these OS/VS COBOL and VS COBOL II NORES programs, you must recompile them with Enterprise COBOL 6 so that they can work in the same application with Enterprise COBOL 6 programs. For details, see Chapter 21, "Adding Enterprise COBOL 5 or 6 programs to existing COBOL applications," on page 233.

  To improve the performance of your VS COBOL II NORES programs without recompiling, you can use the IBM Automatic Binary Optimizer for z/OS (ABO) product. However, the interoperation between COBOL 6 programs and ABO-optimized VS COBOL II NORES programs is not supported, either.
- **Enterprise COBOL 6 is runtime compatible with earlier versions of IBM COBOL. This means that COBOL programs using valid data will continue to produce the same runtime results after being recompiled with Enterprise COBOL 6.** A small number of exception cases and how to handle invalid data are documented in "Changes at run time with Enterprise COBOL 5 and 6" on page 217.

Does my IBM COBOL or Enterprise COBOL compiler support the latest IBM hardware and operating systems?

IBM COBOL and Enterprise COBOL compilers support forward compatibility with IBM hardware and operating systems. There are no known compatibility issues with running older versions of the COBOL compilers themselves on the latest hardware or the latest operating systems, nor are there any known compatibility issues with running the load modules or executables of these older compilers on the latest hardware and operating systems.

Depending on the functions used, you might require other software products such as CICS, Db2, or IMS. For a list of hardware, operating systems, or software products compatible with your IBM COBOL or Enterprise COBOL compiler, see the Software Product Compatibility Reports (SPCR) site.

Can OS/VS COBOL and VS COBOL II programs call Enterprise COBOL programs?

Under non-CICS, calls between OS/VS COBOL and Enterprise COBOL are not supported. Under CICS, OS/VS COBOL programs cannot run at all.

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 for z/OS 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 310 .

Can programs compiled with Enterprise COBOL 3 or 4 call programs compiled with Enterprise COBOL 6?

Yes, you can have applications with Enterprise COBOL 3, 4, and 6 programs and they can work well together. Enterprise COBOL 6 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 6 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 120.

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 for z/OS Programming Guide*.

How is Enterprise COBOL 6 different from previous versions?

Enterprise COBOL 6 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 6?

The removed features are the Millennium Language Extensions and LABEL declaratives. Learn more details at "COBOL source code differences in Enterprise COBOL 5 and 6" on page 201.

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?

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 in the *Enterprise COBOL for z/OS Programming Guide*: Use SSRANGE to have the compiler generate code that checks for out-of-range storage references.

- NUMCHECK in the *Enterprise COBOL for z/OS Programming Guide*: Use NUMCHECK to have the compiler generate extra code to validate data items when they are used as sending data items.
- PARMCHECK in the *Enterprise COBOL for z/OS Programming Guide*: 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 in the *Enterprise COBOL for z/OS Programming Guide*: 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 6 offers several new and substantially changed compiler options that can affect performance, and the recommended compiler option set for best performance is OPT(2), ARCH(x), and TUNE(y). For more information about performance tuning, see How to tune compiler options to get the most out of 6 in the *Enterprise COBOL for z/OS Performance Tuning Guide*.

To learn more migration best practices, see Chapter 5, "Upgrade recommendations and best practices," on page 37.

Regarding invalid data, is the testing done at run time?

Most testing is done at run time, but certain testing is done at compile time. Generally speaking, 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 23.

Can you compile programs written for VS COBOL II with Enterprise COBOL?

Yes. For details, see "Upgrading your source to Enterprise COBOL" on page 23.

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 File Manager View Load Module can determine the language translator for each object in your program objects. The File Manager View Load Module is included with the IBM File Manager for z/OS 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 6 only: what should I do if the compiler gives me a message about insufficient memory?

With Enterprise COBOL 6, 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 and 2014 COBOL Standard?

Enterprise COBOL supports many parts of the 2002 COBOL Standard and 2014 COBOL Standard. For details, see *2002/2014 COBOL Standard features implemented in Enterprise COBOL 3 or later versions* in the *Enterprise COBOL for z/OS 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), but Enterprise COBOL 6.4 has an LP(64) compiler option that enables programs to address the data above the bar (AMODE 64). Learn more about LP in the *Enterprise COBOL for z/OS Programming Guide*.

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?

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 4 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 5.1 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 5 or 6?

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 4 and 5 or 6?

If you use binder statements such as CHANGE to inspect or modify a 4 compiler generated symbol, you should use the AMBLIST utility to understand the symbols generated in COBOL 5 and 6 GOFF executables. For details, see AMBLST in the *MVS Program Management: User's Guide and Reference*.

The 5 and 6 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?

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 4.2 or earlier releases
- Compiled with the `DATA(24)` compiler option
- Running in CICS
- A COBOL 5.1.1 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 5.1.0 programs.
- A COBOL 5 program in a program object where the main entry point is COBOL 5. In this case, the program object can contain Language Environment interlanguage calls, with COBOL statically linking with C, C++ or PL/I. All COBOL 5 programs within such program objects (even if they are not the main entry point) have their `WORKING-STORAGE` allocated from heap storage.
- A COBOL 6.1 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?

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 6 programs?

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. Otherwise, assembler programs that currently interoperate with Enterprise COBOL 4 and earlier programs will continue to work fine with Enterprise COBOL 6 programs.

Is Enterprise COBOL 6 less compatible with non-LE-conforming assembler than Enterprise COBOL 4?

If your assembler programs are not LE-enabled (running well with LE), then problems may occur. Assembler programs do not need to be LE-conforming (using CEEENTRY and CEETERM macros), but they do need to be LE-enabled.

z/OS

Does COBOL run in 64-bit z/OS?

Yes. COBOL now supports AMODE 64 addressing in COBOL programs, and you can fully exploit AMODE 64 capabilities in COBOL programs. Even in AMODE 31, you can get some of the benefits of AMODE 64 z/OS just by moving to it. With an AMODE 64 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 AMODE 64 addressing for SQL statements in COBOL programs without any change 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?

Yes. Enterprise COBOL 5 and 6 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 for z/OS Performance Tuning Guide*.

How do I know the performance gains after recompiling with Enterprise COBOL 6?

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 4 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 4 modules that you backed up and your new COBOL 6 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 4 performance before migration with COBOL 6 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 28.

Object-oriented syntax, and Java 6 or later SDKs

How do I run existing COBOL applications with Java 6 or later?

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 or later, do these steps:

1. Recompile and relink the applications using Enterprise COBOL 5.2 or later.
2. Recompile the generated Java class that is associated with each object-oriented COBOL class using the `javac` command from Java 6 or later.

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 9, “Upgrading OS/VS COBOL source programs,” on page 61
- Chapter 11, “Upgrading VS COBOL II source programs,” on page 105
- Chapter 13, “Upgrading IBM COBOL source programs,” on page 115
- Chapter 15, “Upgrading programs from Enterprise COBOL 3,” on page 159
- Chapter 17, “Upgrading from Enterprise COBOL 4,” on page 171

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 55. 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
ALLOCATE[1]	X Reserved only in Enterprise COBOL 6.1 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

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
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
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
BYTE-LENGTH	X Reserved only in Enterprise COBOL 6.3 or later	-	-	-
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

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
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
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 2.2 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

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
COMPUTATIONAL-5	X	X Reserved only in COBOL for OS/390 & VM 2.2 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	-
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

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
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
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 6.1 or later	RFD	RFD	-
DELETE	X	X	X	X
DELIMITED	X	X	X	X
DELIMITER	X	X	X	X
DEPENDING	X	X	X	X

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
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	-
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	-

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
END-EXEC	X	X Reserved only in COBOL for OS/390 & VM 2.2 or later	-	-
END-IF	X	X	X	-
END-INVOKE	X	X	-	-
END-JSON[1]	X Reserved only in Enterprise COBOL 6.1 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	-
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

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
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 2.2 or later	-	-
EXECUTE	X	X Reserved only in COBOL for OS/390 & VM 2.2 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 2.2 or later	-	-
FALSE	X	X	X	-
FD	X	X	X	X
FILE	X	X	X	X
FILE-CONTROL	X	X	X	X

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
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	-
FREE[1]	X Reserved only in Enterprise COBOL 6.1 or later	RFD	RFD	-
FROM	X	X	X	X
FUNCTION	X	X	-	-
FUNCTION-ID	**RFD** In Enterprise COBOL 6.3 or earlier **X** Reserved since Enterprise COBOL 6.4	-	-	-
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	-	-	-

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
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
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
JAVA	X Reserved only in Enterprise COBOL 6.3 or later	-	-	-
JNIENVPTR[1]	X	-	-	-

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
JSON[1]	X Reserved only in Enterprise COBOL 6.1 or later	-	-	-
JSON-CODE[1]	X Reserved only in Enterprise COBOL 6.1 or later	-	-	-
JSON-STATUS[1]	X Reserved only in Enterprise COBOL 6.2 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
LIMIT	X Reserved only in Enterprise COBOL 6.3 or later	UNS	UNS	X
LIMITS	UNS	UNS	UNS	X
LINAGE	X	X	X	X
LINAGE-COUNTER	X	X	X	-
LINE	X	X	X	X
LINE-COUNTER	UNS	UNS	UNS	X
LINES	X	X	X	X

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
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
NULL	X	X	X	-
NULLS	X	X	X	-
NUMBER	UNS	UNS	UNS	X
NUMERIC	X	X	X	X

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
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
PLUS	UNS	UNS	UNS	X
POINTER	X	X	X	X
POINTER-24	RFD	-	-	-
POINTER-31	RFD	-	-	-

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
POINTER-32	X Reserved only in Enterprise COBOL 6.3 or later	-	-	-
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

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
RECORD	X	X	X	X
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

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
REWRITE	X	X	X	X
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

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
SORT-CONTROL	X	X	X	-
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 2.2 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	-	-

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
SUPPRESS	X	X	X	X
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

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
TRACKS	-	-	-	X
TRAILING	X	X	X	X
TRANSFORM	-	-	-	X
TRUE	X	X	X	-
TYPE	X	X Reserved only in COBOL for OS/390 & VM 2.2 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

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
UTF-8	X Reserved only in Enterprise COBOL 6.3 or later	-	-	-
VAL-STATUS	RFD	-	-	-
VALID	RFD	RFD	RFD	-
VALIDATE	RFD	RFD	RFD	-
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 5.2 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 4.2 or later	-	-	-
XML-NAMESPACE[1]	X Reserved only in Enterprise COBOL 4.1 or later	-	-	-

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
XML-NAMESPACE-PREFIX[1]	X Reserved only in Enterprise COBOL 4.1 or later	-	-	-
XML-NNAMESPACE[1]	X Reserved only in Enterprise COBOL 4.1 or later	-	-	-
XML-NNAMESPACE-PREFIX[1]	X Reserved only in Enterprise COBOL 4.1 or later	-	-	-
XML-NTEXT[1]	X	-	-	-
XML-SCHEMA[1]	X Reserved only in Enterprise COBOL 4.2 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 4.2 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

Table 55. Reserved word comparison (continued)

Reserved word	Enterprise COBOL	IBM COBOL	VS COBOL II	OS/VS COBOL
/	X	X	X	X
>	X	X	X	X
>=	X	X	X	-
=	X	X	X	X
*>[1]	X Reserved only in Enterprise COBOL 5.1 or later	-	-	-
::	RFD	-	-	-

Note:

1. This is a new reserved word that has been added since IBM COBOL.

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)
- FLAGMIG4 compiler option (Enterprise COBOL 4.2 with current service applied)
- 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

  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
- Alphanumeric literal IS mnemonic-name in SPECIAL NAMES
- REPORT clause of FD
- REPORT SECTION header
- USE BEFORE REPORTING declarative

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

FLAGMIG compiler option

The FLAGMIG option helps identify source statements that need to be converted to compile under Enterprise COBOL. FLAGMIG is available in compilers prior to Enterprise COBOL that support the CMPR2 option. If you are already using Enterprise COBOL 4.2, it is recommended that you use the FLAGMIG4 option (available in Enterprise COBOL 4.2 with current service applied) to help you migrate to Enterprise COBOL 5 or 6.

To get similar migration flagging, use "COBOL and CICS Command Level Conversion Aid for z/OS (CCCA)" on page 303, this *Migration Guide*, or a compiler released prior to Enterprise COBOL to compile programs that use FLAGMIG.

For details about using the FLAGMIG and CMPR2 options to aid you with migration to Enterprise COBOL, see "Upgrading programs compiled with the CMPR2 compiler option" on page 120.

If you are already using Enterprise COBOL 4.2 and want to migrate to Enterprise COBOL 5 or 6, use the FLAGMIG4 option to flag source code syntax-related changes required to move to Enterprise COBOL 5 or 6. For details, see "FLAGMIG4 compiler option" on page 22.

FLAGMIG4 compiler option

The FLAGMIG4 option helps you migrate to Enterprise COBOL 5 or 6. FLAGMIG4 is available in Enterprise COBOL 4.2 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 4 programs that are not supported, or that are supported differently in Enterprise COBOL 5 or 6. The compiler generates a warning diagnostic message for all such language elements.

Note: The source code changes for COBOL 5 and 6 are rarely used COBOL language features and do not affect 99% of COBOL users.

Conversion aid programs

Several conversion aid programs are available that offer you help in the conversion tasks.

The following programs help automate the conversion process, identify potential issues, and facilitate smoother migration:

- IBM COBOL and CICS Command Level Conversion Aid (CCCA)

  CCCA is bundled with IBM Debug for z/OS (IDz) 14.2 or earlier versions, and it is removed since IDz 15.0. After IDz 14.2 reached EOS on September 30, 2022, you can download CCCA from here at no charge.

  For details about CCCA, see "COBOL and CICS Command Level Conversion Aid for z/OS (CCCA)" on page 303.
- IBM COBOL Upgrade Advisor for z/OS (CUAZ)

  CUAZ accelerates and simplifies the upgrade to IBM Enterprise COBOL for z/OS with analysis and reporting in a modern Visual Studio Code (VS Code) interface.
- IBM COBOL Report Writer Precompiler

  COBOL Report Writer Precompiler helps to compile applications that contain Report Writer statements, or to permanently convert Report Writer statements to valid Enterprise COBOL statements.

- z/OS Debugger Load Module Analyzer can determine the language translator for each object in the program objects.

  z/OS Debugger Load Module Analyzer is included in Debug Tool.

COBOL and CICS Command Level Conversion Aid for z/OS (CCCA)

IBM COBOL and CICS Command Level Conversion Aid for z/OS (CCCA) converts CICS and non-CICS COBOL source programs and copybooks from old 68 COBOL Standard and 74 COBOL Standard languages to the 85 COBOL Standard language. IBM Enterprise COBOL for z/OS 3 and later compilers require source code to be at the 85 COBOL Standard level or later.

For a list of COBOL compilers, see Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3.

CCCA is bundled with IBM Debug for z/OS (IDz) 14.2 or earlier versions, and it is removed since IDz 15.0. After IDz 14.2 reached EOS on September 30, 2022, you can download CCCA from here at no charge.

CCCA is updated for reserved word conversions for Enterprise COBOL 5.1 by the PTF for APAR PM86253. For Enterprise COBOL 5.2, CCCA is updated for reserved word conversions by the PTF for APAR PI32750. For Enterprise COBOL 6.1, 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 IBM COBOL and CICS Command Level Conversion Aid User's Guide.

Frequently asked questions (FAQ) and answers about CCCA

This topic describes frequently asked questions and answers about CCCA.

When should I 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.

Do I need CCCA if I do not have applications built from earlier COBOL versions than Enterprise COBOL 3?

CCCA also supports converting applications from older to newer releases of Enterprise COBOL, for example, checking for data names that match new reserved words and systematically changing them as necessary.

Which z/OS levels is CCCA supported on?

CCCA is compatible with all releases of z/OS. It is like a user program, in that it runs without Authorized Program Facility (APF) authorization and only uses standard operating system interfaces, so it should continue to run on any current and future level of z/OS unless specifically notified otherwise. No specific maintenance is needed to run under z/OS.

Where can I find the CCCA documentation?

To learn more about CCCA and how to customize it, see the IBM COBOL and CICS Command Level Conversion Aid Program Directory.

To learn how to use CCCA, see the IBM COBOL and CICS Command Level Conversion Aid User's Guide.

Notes:

- The CCCA manuals have not been updated for a while, and the following information no longer applies:
  - Ordering CCCA via Shopz.

    For the latest information about how to obtain CCCA, see “How can I get CCCA and at what cost?” on page 304
  - Program support.

    If you have issues when using CCCA, see “How can I get support if I encounter issues with CCCA?” on page 305
  - Millennium language extensions (MLE) support.
  - Running CCCA under VM.
  - For OS/VS COBOL programs, recompile each program using OS/VS COBOL 2.4 before you input these programs to CCCA.
- The CCCA manuals might not include the latest updates for CCCA. For example, CCCA is updated for reserved word conversions by PTF for APAR PM86253, PTF for APAR PI32750, and PTF for APAR PI55980, due to new reserved words introduced in Enterprise COBOL 5.1, 5.2, and 6.1, respectively.

How can I get CCCA and at what cost?

CCCA is bundled with IBM Debug for z/OS (IDz) 14.2 or earlier versions, and it has been removed since IDz 15.0. After IDz 14.2 reached EOS on September 30, 2022, you can download CCCA from here at no charge.

How can I get support if I encounter issues with CCCA?

You can submit an issue in the COBOL community to report CCCA problems.

Which CICS TS (CICS) levels is CCCA compatible with?

CCCA support for CICS COBOL programs does not have any specific relationship to the CICS TS version.

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 ADDRESS 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 56 on page 306.

Statements dealing with the secondary BLLs are replaced by CONTINUE.

Table 56. 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 Upgrade Advisor for z/OS

IBM COBOL Upgrade Advisor for z/OS (CUAZ) helps simplify and accelerate the upgrade process to IBM Enterprise COBOL for z/OS 6.

CUAZ supports various COBOL upgrade scenarios across versions and editions. For a list of COBOL compilers, see Chapter 1, “COBOL compiler versions, required runtimes, and support information,” on page 3.

CUAZ offers automated inventory discovery and reporting in a modern Visual Studio Code (VS Code) interface. The program helps organizations to identify and address compiler issues including invalid code and data issues, understand the size and scope of their upgrade projects, and streamline the recompilation process.

The program is designed to help customers stay current with the Enterprise COBOL for z/OS 6 compiler release, and it includes the following benefits:

- Inventory insights
  - You see a visual summary of the COBOL inventory on the workstation that offers a complete view of the size of an upgrade project and recommendations for scoping it down.
  - You are provided with two inventory scanning systems, static and dynamic scans, that offer flexibility and accuracy in assessing COBOL inventory. Both scans provide insights into compiler versions, last compiled dates, compiler options, and other metadata. Also, the dynamic scan shows the programs that are used for each application. This feature can be useful for complex or traditional applications where it is unclear which programs are called and which programs are in scope for upgrade in a specific application.
  - You can re-run the inventory scan at regular intervals to track the progress of COBOL upgrade projects.
- Data export
  - You can export the COBOL inventory to a CSV file, to easily share COBOL inventory data with team members.
  - You can manipulate the CSV data file to create custom reports in any tool that supports CSV.
  - You can share insights with team members who cannot use VS Code.
- Upgrade readiness assessment
  - You can view major prerequisite tasks for each program, such as COBOL runtime updates or source code conversion to help teams prioritize any larger efforts before recompilation.
  - You can avoid reading a large volume of documentation to understand scenarios that are applicable to specific applications and make sure that the relevant but ambiguous upgrade tasks are not missed.
- Compiler option recommendations
  - You are provided with tailored recommendations for compiler option changes, enabling developers to optimize their applications and detect invalid data problems, when upgrading to IBM Enterprise COBOL for z/OS 6.

Other programs that aid conversion

Other programs, such as COBOL Report Writer Precompiler and z/OS Debugger Load Module Analyzer also offer you help in the conversion tasks.

COBOL Report Writer Precompiler

COBOL Report Writer Precompiler helps 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, contact SPC Systems.

COBOL Report Writer Precompiler offers the following features:

- Supports extended Report Writer language capabilities.
- Supports integration with the target COBOL compiler, as though Report Writer statements in the source program are processed by the COBOL compiler itself.
- Provides single consolidated source listing merges information from the precompiler listing and the COBOL compiler listings.
- Consists COPY library members that 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*.

z/OS Debugger Load Module Analyzer

z/OS Debugger 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.

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 5

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 85

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 57 on page 309 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.

Table 57. 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

Table 57. 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**
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

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 58 on page 311 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 58. 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
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 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, maintaining this initialization for subsequent invocations and bypassing most of the runtime environment setup and termination.

CAUTION: Although RTEREUS is beneficial for scenarios involving non-COBOL drivers repeatedly calling COBOL subprograms (for example, a non-LE-conforming assembler driver that repeatedly calls COBOL applications), using it significantly changes the behavior of COBOL programs. Before using RTEREUS, thoroughly explore the possible side effects and understand the impact on your application.

For details about the RTEREUS runtime option, see RTEREUS (COBOL only) in the *z/OS Language Environment Customization*.

Assembler programs that load and BALR to MAIN COBOL programs

Previous to Enterprise COBOL 5, 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 a couple of possible solutions:

- Compile with RENT.
- 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

Restriction: Language Environment cannot keep track of SVC delete, which can free storage, control areas, and file I/O areas associating with the program. Any files not closed by the program, or storage allocated for it, will not be freed properly by the Language Environment or the COBOL library. Subsequent access to these resources may lead to unpredictable results. In addition, 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

If assembler programs SVC delete load modules that contain these kinds of programs, unpredictable results can occur.

In general, for assembler programs that need to load and delete load modules that contain a COBOL program, the recommended method is one of the following. This applies to COBOL programs with RENT or NORENT options.

- 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 5 or 6 programs, because COBOL 5 and 6 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 5 or 6.

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 5 or 6 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 5 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 5 or 6 programs

You can find the program name (and PPA1) for COBOL 5 or 6 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 5 or 6 program

You can find the name of the calling programs from a COBOL 5 or 6 program at run time by using the LE service CEETBCK. For more information, see the *z/OS Language Environment Vendor Interfaces*.

Option comparison

The following table describes the Enterprise COBOL 5 and 6 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 3 and 4.

For complete descriptions of the Enterprise COBOL 5 and 6 options, see *Compiler options* in the *Enterprise COBOL for z/OS Programming Guide*.

Key:

X
The compiler option is available.

-
The compiler option is *not* available.

Table 59. Option comparison

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	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 IBM z/Architecture processors. • In Enterprise COBOL 5.1, 5.2, and 6.1, AFP(VOLATILE) is the default. • In Enterprise COBOL 6.2, AFP(NOVOLATILE) is the default.
ANALYZE	-	-	X Available only in COBOL for OS/390 & VM 2.1, or later	-	-	-	Causes the compiler to check the syntax of embedded SQL and CICS statements in addition to native COBOL statements.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
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.
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(10) 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.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
BUF	X	-	-	-	-	-	Allocates buffer storage for compiler work data sets. In Enterprise COBOL, the BUFSIZE option replaces the OS/VS COBOL BUF option.
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 1.2 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 4, but was tolerated with informational or warning messages to ease migration from 3 or prior versions. With Enterprise COBOL 5 and 6, CMPR2 option is no longer tolerated, and specifying it will result in an error message.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
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.
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.
CONDCOMP	-	-	-	-	-	X	Use CONDCOMP to control how conditional code will be displayed in the listing for programs with conditional compilation directives.
COPYLOC	-	-	-	-	-	X Available only in Enterprise COBOL 6.1 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.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
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.
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.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
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.
DEFINE	-	-	-	-	-	X Available only in Enterprise COBOL 6.1 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.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
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.
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 4.2 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.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
FLAGMIG	-	X	X	X	-	-	Specifies NOCMPR2 flagging for possible semantic changes from VS COBOL II 1.2 or other programs with CMPR2 behavior.
FLAGMIG4	-	-	-	X Available only in Enterprise COBOL 4.2 with service applied	-	-	APAR PM93450 for Enterprise COBOL 4.2 adds option FLAGMIG4 to identify language elements in Enterprise COBOL 4 programs that are not supported, or that are supported differently in Enterprise COBOL 5 or 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 5 and 6 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 IBM z/Architecture processors. HGPR(PRESERVE) is the default.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
INITCHECK	-	-	-	-	-	X Available only in Enterprise COBOL 6.1 with service applied, or later	Controls whether to check for uninitialized data items and issue warning messages when they are used without being initialized.
INITIAL	-	-	-	-	-	X Available only in Enterprise COBOL 6.2 with service applied, or later	Causes a program and all of its nested programs to behave as if the IS INITIAL clause was specified on the PROGRAM-ID paragraph.
INLINE	-	-	-	-	-	X Available only in Enterprise COBOL 6.1 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 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
INVDATA	-	-	-	-	-	Available only in Enterprise COBOL 6.2 with service applied, or later	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.
JAVAIOP	-	-	-	-	-	X Available only in Enterprise COBOL 6.4 or later	Controls the behavior of COBOL programs that interoperate with Java through the JAVA-CALLABLE or JAVA-SHAREABLE directives or by calling Java static methods using the CALL statement.
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.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
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.
LP	-	-	-	-	-	X Available only in Enterprise COBOL 6.3, or later	Indicates whether an AMODE 31 or AMODE 64 program should be generated with the related language features enabled. LP(32) is the default.
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 5.1 with the latest service installed, and Enterprise COBOL 5.2 and 6, 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 5.1 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 5 and 6 as in earlier COBOL compilers.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
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.
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 6.1 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 ERR0R checking for binary data items. For details, see *NUMCHECK* in the *Enterprise COBOL for z/OS Programming Guide*.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
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 for z/OS Customization Guide*.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	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 5 and 6. To migrate your programs that are compiled with NUMPROC(MIG) to Enterprise COBOL 6, use 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. For details, see *NUMCHECK* in the *Enterprise COBOL for z/OS Programming Guide*. NUMPROC(NOPFD) is the default.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	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 5, OPTIMIZE had the suboptions of (STD/FULL). The default was NOOPTIMIZE. In Enterprise COBOL 5 and 6, 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.
PARMCHECK	-	-	-	-	-	X Available only in Enterprise COBOL 6.1 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.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
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.
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.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
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 5.1 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.
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 5.1. The SIZE option is not supported in Enterprise COBOL 5.2.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
SMARTBIN	-	-	-	-	-	X Available only in Enterprise COBOL 6.4 or later	Instructs the compiler to generate modules containing additional binary metadata that enables them to be optimized by IBM Automatic Binary Optimizer (ABO) for z/OS 2.2. Default is SMARTBIN when LP(32) is in effect. SMARTBIN is not supported when LP(64) is in effect.
SOURCE	X	X	X	X	X	X	Produces a listing of the source program and embedded messages. SOURCE(DEC) is the default. From Enterprise COBOL 6.3 with the latest service installed, new suboptions HEX and DEC are added. If SOURCE(DEC) is in effect, the line numbers for the listing of the source will be in decimal format. If SOURCE(HEX) is in effect, the line numbers for the listing of the source will be in hexadecimal format.
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.
SQLIMS	-	-	-	-	X	X	Enables the IMS SQL coprocessor capability and specifies IMS suboptions. NOSQLIMS is the default.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
SSRANGE	-	X	X	X	X	X	At run time, checks validity of subscript, index, and reference modification references. In Enterprise COBOL 6.2, new suboptions MSG and ABD are added to control the runtime behavior of the COBOL program when a range check fails. In Enterprise COBOL 6.1, 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.
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.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
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 for z/OS Programming Guide*.
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.

Table 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
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 for z/OS Programming Guide*.
TUNE	-	-	-	-	-	X Available only in Enterprise COBOL 6.3 with service applied, or later	Specifies the architecture for which the executable program will be optimized. The default TUNE level matches the ARCH level if ARCH is specified. If ARCH is not specified, both ARCH and TUNE default to 10.
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 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	Usage notes
VLR	-	-	-	-	X Available only in Enterprise COBOL 5.1 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 5.2 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 4.1, or later	X Available only in Enterprise COBOL 5.1 with service applied, or later	X	For Enterprise COBOL 4 and later only (available in Enterprise COBOL 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 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 59. Option comparison (continued)

Option	OS/VS COBOL	VS COBOL II	IBM COBOL	Enterprise COBOL 3 and 4	Enterprise COBOL 5	Enterprise COBOL 6	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 5.1 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. In Enterprise COBOL 6.1 with the service PTFs and from 6.2, ZONECHECK is deprecated but is tolerated for compatibility. Use NUMCHECK(ZON) instead. For details, see *NUMCHECK* in the *Enterprise COBOL for z/OS Programming Guide*.
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.

Compiler limit comparison

The following table lists the compiler limits for Enterprise COBOL 5 and 6, 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 5 and 6	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

Language element	Enterprise COBOL 5 and 6	Other Enterprise COBOL versions	IBM COBOL and VS COBOL II	OS/VS COBOL
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	32,760-B	32,760-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
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				

Language element	Enterprise COBOL 5 and 6	Other Enterprise COBOL versions	IBM COBOL and VS COBOL II	OS/VS COBOL
77 data item size	With LP(32): 999,999,999 -B With LP(64): 2,147,483,646 -B	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 ( )	With LP(32): 999,999,999 With LP(64): 2,147,483,646	134,217,727	16,777,215	99,999
PICTURE symbol replication ( ), class DBCS items	With LP(32): 499,999,999 With LP(64): 1,073,741,823	67,108,863	8,388,607	N/A
PICTURE symbol replication ( ), class national items	With LP(32): 499,999,999 With LP(64): 1,073,741,823	67,108,863	N/A	N/A
PICTURE symbol replication (editing)	32,767	32,767	32,767	99,999
Elementary item size	With LP(32): 999,999,999 With LP(64): 2,147,483,646	134,217,727	16,777,215	32,767
OCCURS integer	With LP(32): 999,999,999 With LP(64): 2,147,483,646	134,217,727	4,194,303	65,535

Language element	Enterprise COBOL 5 and 6	Other Enterprise COBOL versions	IBM COBOL and VS COBOL II	OS/VS COBOL
Table size	With LP(32): 999,999,999 With LP(64): 2,147,483,646	134,217,727	8,388,607	32,767
Table element size	With LP(32): 999,999,999 With LP(64): 2,147,483,646	134,217,727		
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				

Language element	Enterprise COBOL 5 and 6	Other Enterprise COBOL versions	IBM COBOL and VS COBOL II	OS/VS COBOL
Total size of items without the EXTERNAL attribute	With LP(32): 2,147,483,646 -B With LP(64): Unlimited, up to the available 64-bit addressing capacity of the machine.	134,217,727-B	134,217,727-B	1,048,576
Total size of items with the EXTERNAL attribute	With LP(32): 2,147,483,646 -B With LP(64): Unlimited, up to the available 64-bit addressing capacity of the machine.	134,217,727-B	134,217,727-B	N/A
LINKAGE SECTION				
Total size	With LP(32): 2,147,483,646 -B With LP(64): Unlimited, up to the available 64-bit addressing capacity of the machine.	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]
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

Language element	Enterprise COBOL 5 and 6	Other Enterprise COBOL versions	IBM COBOL and VS COBOL II	OS/VS COBOL
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
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

Language element	Enterprise COBOL 5 and 6	Other Enterprise COBOL versions	IBM COBOL and VS COBOL II	OS/VS COBOL

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 2.10.0 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 for z/OS Programming Guide*.

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 for z/OS 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.

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.

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 5 and 6 NORENT programs to RMODE ANY.
- Do not change the AMODE of Enterprise COBOL 5.1.0 programs to AMODE 24. You can change the AMODE of Enterprise COBOL 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).

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.

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 60 on page 352. 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.
  - **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 60 on page 352. 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 for z/OS Programming Guide*
  - **COMPAT:** XML-CODE values are described in decimal in the *Enterprise COBOL for z/OS Programming Guide*.
  - **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 60. The predefined entity references	
Predefined entity	**Character**
&lt;	<
&gt;	>
&amp;	&
&apos;	'
&quot;	"

Controlling the suppression of the OS/VS COBOL warning messages (IGZ2OPT)

The COBOL runtime can detect the execution of an OS/VS program that is called or calls other programs. With each invocation of the OS/VS program, the COBOL runtime will issue a message IGZ0268W or IGZ0269W to inform you that an OS/VS program was invoked in your environment. The suppression of these messages is useful in environments such as IMS or CICS, where OS/VS programs are heavily used.

To control the number of OS/VS invocation warning messages issued, perform the following steps:

- In the Language Environment sample data set .SCEESAMP, copy and customize the sample JCL IGZ2OPT. Specify the SUPP_OSV option as directed below. Change the JOB card and load library name.
- Run this JCL to build the IGZUOPT module. JOB STEP1 of the JCL assembles this program which invokes a MACRO called IGZXOPT. This macro is used to specify special COBOL runtime options.
- Put the IGZUOPT module in a data set in the STEPLIB concatenation when running the application. For CICS, add the IGZUOPT module to the CSD.

When using the sample JCL IGZ2OPT to create IGZUOPT, specify the SUPP_OSV option with the following syntax:

```
IGZXOPT SUPP_OSV=OFF | ONCE | ON
```

You can set SUPP_OSV OFF, ONCE, or ON, and the default value is OFF. The IGZ0268W and IGZ0269W messages are suppressed based on the value specified:

- If OFF is specified, the IGZ0268W or IGZ0269W message is issued each time an OS/VS program is invoked in an application and the messages are not suppressed. For example, an OS/VS program that is invoked 5 times will issue 5 messages.
- If ONCE is specified, the IGZ0268W or IGZ0269W message is issued only once per OS/VS program, regardless of how many times that program is invoked within the application. This option is useful in an IMS/CICS environment where a large volume of OS/VS programs are being run.
- If ON is specified, no IGZ0268W or IGZ0269W messages will be issued, regardless of how many times that program is invoked within the application.

Requesting QSAM buffers above the line (IGZ3OPT)

If a program in Enterprise COBOL 5 or later is compiled with NORENT, RMODE(AUTO|24) and is running in AMODE 31, then when the COBOL runtime allocates QSAM buffers, it might be allocated below the line, which can cause region problems for an application. When this occurs, you can force the allocation of the QSAM buffers to be above the line.

To force the QSAM buffers to be allocated above the line, perform the following steps:

- In the Language Environment sample data set .SCEESAMP, copy and customize the sample JCL IGZ3OPT. Specify the QSAMBUFFATL option as directed below. Change the JOB card and load library name.

- Run this JCL to build the IGZUOPT module. JOB STEP1 of the JCL assembles this program which invokes a MACRO called IGZXOPT. This macro is used to specify special COBOL runtime options.
- Put the IGZUOPT module in a data set in the STEPLIB concatenation when running the application. For CICS, add the IGZUOPT module to the CSD.

When using the sample JCL IGZ3OPT to create IGZUOPT, specify the QSAMBUFFATL option with the following syntax:

```
IGZXOPT QSAMBUFFATL=OFF | ON
```

You can set QSAMBUFFATL OFF or ON, and the default value is OFF. The location of the QSAM buffers is controlled based on the value specified:

- If OFF is specified, the QSAM buffers will be allocated according to the normal documented behavior.
- If ON is specified, the QSAM buffers will be allocated above the line for a program in Enterprise COBOL 5 or later that is compiled with options NORENT, RMODE(AUTO|24) and running in AMODE 31.

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 5.1 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 5.1 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').

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* (http://publib.boulder.ibm.com/cgi-bin/bookmgr/BOOKS/ikj4p120)
- *z/OS TSO/E User's Guide* (http://publib.boulder.ibm.com/cgi-bin/bookmgr/BOOKS/ikj4c240/APPENDIX1.3)
- *z/OS ISPF User's Guide Volume I* (http://publib.boulder.ibm.com/cgi-bin/bookmgr/BOOKS/ispzug70)

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.

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 - 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*
- *ANSI X3.172-2002, American National Standard Dictionary for Information Systems*
- *INCITS/ISO/IEC 1989-2002, Information technology - Programming languages - COBOL*
- *INCITS/ISO/IEC 1989:2014, Information technology - Programming languages, their environments and system software interfaces - Programming language COBOL*

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 2 GB bar
Storage located above the so-called 2 GB bar (or boundary). This storage is only addressable by `AMODE 64` programs.

above the 16 MB line
Storage located above the so-called 16 MB line (or boundary) but below the 2 GB bar. This storage is not addressable by `AMODE 24` programs. 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 link-edited as `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 can have `AMODE 31` and can be loaded 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.

actual 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
- UTF-8
- UTF-16, either big-endian or little-endian
- Other unsupported encoding
- No recognizable encoding

*** 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 or both.

*** alphabetic character**
A letter or a space character.

alphanumeric character position
See *character position*.

alphabetic data item
A data item that is described with a PICTURE character string that contains only the symbol A. An alphabetic data item has USAGE DISPLAY.

*** alphanumeric character**
Any character in the single-byte character set of the computer.

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 alphanumeric character set of the computer.

alphanumeric group item
A group item that is defined without a GROUP-USAGE NATIONAL clause. For operations such as INSPECT, STRING, and UNSTRING, an alphanumeric group item is processed as though all its content were described as USAGE DISPLAY regardless of the actual content of the group. For operations that require processing of the elementary items within a group, such as MOVE CORRESPONDING, ADD CORRESPONDING, or INITIALIZE, an alphanumeric group item is processed using group semantics.

alphanumeric literal
A literal that has an opening delimiter from the following set: ', ", X', X", Z', or Z". The string of characters can include any character in the character set of the computer.

*** alternate record key**
A key, other than the prime record key, whose contents identify a record within an indexed file.

ANSI (American National Standards Institute)
An organization that consists of producers, consumers, and general-interest groups and establishes the procedures by which accredited organizations create and maintain voluntary industry standards in the United States.

argument
(1) An identifier, a literal, an arithmetic expression, or a function-identifier that specifies a value to be used in the evaluation of a function. (2) An operand of the USING phrase of a CALL or INVOKE statement, used for passing values to a called program or an invoked method.

*** arithmetic expression**
A numeric literal, an identifier representing a numeric elementary item, 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 ADD, COMPUTE, DIVIDE, MULTIPLY, and SUBTRACT.

array
An aggregate that consists of data objects, each of which can be uniquely referenced by subscripting. An array is 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 uses a coded character set that is based on 7-bit coded characters (8 bits including parity check). The standard is used for information interchange between data processing systems, data communication systems, and associated equipment. The ASCII set consists of control characters and graphic characters.

IBM has defined an extension to ASCII (characters 128-255).

ASCII DBCS
See *double-byte ASCII*.

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 but no physical representation.

AT END condition
A condition that is caused during the execution of a READ, RETURN, or SEARCH statement under certain conditions:

- A READ statement runs on a sequentially accessed file when no next logical record exists in the file, or when the number of significant digits in the relative record number is larger than the size of the relative key data item, or when an optional input file is not available.
- A RETURN statement runs when no next logical record exists for the associated sort or merge file.
- A SEARCH statement runs when the search operation terminates without satisfying the condition specified in any of the associated WHEN phrases.

B

basic character set
The basic set of characters used in writing words, character-strings, and separators of the language. The basic character set is implemented in single-byte EBCDIC. The extended character set includes DBCS characters, which can be used in comments, literals, and user-defined words.

Synonymous with *COBOL character set* in the 85 COBOL Standard.

batch compilation
Synonymous with *sequence of programs*.

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 that is represented in binary notation (on the base 2 numbering system). The decimal equivalent consists 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 can 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 records that are either contained within the block or that overlap the block. Synonymous with *physical record*.

boolean condition
A boolean condition determines whether a boolean literal is true or false. A boolean condition can only be used in a constant conditional expression.

boolean literal
Can be either B'1', indicating a true value, or B'0', indicating a false value. Boolean literals can only be used in constant conditional expressions.

breakpoint
A place in a computer program, usually specified by an instruction, where external intervention or a monitor program can interrupt the program as it runs.

buffer
A portion of storage that is used to hold input or output data temporarily.

built-in function
See *intrinsic function*.

business method
A method of an enterprise bean that implements the business logic or rules of an application. (Oracle)

byte
A string that consists of a certain number of bits, usually eight, treated as a unit, and representing a character or a control function.

byte order mark (BOM)
A Unicode character that can be used at the start of UTF-16 or UTF-32 text to indicate the byte order of subsequent text; the byte order can be either big-endian or little-endian.

bytecode
Machine-independent code that is generated by the Java compiler and executed by the Java interpreter. (Oracle)

C

callable services
In Language Environment, a set of services that a COBOL program can invoke by using the conventional Language Environment-defined call interface. All programs that share the Language Environment conventions can use these services.

called program
A program that is the object of a CALL statement. At run time the called program and calling program are combined to produce a *run unit*.

*** calling program**
A program that executes a CALL to another program.

canonical decomposition
A way to represent a single precomposed Unicode character using two or more Unicode characters. A canonical decomposition is typically used to separate latin letters with a diacritical mark so that the L atin letter and the diacritical mark are represented individually. See *precomposed character* for an example showing a precomposed Unicode character and its canonical decomposition.

case structure
A program-processing logic in which a series of conditions is tested in order to choose between a number of resulting actions.

cataloged procedure
A set of job control statements that are placed in a partitioned data set called the procedure library (SYS1.PROCLIB). You can use cataloged procedures to save time and reduce errors in coding JCL.

CCSID
See *coded character set identifier*.

century window
A 100-year interval within which any two-digit year is unique. Several types of century window are available to COBOL programmers:

- For the windowing intrinsic functions `DATE-TO-YYYYMMDD`, `DAY-TO-YYYYDDD`, and `YEAR-TO-YYYY`, you specify the century window with *argument-2*.
- For Language Environment callable services, you specify the century window in CEESCEN.

*** character**
The basic indivisible unit of the language.

character encoding unit
A unit of data that corresponds to one code point in a coded character set. One or more character encoding units are used to represent a character in a coded character set. Also known as *encoding unit*.

For `USAGE NATIONAL`, a character encoding unit corresponds to one 2-byte code point of UTF-16.

For `USAGE DISPLAY`, a character encoding unit corresponds to a byte.

For `USAGE DISPLAY-1`, a character encoding unit corresponds to a 2-byte code point in the DBCS character set.

character position
The amount of physical storage or presentation space required to hold or present one character. The term applies to any class of character. For specific classes of characters, the following terms apply:

- *Alphanumeric character position*, for characters represented in `USAGE DISPLAY`
- *DBCS character position*, for DBCS characters represented in `USAGE DISPLAY-1`
- *National character position*, for characters represented in `USAGE NATIONAL`; synonymous with *character encoding unit* for UTF-16

character set
A collection of elements that are used to represent textual information, but for which no coded representation is assumed. See also *coded character set*.

character string
A sequence of contiguous characters that form a COBOL word, a literal, a `PICTURE` character string, or a comment-entry. A character string 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 restarted later.

*** 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. Classes can be defined hierarchically, allowing one class to inherit from another.

class (object-oriented)
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, is wholly DBCS, is wholly Kanji, or consists exclusively of the characters that are listed in the definition of a class-name.

*** class definition**
The COBOL source unit that defines a class.

class hierarchy
A tree-like structure that shows relationships among object classes. It places one class at the top and one or more layers of classes below it. Synonymous with *inheritance hierarchy*.

*** class identification entry**
An entry in the `CLASS-ID` paragraph of the `IDENTIFICATION DIVISION`; this entry contains clauses that specify the class-name and assign selected attributes to the class definition.

class-name (object-oriented)
The name of an object-oriented COBOL class definition.

*** class-name (of data)**
A user-defined word that is defined in the `SPECIAL-NAMES` paragraph of the `ENVIRONMENT DIVISION`; this word assigns a name to the proposition (for which a truth value can be defined) that the content of a data item consists exclusively of the characters that are 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.

client
In object-oriented programming, a program or method that requests services from one or more methods in a class.

COBOL character set
The set of characters used in writing COBOL syntax. The complete COBOL character set consists of these characters:

Character	Meaning
0,1, . . . ,9	Digit
A,B, . . . ,Z	Uppercase letter
a,b, . . . ,z	Lowercase letter
	Space
+	Plus sign
-	Minus sign (hyphen)
*	Asterisk
/	Slant (forward slash)
=	Equal sign
$	Currency sign
,	Comma
;	Semicolon
.	Period (decimal point, full stop)

Character	Meaning
"	Quotation mark
'	Apostrophe
(	Left parenthesis
)	Right parenthesis
>	Greater than
<	Less than
:	Colon
_	Underscore

*** COBOL word**
See *word*.

code page
An assignment of graphic characters and control function meanings to all code points. For example, one code page could assign characters and meanings to 256 code points for 8-bit code, and another code page could assign characters and meanings to 128 code points for 7-bit code. For example, one of the IBM code pages for English on the workstation is IBM-1252 and on the host is IBM-1047. A *coded character set*.

code point
A unique bit pattern that is defined in a coded character set (code page). Graphic symbols and control characters are assigned to code points.

coded character set
A set of unambiguous rules that establish a character set and the relationship between the characters of the set and their coded representation. Examples of coded character sets are the character sets as represented by ASCII or EBCDIC code pages or by the UTF-16 encoding scheme for Unicode.

coded character set identifier (CCSID)
An IBM-defined number in the range 1 to 65,535 that identifies a specific code page.

*** 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 byte position within a print line or within a reference format line. The columns are numbered from 1, by 1, starting at the leftmost position of the line and extending to the rightmost position of the line. A column holds one single-byte character.

*** combined condition**
A condition that is the result of connecting two or more conditions with the `AND` or the `OR` logical operator. See also *condition* and *negated combined condition*.

combining characters
A Unicode character used to modify other succeeding or preceding Unicode characters. Combining characters are typically Unicode diacritical mark used to modify latin letters. See *precomposed character* for an example of combining character U+0308 (¨) used with latin letter U+0061 (a).

*** comment-entry**
An entry in the `IDENTIFICATION DIVISION` that is used for documentation and has no effect on execution.

comment line
A source program line represented by an asterisk (*) in the indicator area of the line or by an asterisk followed by greater-than sign (*>) as the first character string in the program text area (Area A plus Area B), and any characters from the character set of the computer that follow in Area A and Area B of that line. A comment line serves only for documentation. A special form of comment line represented

by a slant (/) in the indicator area of the line and any characters from the character set of the computer in Area A and Area B of that line causes page ejection before the comment is printed.

*** common program**
A program that, despite being directly contained within another program, can be called from any program directly or indirectly contained in that other program.

compilation group
Synonymous with *sequence of programs*.

compilation unit
A unit of COBOL source code that can be separately compiled: a program, class, user-defined function, or prototype definition. Also known as a source unit.

compilation variable
A symbolic name for a particular literal value or the value of a compile-time arithmetic expression as specified by the DEFINE directive or by the DEFINE compiler option.

*** 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 COBOL source code is translated, by a COBOL compiler, to a COBOL object program.

compile unit
The executable program unit, beginning with the first executable instruction and continuing to the last executable instruction. “Compile unit” does not include the non-executable instructions (DC) that may be present before the first executable instruction, as in a C program or an AMODE 64 COBOL program. Synonymous with *program unit*.

compile unit address
The address of the first executable instruction in a compile unit. Synonymous with program unit address (PU Addr) as found in a CEEDUMP traceback.

compile unit offset
The offset from the address of the first executable instruction in the compile unit to the address of the abend. Synonymous with program unit offset (PU Offset) as found in a CEEDUMP traceback.

compile-time arithmetic expression
A subset of arithmetic expressions that are specified in the DEFINE and EVALUATE directives or in a constant conditional expression. The difference between compile-time arithmetic expressions and regular arithmetic expressions is that in a compile-time arithmetic expression:

- The exponentiation operator shall not be specified.
- All operands shall be integer numeric literals or arithmetic expressions in which all operands are integer numeric literals.
- The expression shall be specified in such a way that a division by zero does not occur.

compiler
A program that translates source code written in a higher-level language into machine-language object code.

compiler-directing statement
A statement that causes the compiler to take a specific action during compilation. The standard compiler-directing statements are COPY, REPLACE, and USE.

*** complex condition**
A condition in which one or more logical operators act upon one or more conditions. See also *condition*, *negated simple condition*, and *negated combined condition*.

complex ODO
Certain forms of the OCCURS DEPENDING ON clause:

- Variably located item or group: A data item described by an OCCURS clause with the DEPENDING ON option is followed by a nonsubordinate data item or group. The group can be an alphanumeric group or a national group.
- Variably located table: A data item described by an OCCURS clause with the DEPENDING ON option is followed by a nonsubordinate data item described by an OCCURS clause.
- Table with variable-length elements: A data item described by an OCCURS clause contains a subordinate data item described by an OCCURS clause with the DEPENDING ON option.
- Index name for a table with variable-length elements.
- Element of a table with variable-length elements.

component
(1) A functional grouping of related files. (2) In object-oriented programming, a reusable object or program that performs a specific function and is designed to work with other components and applications. JavaBeans is Oracle's architecture for creating components.

composed form
Representation of a precomposed Unicode character through a canonical decomposition. See *precomposed character* for details.

*** computer-name**
A system-name that identifies the computer where the program is to be compiled or run.

condition (exception)
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 or the operating system and result in an interrupt. They can also be detected by language-specific generated code or language library code.

condition (expression)
A status of data at run time for which a truth value can be determined. Where used in this information in or in reference to "condition" (*condition-1*, *condition-2*,. . .) of a general format, the term refers to a conditional expression that consists 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. See also *simple condition*, *complex condition*, *negated simple condition*, *combined condition*, and *negated combined condition*.

*** 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 phrase that specifies the action to be taken upon determination of the truth value of a condition that results from the execution of a conditional statement.

*** conditional statement**
A statement that specifies that the truth value of a condition is to be determined and that the subsequent action of the object program depends 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 can assume; or a user-defined word assigned to a status of an implementor-defined switch or device.

*** 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.

constant conditional expression
A subset of conditional expressions that may be used in IF directives or WHEN phrases of the EVALUATE directives.

A constant conditional expression shall be one of the following items:

- A relation condition in which both operands are literals or arithmetic expressions that contain only literal terms. The condition shall follow the rules for relation conditions, with the following additions:
  - The operands shall be of the same category. An arithmetic expression is of the category numeric.
  - If literals are specified and they are not numeric literals, the relational operator shall be "IS EQUAL TO", "IS NOT EQUAL TO", "IS =", "IS NOT =", or "IS <>".

  See also *relation condition*.
- A defined condition. See also *defined condition*.
- A boolean condition. See also *boolean condition*.
- A complex condition formed by combining the above forms of simple conditions into complex conditions by using AND, OR, and NOT. Abbreviated combined relation conditions shall not be specified. See also *complex condition*.

contained program
A COBOL program that is nested within another COBOL program.

*** contiguous items**
Items that are described by consecutive entries in the DATA DIVISION, and that bear a definite hierarchic relationship to each other.

copybook
A file or library member that contains 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. Synonymous with *copy file*.

*** 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 on where files, fields, and indicators are defined, referenced, and modified in a program.

currency-sign value
A character string that identifies the monetary units stored in a numeric-edited item. Typical examples are $, USD, and EUR. A currency-sign value can be defined by either the CURRENCY compiler option or the CURRENCY SIGN clause in the SPECIAL-NAMES paragraph of the ENVIRONMENT DIVISION. If the CURRENCY SIGN clause is not specified and the NOCURRENCY compiler option is in effect, the dollar sign ($) is used as the default currency-sign value. See also *currency symbol*.

currency symbol
A character used in a PICTURE clause to indicate the position of a currency sign value in a numeric-edited item. A currency symbol can be defined by either the CURRENCY compiler option or the CURRENCY SIGN clause in the SPECIAL-NAMES paragraph of the ENVIRONMENT DIVISION. If the CURRENCY SIGN clause is not specified and the NOCURRENCY compiler option is in effect, the dollar sign ($) is used as the default currency sign value and currency symbol. Multiple currency symbols and currency sign values can be defined. See also *currency sign value*.

*** 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
The division of a COBOL program or method that describes the data to be processed by the program or method: the files to be used and the records contained within them; internal WORKING-STORAGE records that will be needed; data to be made available in more than one program in the COBOL run unit.

*** data item**
A unit of data (excluding literals) defined by a COBOL program or by the rules for function evaluation.

data set
Synonym for *file*.

*** 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
See *double-byte character set (DBCS)*.

DBCS character
Any character defined in IBM's double-byte character set.

DBCS character position
See *character position*.

DBCS data item
A data item that is described by a PICTURE character string that contains at least one symbol G, or, when the NSYMBOL(DBCS) compiler option is in effect, at least one symbol N. A DBCS data item has USAGE DISPLAY-1.

*** debugging line**
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 that consists 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 DECLARATIVE 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 the unedited numeric value of the item.

defined condition
A compile-time condition that tests whether a compilation variable is defined. Defined conditions are specified in IF directives or WHEN phrases of the EVALUATE directives.

*** 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.

dependent region
In IMS, the MVS virtual storage region that contains message-driven programs, batch programs, or online utilities.

*** 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 to refer to any other symbol.

*** digit position**
The amount of physical storage required to store a single digit. This amount can 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.

display floating-point data item
A data item that is described implicitly or explicitly as `USAGE DISPLAY` and that has a `PICTURE` character string that describes an external floating-point data item.

*** 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 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 (DLL)*.

DLL application
An application that references imported programs, functions, or variables.

DLL linkage
A `CALL` in a program that has been compiled with the `DLL` and `NODYNAM` options; the `CALL` resolves to an exported name in a separate module, or to an `INVOKE` of a method that is defined in a separate module.

do construct
In structured programming, a DO statement is used to group a number of statements in a procedure. In COBOL, an inline `PERFORM` statement functions in the same way.

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.

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.

document type definition (DTD)
The grammar for a class of XML documents. See *document type declaration*.

double-byte ASCII
An IBM character set that includes DBCS and single-byte ASCII characters. (Also known as ASCII DBCS.)

double-byte EBCDIC
An IBM character set that includes DBCS and single-byte EBCDIC characters. (Also known as EBCDIC DBCS.)

double-byte character set (DBCS)
A set of characters in which each character is represented by 2 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 2 bytes, entering, displaying, and printing DBCS characters requires hardware and supporting software that are DBCS-capable.

DWARF
DWARF was developed by the UNIX International Programming Languages Special Interest Group (SIG). It is designed to meet the symbolic, source-level debugging needs of different languages in a unified fashion by supplying language-independent debugging information. A DWARF file contains debugging data organized into different elements. For more information, see *DWARF program information* in the *DWARF/ELF Extensions Library Reference*.

*** 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 CALL
A CALL *literal* statement in a program that has been compiled with the DYNAM option and the NODLL option, or a CALL *identifier* statement in a program that has been compiled with the NODLL option.

dynamic-length
An adjective describing an item whose logical length might change at runtime.

dynamic-length elementary item
An elementary data item whose data declaration entry contains the DYNAMIC LENGTH clause.

dynamic-length group
A group item that contains a subordinate dynamic-length elementary item.

dynamic link library (DLL)
A file that contains executable code and data that are bound to a program at load time or run time, rather than during linking. Several applications can share the code and data in a DLL simultaneously. Although a DLL is not part of the executable file for a program, it can be required for an executable file to run properly.

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). A DSA is allocated upon invocation of a program or function and persists for the duration of the invocation instance. DSAs are generally allocated within stack segments managed by Language Environment.

E

*** EBCDIC (Extended Binary-Coded Decimal Interchange Code)**
A coded character set based on 8-bit coded characters.

EBCDIC character
Any one of the symbols included in the EBCDIC (Extended Binary-Coded-Decimal Interchange Code) set.

EBCDIC DBCS
See *double-byte EBCDIC*.

edited data item
A data item that has been modified by suppressing zeros or inserting editing characters or both.

*** 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 (forward slash)

EGCS
See *extended graphic character set (EGCS)*.

EJB
See *Enterprise JavaBeans*.

EJB container
A container that implements the EJB component contract of the J2EE architecture. This contract specifies a runtime environment for enterprise beans that includes security, concurrency, life cycle management, transaction, deployment, and other services. An EJB container is provided by an EJB or J2EE server. (Oracle)

EJB server
Software that provides services to an EJB container. An EJB server can host one or more EJB containers. (Oracle)

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.

encapsulation
In object-oriented programming, the technique that is used to hide the inherent details of an object. The object provides an interface that queries and manipulates the data without exposing its underlying structure. Synonymous with *information hiding*.

enclave
When running under Language Environment, an enclave is analogous to a run unit. An enclave can create other enclaves by using `LINK` and by using the system() function in C.

encoding unit
See *character encoding unit*.

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.
```

enterprise bean
A component that implements a business task and resides in an EJB container. (Oracle)

Enterprise JavaBeans
A component architecture defined by Oracle for the development and deployment of object-oriented, distributed, enterprise-level applications.

*** 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.

entry offset
The offset from the address of the first executable instruction to which control was passed when the program was invoked to the address of the abend.

entry point
The address or label of the first instruction that is executed when a routine is entered for execution. Within a load module/program object it is the location to which control is passed when the load module is invoked.

An entry point can be a main entry point (first executable instruction) in a program, or an alternate entry point defined in the program to which control is passed when the program is invoked.

*** 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 where the source program is compiled and those where the object program is run. It 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, program switches or all of these. When an environment-name is associated with a mnemonic-name in the ENVIRONMENT DIVISION, the mnemonic-name can be substituted in any format in which such substitution is valid.

environment variable
Any of a number of variables that define some aspect of the computing environment, and are accessible to programs that operate in that environment. Environment variables can affect the behavior of programs that are sensitive to the environment in which they operate.

escape sequence
A sequence of characters that are used to represent certain special characters within string literals and character literals.

Escape sequences consist of two or more characters, the first of which is the backslash (\) character, which is called the "escape character"; the remaining characters determine the interpretation of the escape sequence. For example, `\n` is an escape sequence that denotes a newline character.

Escape sequences are used in programming languages such as C, C++, Java, or Python. COBOL does not have the concept of "escape sequence" or "escape character". To handle special characters within COBOL literals, see *Basic alphanumeric literals* and *DBCS literals* in the *Enterprise COBOL for z/OS Language Reference*.

execution time
See *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 that indicates the power to which another number (the base) is to be raised. Positive exponents denote multiplication; negative exponents denote division; and 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.

extended graphic character set (EGCS)
A graphic character set, such as a kanji character set, that requires two bytes to identify each graphic character. It is refined and replaced by *double-byte character set (DBCS)*.

Extensible Markup Language
See *XML*.

extensions
COBOL syntax and semantics supported by IBM compilers in addition to those described in the 85 COBOL Standard.

external code page
For XML documents, the value specified by the `CODEPAGE` compiler option.

*** external data**
The data that is described in a program as external data items and external file connectors.

*** external data item**
A data item that is described as part of an external record in one or more programs of a run unit and that can be referenced from any program in which it is described.

*** external data record**
A logical record that is described in one or more programs of a run unit and whose constituent data items can be referenced from any program in which they are described.

external decimal data item
See *zoned decimal data item* and *national decimal data item*.

*** external file connector**
A file connector that is accessible to one or more object programs in the run unit.

external floating-point data item
See *display floating-point data item* and *national floating-point data item*.

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

factory data
Data that is allocated once for a class and shared by all instances of the class. Factory data is declared in the WORKING-STORAGE SECTION of the DATA DIVISION in the FACTORY paragraph of the class definition, and is equivalent to Java private static data.

factory method
A method that is supported by a class independently of an object instance. Factory methods are declared in the FACTORY paragraph of the class definition, and are equivalent to Java public static methods. They are typically used to customize the creation of objects.

*** figurative constant**
A compiler-generated value referenced through the use of certain reserved words.

*** file**
A collection of logical records.

*** 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 that 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 that declare the relevant physical attributes of a file.

FILE-CONTROL paragraph
A paragraph in the ENVIRONMENT DIVISION in which the data files for a given source unit are declared.

*** 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 available, 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
The collection of files that conform to a specific set of data-record and file-description protocols, and a set of programs that manage these files.

*** fixed file attributes**
Information about a file that is established when a file is created and that 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 bytes.

fixed-point item
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 can be either binary, packed decimal, or external decimal.

floating comment indicators (*>)
A floating comment indicator indicates a comment line if it is the first character string in the program-text area (Area A plus Area B), or indicates an inline comment if it is after one or more character strings in the program-text area.

floating point
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.

floating-point data item
A numeric data item that contains 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 that the exponent specifies.

*** format**
A specific arrangement of a set of data.

*** function**
A temporary data item whose value is determined at the time the function is referenced during the execution of a statement.

*** 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 can include a reference-modifier. A function-identifier that references an alphanumeric function can be specified anywhere in the general formats that an identifier can be specified, subject to certain restrictions. A function-identifier that references an integer or numeric function can be referenced anywhere in the general formats that an arithmetic expression can be specified.

function-name
A word that names the mechanism whose invocation, along with required arguments, determines the value of a function.

function-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 FUNCTION-POINTER clause contains the address of a function entry point. Typically used to communicate with C and Java programs.

G

garbage collection
The automatic freeing by the Java runtime system of the memory for objects that are no longer referenced.

*** global name**
A name that is declared in only one program but that can be referenced from the program and from any program contained within the program. Condition-names, data-names, file-names, record-names, report-names, and some special registers can be global names.

global reference
A reference to an object that is outside the scope of a method.

group item
(1) A data item that is composed of subordinate data items. See *alphanumeric group item* and *national group item*. (2) When not qualified explicitly or by context as a national group or an alphanumeric group, the term refers to groups in general.

grouping separator
A character used to separate units of digits in numbers for ease of reading. The default is the character comma.

H

header label
(1) A data-set label that precedes the data records in a unit of recording media. (2) Synonym for *beginning-of-file label*.

hide (a method)
To redefine (in a subclass) a factory or static method defined with the same method-name in a parent class. Thus, the method in the subclass *hides* the method in the parent class.

*** high-order end**
The leftmost character of a string of characters.

hiperspace
In a z/OS environment, a range of up to 2 GB of contiguous virtual storage addresses that a program can use as a buffer.

I

IBM COBOL extension
COBOL syntax and semantics supported by IBM compilers in addition to those described in the 85 COBOL 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, class, or method. The IDENTIFICATION DIVISION can 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 that is a function, a function-identifier is used.

IGZCBSN
The bootstrap routine for COBOL/370 1.1. It must be link-edited with any module that contains a COBOL/370 1.1 program.

IGZCBSO
The bootstrap routine for COBOL for MVS & VM 1.2, COBOL for OS/390 & VM and Enterprise COBOL. It must be link-edited with any module that contains a COBOL for MVS & VM 1.2, 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 can consist of a sequence of imperative statements.

*** implicit scope terminator**
A separator period that terminates the scope of any preceding unterminated statement, or a phrase of a statement that 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
A mechanism for using the implementation of a class as the basis for another class. By definition, the inheriting class conforms to the inherited classes. Enterprise COBOL does not support *multiple inheritance*; a subclass has exactly one immediate superclass.

inheritance hierarchy
See *class hierarchy*.

*** 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.

inline comments
An inline comment is identified by a floating comment indicator (*>) preceded by one or more character-strings in the program-text area, and can be written on any line of a compilation group. All characters that follow the floating comment indicator up to the end of area B are comment text.

*** 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 at run time.

*** input-output statement**
A statement that causes files to be processed by performing operations on individual records or on 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 that defines the state of an object. The instance data introduced by a class is defined in the WORKING-STORAGE SECTION of the DATA DIVISION in the OBJECT paragraph of the class definition. The state of an object also includes the state of the instance variables introduced by 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.

Interactive System Productivity Facility (ISPF)
An IBM software product that provides a menu-driven interface for the TSO or VM user. ISPF includes library utilities, a powerful editor, and dialog management.

interlanguage communication (ILC)
The ability of routines written in different programming languages to communicate. ILC support lets you readily build applications from component routines written in a variety of languages.

intermediate result
An intermediate field that contains the results of a succession of arithmetic operations.

*** internal data**
The data that is described in a program and excludes 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 that is described in one program in a run unit. An internal data item can have a global name.

internal decimal data item
A data item that is described as USAGE PACKED-DECIMAL or USAGE COMP-3, and that has a PICTURE character string that defines the item as numeric (a valid combination of symbols 9, S, P, or V). Synonymous with *packed-decimal data item*.

*** internal file connector**
A file connector that is accessible to only one object program in the run unit.

internal floating-point data item
A data item that is described as USAGE COMP-1 or USAGE COMP-2. COMP-1 defines a single-precision floating-point data item. COMP-2 defines a double-precision floating-point data item. There is no PICTURE clause associated with an internal floating-point data item.

*** intrarecord data structure**
The entire collection of groups and elementary data items from a logical record that a contiguous subset of the data description entries defines. 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 run time, caused when a specific value of the key associated with an indexed or relative file is determined to be not valid.

*** 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; this entry 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 that 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.

is-a
A relationship that characterizes classes and subclasses in an inheritance hierarchy. Subclasses that have an is-a relationship to a class inherit from that class.

ISPF
See *Interactive System Productivity Facility (ISPF)*.

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.

J

J2EE
See *Java 2 Platform, Enterprise Edition (J2EE)*.

Java 2 Platform, Enterprise Edition (J2EE)
An environment for developing and deploying enterprise applications, defined by Oracle. The J2EE platform consists of a set of services, application programming interfaces (APIs), and protocols that provide the functionality for developing multitiered, Web-based applications. (Oracle)

Java Batch Launcher and Toolkit for z/OS (JZOS)
A set of tools that helps you develop z/OS Java applications that run in a traditional batch environment, and that access z/OS system services.

Java batch-processing program (JBP)
An IMS batch-processing program that has access to online databases and output message queues. JBPs run online, but like programs in a batch environment, they are started with JCL or in a TSO session.

Java batch-processing region
An IMS dependent region in which only Java batch-processing programs are scheduled.

Java Database Connectivity (JDBC)
A specification from Oracle that defines an API that enables Java programs to access databases.

Java message-processing program (JMP)
A Java application program that is driven by transactions and has access to online IMS databases and message queues.

Java message-processing region
An IMS dependent region in which only Java message-processing programs are scheduled.

Java Native Interface (JNI)
A programming interface that lets Java code that runs inside a Java virtual machine (JVM) interoperate with applications and libraries written in other programming languages.

Java virtual machine (JVM)
A software implementation of a central processing unit that runs compiled Java programs.

JavaBeans
A portable, platform-independent, reusable component model. (Oracle)

JBP
See *Java batch-processing program (JBP)*.

JDBC
See *Java Database Connectivity (JDBC)*.

JMP
See *Java message-processing program (JMP)*.

job control language (JCL)
A control language used to identify a job to an operating system and to describe the job's requirements.

JSON
JSON (JavaScript Object Notation) is a lightweight data-interchange format.

JVM
See *Java virtual machine (JVM)*.

JZOS
See *Java Batch Launcher and Toolkit for z/OS*.

K

K
When referring to storage capacity, two to the tenth power; 1024 in decimal notation.

*** key**
A data item that identifies the location of a record, or a set of data items that 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.

*** keyword**
A context-sensitive word or a reserved word whose presence is required when the format in which the word appears is used in a source unit.

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
A characteristic of compiler products (such as Enterprise COBOL, COBOL for OS/390 & VM, COBOL for MVS & VM, C/C++ for MVS & VM, PL/I for MVS & VM) that produce object code conforming to the Language Environment conventions.

last-used state
A state that a program is in if its internal values remain the same as when the program was exited (the values 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) that 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 can 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 the compiler is to use for compiling a given source program.

*** library text**
A sequence of text words, comment lines, inline comments, 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
(1) The combination of the link connection (the transmission medium) and two link stations, one at each end of the link connection. A link can be shared among multiple links in a multipoint or token-ring configuration. (2) To interconnect items of data or portions of one or more computer programs; for example, linking object programs by a linkage-editor to produce an executable file.

LINKAGE SECTION
The section in the DATA DIVISION of the called program or invoked method that describes data items available from the calling program or invoking method. Both the calling program or invoking method and the called program or invoked method can refer to these data items.

linker
A term that refers to either the z/OS binder (linkage-editor).

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
The default format that Intel processors use to store binary data and UTF-16 characters. In this format, the most significant byte of a binary data item is at the highest address and the most significant byte of a UTF-16 character is at the highest address. Compare with *big-endian*.

local reference
A reference to an object that is within the scope of your method.

locale
A set of attributes for a program execution environment that indicates culturally sensitive considerations, such as character code page, collating sequence, date and time format, monetary value representation, numeric value representation, or language.

*** 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 the 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 can be either an elementary item or a group of items. Synonymous with *record*.

*** low-order end**
The rightmost character of a string of characters.

M

main program
In a hierarchy of programs and subroutines, the first program that receives control when the programs are run within a process.

makefile
A text file that contains a list of the files for your application. The make utility uses this file to update the target files with the latest changes.

*** mass storage**
A storage medium in which data can be organized and maintained in both a sequential manner and a nonsequential manner.

*** mass storage device**
A device that has a large storage capacity, such as a magnetic disk.

*** mass storage file**
A collection of records that is stored in a mass storage medium.

*** megabyte (MB)**
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.

message-processing program (MPP)
An IMS application program that is driven by transactions and has access to online IMS databases and message queues.

message queue
The data set on which messages are queued before being processed by an application program or sent to a terminal.

method
Procedural code that defines an operation supported by an object and that is executed by an `INVOKE` statement on that object.

*** method definition**
The COBOL source code that defines a method.

*** method identification entry**
An entry in the `METHOD-ID` paragraph of the `IDENTIFICATION DIVISION`; this entry contains a clause that specifies the method-name.

method invocation
A communication from one object to another that requests the receiving object to execute a method.

method-name
The name of an object-oriented operation. When used to invoke the method, the name can be an alphanumeric or national literal or a category alphanumeric or category national data item. When used in the `METHOD-ID` paragraph to define the method, the name must be an alphanumeric or national literal.

method hiding
See *hide*.

method overloading
See *overload*.

method overriding
See *override*.

*** mnemonic-name**
A user-defined word that is associated in the `ENVIRONMENT DIVISION` with a specified implementor-name.

module definition file
A file that describes the code segments within a program object.

MPP
See *message-processing program (MPP)*.

multitasking
A mode of operation that provides for the concurrent, or interleaved, execution of two or more tasks.

multithreading
Concurrent operation of more than one path of execution within a computer. Synonymous with *multiprocessing*.

N

name
A word (composed of not more than 30 characters) that defines a COBOL operand.

namespace
See *XML namespace*.

national character
(1) A UTF-16 character in a `USAGE NATIONAL` data item or national literal. (2) Any character represented in UTF-16.

national character data
A general reference to data represented in UTF-16.

national character position
See *character position*.

national data
See *national character data*.

national data item
A data item of category national, national-edited, or numeric-edited of USAGE NATIONAL.

national decimal data item
An external decimal data item that is described implicitly or explicitly as USAGE NATIONAL and that contains a valid combination of PICTURE symbols 9, S, P, and V.

national-edited data item
A data item that is described by a PICTURE character string that contains at least one instance of the symbol N and at least one of the simple insertion symbols B, 0, or /. A national-edited data item has USAGE NATIONAL.

national floating-point data item
An external floating-point data item that is described implicitly or explicitly as USAGE NATIONAL and that has a PICTURE character string that describes a floating-point data item.

national group item
A group item that is explicitly or implicitly described with a GROUP-USAGE NATIONAL clause. A national group item is processed as though it were defined as an elementary data item of category national for operations such as INSPECT, STRING, and UNSTRING. This processing ensures correct padding and truncation of national characters, as contrasted with defining USAGE NATIONAL data items within an alphanumeric group item. For operations that require processing of the elementary items within a group, such as MOVE CORRESPONDING, ADD CORRESPONDING, and INITIALIZE, a national group is processed using group semantics.

*** 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.

native method
A Java method with an implementation that is written in another programming language, such as COBOL.

*** negated combined condition**
The NOT logical operator immediately followed by a parenthesized combined condition. See also *condition* and *combined condition*.

*** negated simple condition**
The NOT logical operator immediately followed by a simple condition. See also *condition* and *simple condition*.

nested program
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 SECTION and LINKAGE SECTION that bear no hierarchic relationship to other data items.

*** 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.

null
A figurative constant that is used to assign, to pointer data items, the value of an address that is not valid. NULLS can be used wherever NULL can be used.

*** numeric character**
A character that belongs to the following set of digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

numeric data item
(1) A data item whose description restricts its content to a value represented by characters chosen from the digits 0 through 9. If signed, the item can also contain a +, -, or other representation of an operational sign. (2) A data item of category numeric, internal floating-point, or external floating-point. A numeric data item can have USAGE DISPLAY, NATIONAL, PACKED-DECIMAL, BINARY, COMP, COMP-1, COMP-2, COMP-3, COMP-4, or COMP-5.

numeric-edited data item
A data item that contains numeric data in a form suitable for use in printed output. The data item can consist of external decimal digits from 0 through 9, the decimal separator, commas, the currency sign, sign control characters, and other editing characters. A numeric-edited item can be represented in either USAGE DISPLAY or USAGE NATIONAL.

*** numeric function**
A function whose class and category are numeric but that 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 can contain 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. Each object in the class is said to be an instance of the class.

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, where the object program is run, is described.

*** object computer entry**
An entry in the OBJECT-COMPUTER paragraph of the ENVIRONMENT DIVISION; this entry 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 instance
A single object, of possibly many, instantiated from the specifications in the object paragraph of a COBOL class definition. An object instance has a copy of all the data described in its class definition and all inherited data. The methods associated with an object instance includes the methods defined in its class definition and all inherited methods.

An object instance can be an instance of a Java class.

object module
Synonym for *object deck* or *text 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-oriented programming
A programming approach based on the concepts of encapsulation and inheritance. Unlike procedural programming techniques, object-oriented programming concentrates on the data objects that comprise the problem and how they are manipulated, not on how something is accomplished.

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 or class definition. Where there is no danger of ambiguity, the word *program* can be used in place of *object program*.

object reference
A value that identifies an instance of a class. If the class is not specified, the object reference is universal and can apply to instances of any class.

*** object time**
The time at which an object program is executed. Synonymous with *run time*.

*** obsolete element**
A COBOL language element in the 85 COBOL Standard that was deleted from the 2002 COBOL Standard.

ODO object
In the example below, X is the object of the `OCCURS DEPENDING ON` clause (ODO object).

```
WORKING-STORAGE SECTION.
01  TABLE-1.
    05  X                   PIC S9.
    05  Y OCCURS 3 TIMES
          DEPENDING ON X    PIC X.
```

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**
(1) The general definition of operand is "the component that is operated upon." (2) For the purposes of this document, any lowercase word (or words) that appears in a statement or entry format can be considered to be an operand and, as such, is an implied reference to the data indicated by the operand.

operation
A service that can be requested of an object.

*** operational sign**
An algebraic sign that is associated with a numeric data item or a numeric literal, to indicate whether its value is positive or negative.

optional file
A file that is declared as being not necessarily available each time the object program is run.

*** optional word**
A reserved word that is included in a specific format only to improve the readability of the language. Its presence is optional to the user when the format in which the word appears is used in a source unit.

*** output file**
A file that is opened in either output mode or extend mode.

*** 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.

overload
To define a method with the same name as another method that is available in the same class, but with a different signature. See also *signature*.

override
To redefine an instance method (inherited from a parent class) in a subclass.

P

package
A group of related Java classes, which can be imported individually or as a whole.

packed-decimal data item
See *internal decimal data item*.

padding character
An alphanumeric or national character that is used to fill the unused character positions in a physical record.

page
A vertical division of output data that represents a physical separation of the data. The separation is based on internal logical requirements or external characteristics of the output medium or both.

*** page body**
That part of the logical page in which lines can be written or spaced or both.

*** paragraph**
In the PROCEDURE DIVISION, a paragraph-name followed by a separator period and by zero, one, or more sentences. In the IDENTIFICATION DIVISION 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 DIVISION and ENVIRONMENT DIVISION. The permissible paragraph headers in the IDENTIFICATION DIVISION are:

```
PROGRAM-ID. (Program IDENTIFICATION
   DIVISION)
```

```
CLASS-ID. (Class IDENTIFICATION DIVISION)
METHOD-ID. (Method IDENTIFICATION
   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
(1) Data passed between a calling program and a called program. (2) A data element in the USING phrase of a method invocation. Arguments provide additional information that the invoked method can use to perform the requested operation.

Persistent Reusable JVM
A JVM that can be serially reused for transaction processing by resetting the JVM between transactions. The reset phase restores the JVM to a known initialization state.

*** phrase**
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.

port
(1) To modify a computer program to enable it to run on a different platform. (2) In the Internet suite of protocols, a specific logical connector between the Transmission Control Protocol (TCP) or the User Datagram Protocol (UDP) and a higher-level protocol or application. A port is identified by a port number.

portability
The ability to transfer an application program from one application platform to another with relatively few changes to the source program.

precomposed character
A single Unicode character that can be represented using two or more Unicode characters through a canonical decomposition. A precomposed character does not have the same physical representation as its composed character form. For example, Unicode character U+00E4 (ä) is a precomposed character that can be represented as a combination of Unicode characters U+0061 + U+0308 (ä) - latin small letter a + combining diaeresis. A precomposed character is typically used to represent a latin letter with a diacritical mark or some other combining character.

preinitialization
The initialization of the COBOL runtime environment in preparation for multiple calls from programs, especially non-COBOL programs. The environment is not terminated until an explicit termination.

*** prime record key**
A key whose contents uniquely identify a record within an indexed file.

*** priority-number**
A user-defined word that classifies sections in the PROCEDURE DIVISION for purposes of segmentation. Segment numbers can contain only the characters 0 through 9. A segment number can be expressed as either one or two digits.

private
As applied to factory data or instance data, accessible only by methods of the class that defines the data.

*** procedure**
A paragraph or group of logically successive paragraphs, or a section or group of logically successive sections, within the PROCEDURE DIVISION.

*** 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 code. 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), XML PARSE.

PROCEDURE DIVISION
The COBOL division that contains instructions for solving a problem.

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 can be qualified) or a section-name.

procedure pointer
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.

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. Typically used to communicate with COBOL and Language Environment programs.

process
The course of events that occurs during the execution of all or part of a program. Multiple processes can run concurrently, and programs that run within a process can share resources.

program
(1) A sequence of instructions suitable for processing by a computer. Processing may include the use of a compiler to prepare the program for execution, as well as a runtime environment to execute it. (2) A logical assembly of one or more interrelated modules. Multiple copies of the same program can be run in different processes.

program-name
In the IDENTIFICATION DIVISION and the end program marker, a user-defined word or an alphanumeric literal that identifies a COBOL source program.

*** program identification entry**
In the PROGRAM-ID paragraph of the IDENTIFICATION DIVISION, an entry that 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.

program unit
Synonym for compile unit.

program unit address
Synonym for compile unit address. Abbreviated as "PU Addr" in the traceback in a CEEDUMP.

program unit offset
Synonym for compile unit offset. Abbreviated as "PU Offset" in the traceback in a CEEDUMP.

project
The complete set of data and actions that are required to build a target, such as a dynamic link library (DLL) or other executable (EXE).

*** pseudo-text**
A sequence of text words, comment lines, inline comments, 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 that 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. 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.

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).

recursion
A program calling itself or being directly or indirectly called by 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. Synonymous with *unit* and *volume*.

reentrant
The attribute of a program or routine that lets more than one user 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 category alphanumeric, category DBCS, or category national data item by specifying the leftmost character and length relative to the leftmost character position of a USAGE DISPLAY, DISPLAY-1, or NATIONAL 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*.

*** 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, alphanumeric literal, or index-name has a specific relationship to the value of another arithmetic expression, data item, alphanumeric literal, or index name. See also *relational operator*.

*** 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:

Character	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

*** 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 logical ordinal position of the record 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 that is an integer.

*** reserved word**
A COBOL word that is specified in the list of words that can be used in a COBOL source program, but that must not appear in the program as a user-defined word or system-name.

*** resource**
A facility or service, controlled by the operating system, that an executing program can use.

*** resultant identifier**
A user-defined data item that is to contain the result of an arithmetic operation.

reusable environment
A reusable environment is created when you establish an assembler program as the main program by using either the old COBOL interfaces for preinitialization (RTEREUS runtime option), or the Language Environment interface, CEEPIPI.

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. Synonymous with *object time*.

runtime environment
The environment in which a COBOL program executes.

*** run unit**
A stand-alone object program, or several object programs, that interact by means of COBOL `CALL` or `INVOKE` statements and function at run time as an entity.

A run unit is also called an enclave in Language Environment terminology.

S

SBCS
See *single-byte character set (SBCS)*.

scope terminator
A COBOL reserved word that marks the end of certain `PROCEDURE DIVISION` statements. It can be either explicit (`END-ADD`, for example) or implicit (separator period).

*** 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 any of these divisions: `ENVIRONMENT`, `DATA`, or `PROCEDURE`. In the `ENVIRONMENT DIVISION` 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`.

segmentation
A feature of Enterprise COBOL that is based on the 85 COBOL Standard segmentation module. The segmentation feature uses priority-numbers in section headers to assign sections to fixed segments or independent segments. Segment classification affects whether procedures contained in a segment receive control in initial state or last-used state.

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 that, together with its contained programs, is compiled separately from all other programs.

*** separator**
A character or two or more 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 of programs
A sequence of separate COBOL programs in a single source file that can be input to the compiler.

A sequence of programs is also called a *batch compilation* or a *compilation group*.

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.

session bean
In EJB, an enterprise bean that is created by a client and that usually exists only for the duration of a single client/server session. (Oracle)

77-level-description-entry
A data description entry that describes a noncontiguous data item that has 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.

signature
(1) The name of an operation and its parameters. (2) The name of a method and the number and types of its formal parameters.

*** simple condition**
Any single condition chosen from this set:

- Relation condition

- Class condition
- Condition-name condition
- Switch-status condition
- Sign condition

See also *condition* and *negated simple condition*.

single-byte character set (SBCS)
A set of characters in which each character is represented by a single byte. See also *ASCII* and *EBCDIC (Extended Binary-Coded Decimal Interchange Code)*.

slack bytes (within records)
Bytes inserted by the compiler between data items to ensure correct alignment of some elementary data items. Slack bytes contain no meaningful data. The SYNCHRONIZED clause instructs the compiler to insert slack bytes when they are needed for proper alignment.

slack bytes (between records)
Bytes inserted by the programmer between blocked logical records of a file, to ensure correct alignment of some elementary data items. In some cases, slack bytes between records improve performance for records processed in a buffer.

*** 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, where the source program is compiled, is described.

*** source computer entry**
An entry in the SOURCE-COMPUTER paragraph of the ENVIRONMENT DIVISION; this entry 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 a source program can be represented by other forms and symbols, in this document the term always refers to a syntactically correct set of COBOL statements. A COBOL source program commences with the IDENTIFICATION DIVISION or a COPY statement and terminates with the end program marker, if specified, or with the absence of additional source program lines.

source unit
A unit of COBOL source code that can be separately compiled: a program or a class definition. Also known as a *compilation unit*.

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

Character	Meaning
;	Semicolon
.	Period (decimal point, full stop)
"	Quotation mark
'	Apostrophe
(	Left parenthesis
)	Right parenthesis
>	Greater than
<	Less than
:	Colon
_	Underscore

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; this entry 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.

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 that is 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 can 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.

substitution character
A character that is used in a conversion from a source code page to a target code page to represent a character that is not defined in the target code page.

*** superclass**
A class that is inherited by another class. See also *subclass*.

surrogate pair
In the UTF-16 format of Unicode, a pair of encoding units that together represents a single Unicode graphic character. The first unit of the pair is called a *high surrogate* and the second a *low surrogate*. The code value of a high surrogate is in the range X'D800' through X'DBFF'. The code value of a low surrogate is in the range X'DC00' through X'DFFF'. Surrogate pairs provide for more characters than the 65,536 characters that fit in the Unicode 16-bit coded character set.

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
(1) The relationship among characters or groups of characters, independent of their meanings or the manner of their interpretation and use. (2) The structure of expressions in a language. (3) The rules governing the structure of a language. (4) The relationship among symbols. (5) The rules for the construction of a statement.

*** system-name**
A COBOL word that is used to communicate with the operating environment.

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 pseudo-text that is any of the following characters:

- A separator, except for space; a pseudo-text delimiter; and the opening and closing delimiters for alphanumeric 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 alphanumeric 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.

thread
A stream of computer instructions (initiated by an application within a process) that is in control of a process.

token
In the COBOL editor, a unit of meaning in a program. A token can contain data, a language keyword, an identifier, or other part of the language syntax.

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 data-set label that follows the data records on a unit of recording medium. (2) Synonym for *end-of-file label*.

troubleshoot
To detect, locate, and eliminate problems in using computer software.

*** truth value**
The representation of the result of the evaluation of a condition in terms of one of two values: true or false.

typed object reference
A data-name that can refer only to an object of a specified class or any of its subclasses.

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.

unbounded table
A table with `OCCURS` *`integer-1`* `to UNBOUNDED` instead of specifying *integer-2* as the upper bound.

Unicode
A universal character encoding standard that supports the interchange, processing, and display of text that is written in any of the languages of the modern world. There are multiple encoding schemes to represent Unicode, including UTF-8, UTF-16, and UTF-32. Enterprise COBOL supports Unicode using UTF-16 in big-endian format as the representation for the national data type.

Uniform Resource Identifier (URI)
A sequence of characters that uniquely names a resource; in Enterprise COBOL, the identifier of a namespace. URI syntax is defined by the document *Uniform Resource Identifier (URI): Generic Syntax*.

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.

unrestricted storage
In `AMODE 31`, unrestricted storage is below the 2 GB bar and can be above or below the 16 MB line.

In `AMODE 64`, unrestricted storage encompasses all the storage available to your program, both above and below the 2 GB bar.

*** 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 can affect status indicators.

UPSI switch
A program switch that performs the functions of a hardware switch. Eight are provided: UPSI-0 through UPSI-7.

URI
See *Uniform Resource Identifier (URI)*.

*** 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 can be changed by execution of the object program. A variable used in an arithmetic expression must be a numeric elementary item.

variable-length item
A group item that contains a table described with the DEPENDING phrase of the OCCURS clause.

*** 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 that 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 record. The group item can be an alphanumeric group or a national group.

*** variably located item**
A data item following, and not subordinate to, a variable-length table in the same record.

*** verb**
A word that expresses an action to be taken by a COBOL compiler or object program.

volume
A module of external storage. For tape devices it is a reel; for direct-access devices it is a unit.

volume switch procedures
System-specific procedures that are executed automatically when the end of a unit or reel has been reached before end-of-file has been reached.

VSAM file system
A file system that supports COBOL sequential, relative, and indexed organizations.

W

web service
A modular application that performs specific tasks and is accessible through open protocols like HTTP and SOAP.

white space
Characters that introduce space into a document. They are:

- Space
- Horizontal tabulation
- Carriage return
- Line feed
- Next line

as named in the Unicode Standard.

*** word**
A character string of not more than 30 characters that 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.

workstation
A generic term for computers, including personal computers, 3270 terminals, intelligent workstations, and UNIX terminals. Often a workstation is connected to a mainframe or to a network.

wrapper
An object that provides an interface between object-oriented code and procedure-oriented code. Using wrappers lets programs be reused and accessed by other systems.

X

x
The symbol in a PICTURE clause that can hold any character in the character set of the computer.

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.

Y

Z

z/OS UNIX file system
A collection of files and directories that are organized in a hierarchical structure and can be accessed by using z/OS UNIX.

zoned decimal data item
An external decimal data item that is described implicitly or explicitly as USAGE DISPLAY and that contains a valid combination of PICTURE symbols 9, S, P, and V. The content of a zoned decimal data item is represented in characters 0 through 9, optionally with a sign. If the PICTURE string specifies a sign and the SIGN IS SEPARATE clause is specified, the sign is represented as characters + or -. If

`SIGN IS SEPARATE` is not specified, the sign is one hexadecimal digit that overlays the first 4 bits of the sign position (leading or trailing).

#

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 standard:

- *INCITS/ISO/IEC 1989-2002, Information technology - Programming languages - COBOL*

2014 COBOL Standard
The COBOL language defined by the following standard:

- *INCITS/ISO/IEC 1989:2014, Information technology - Programming languages, their environments and system software interfaces - Programming language 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:

- *What's New*, SC31-5708-00
- *Customization Guide*, SC27-8712-03
- *Language Reference*, SC27-8713-03
- *Programming Guide*, SC27-8714-03
- *Migration Guide*, GC27-8715-03
- *Performance Tuning Guide*, SC27-9202-02
- *Messages and Codes*, SC27-4648-02
- *Program Directory*, GI13-4526-03
- *Licensed Program Specifications*, GI13-4532-03

Softcopy publications

The following collection kits contain Enterprise COBOL and other product publications. You can find them at https://www.ibm.com/resources/publications.

- *z/OS Software Products Collection*
- *z/OS and Software Products DVD Collection*

Support

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/pages/node/6560933.

Related publications

z/OS library publications

You can find the following publications in the z/OS 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*

- *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 z/OS Debugger (formerly IBM Debug for z Systems and Debug Tool)

You can find information about IBM z/OS Debugger in the IBM z/OS Debugger library.

IBM Developer for z/OS (formerly IBM Developer for z Systems)

You can find information about IBM Developer for z/OS in the IBM Developer for z/OS library.

Note: IBM Developer for z/OS supersedes IBM Developer for z Systems® and Rational Developer for z Systems.

You can find the following publications by searching their publication numbers in the IBM Publications Center.

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/

JSON

- JavaScript Object Notation (JSON), www.json.org

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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Special Characters

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GC27-8715-03