

# GNU COBOL 2.0

(Formerly OpenCOBOL)

[11FEB2012 Version]

## Programmer's Guide

2<sup>nd</sup> Edition, 21 November 2013

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## Summary of Changes

Edition	Date	Change Description
2 <sup>nd</sup>	17 July 2012	<p>Updated for version <b>11FEB2012</b> of GNU COBOL 2.0</p> <ul style="list-style-type: none"><li>▶ The use of a slash character ("/") in column 7 was documented – this feature has existed since at least the 06FEB2009 version of OpenCOBOL 1.1, but was undocumented (section <a href="#">1.6</a>)</li><li>▶ Added documentation on the <b>DEBUG-ITEM</b> special register (section <a href="#">6.1.8</a>).</li><li>▶ Updated <b>DECLARATIVES</b> documentation to better explain how to use it. See section <a href="#">6.1.4</a>.</li><li>▶ A new section was added to the documentation to discuss the ramifications, rules and capabilities of sub-programming (section <a href="#">2</a>).</li><li>▶ Documentation was added on the <b>COB_SET_DEBUG</b> environment variable (section <a href="#">8.1.4</a>).</li><li>▶ The listings of all sample programs in chapter <a href="#">9</a> are now presented as listings generated by the GNU COBOL Interactive Compiler utility (itself included as a sample program in section <a href="#">9.4</a>). This not only shows full source listings of the sample programs but complete cross-reference listings as well.</li><li>▶ A new sample program – <b>DAY-FROM-DATE</b> – was introduced to illustrate how to write a user-defined function (section <a href="#">9.3</a>)</li><li>▶ User-defined functions are now supported (sections <a href="#">3</a>, <a href="#">7.1</a>, <a href="#">7.4.2</a> and <a href="#">9.3</a>)</li><li>▶ A new built-in subroutine – <b>C\$PRINTABLE</b> – was introduced (section <a href="#">8.3.1.11</a>) (the COBDUMP sample program (section <a href="#">10.2</a>) now uses it!)</li></ul>
	7 July 2011	<p>Updated for pre-release version <b>29APR2011</b> of OpenCOBOL 2.0</p> <ul style="list-style-type: none"><li>▶ Corrected a problem with bogus footnote references in <a href="#">Figure 6-23</a>.</li><li>▶ A reference to a new figure documenting error codes was added to the <b>EXCEPTION-STATUS</b> function (section <a href="#">6.1.7.21</a>).</li><li>▶ Documentation was added to the <b>CLOSE</b> statement (section <a href="#">6.4.7</a>) to explicitly document how the last record written to a <b>LINE SEQUENTIAL</b> or <b>LINE ADVANCING</b> file may have a terminating delimiter sequence written at the time the file is closed.</li><li>▶ Documentation was added to the <b>WRITE</b> statement (section <a href="#">6.4.50</a>) to explicitly document how the <b>ADVANCING</b> options are handled with <b>LINE SEQUENTIAL</b> and the new <b>LINE ADVANCING</b> files.</li><li>▶ Additional documentation on the <b>cobcrun</b> command (section <a href="#">8.2.2</a>) was added.</li><li>▶ <b>LINE ADVANCING</b> files are now supported (section <a href="#">1.3.3.5</a>).</li><li>▶ Floating-point literals of the form <code>[+]-nn.nnE[+-]nn</code> are now supported (section <a href="#">1.8</a>)</li><li>▶ Z"xxxxx" null-delimited alphanumeric literals are now supported (section <a href="#">1.8</a>)</li><li>▶ The <b>COPY</b> statement now supports the COBOL2002 standard <b>LEADING</b> and <b>TRAILING</b> options as well as the "IN/OF library-name" and <b>SUPPRESS PRINTING</b> options (section <a href="#">2.1.1</a>)</li><li>▶ The <b>REPLACE</b> Compiler-Directing Facility (CDF) statement was introduced (section <a href="#">2.1.2</a>)</li><li>▶ Conditional code generation is now supported through the use of <b>&gt;&gt;DEFINE</b>, <b>&gt;&gt;IF</b>, <b>&gt;&gt;SET</b>, <b>&gt;&gt;SOURCE</b> and <b>&gt;&gt;TURN</b> Compiler-Directing Facility (CDF) directives (section <a href="#">2.2</a>)</li><li>▶ The <b>COB_LINE_TRACE</b> environment variable was renamed to <b>COB_SET_TRACE</b> (section <a href="#">8.2.4</a>).</li><li>▶ The <b>COB_DISPLAY_WARNINGS</b> (section <a href="#">8.2.4</a>) environment variable was introduced.</li><li>▶ <b>SOURCE-COMPUTER WITH DEBUGGING MODE</b> is now supported (section <a href="#">4.1.1</a>)</li><li>▶ The <b>CHARACTER CLASSIFICATION</b> clause of the <b>OBJECT-COMPUTER</b> clause is now supported</li></ul>

		<p>(section <a href="#">4.1.2</a>).</p> <ul style="list-style-type: none"> <li>▶ Mnemonic names are now optional for <b>SWITCH</b> declarations in <b>SPECIAL-NAMES</b> (section <a href="#">4.1.4</a>); Eight new switches (<b>SWITCH-0</b>, <b>SWITCH-9</b> thru <b>SWITCH-15</b>) are now available; Switches may be specified as <b>SW0</b> thru <b>SW15</b> as well as <b>SWITCH-0</b> thru <b>SWITCH-15</b>; a new print channel designation of <b>CSP</b> is now available; <b>SYMBOLIC CHARACTERS</b> are now supported (section <a href="#">4.1.4</a>)</li> <li>▶ The device name <b>DISC</b> may now be used interchangeably with <b>DISK</b> in <b>SELECT</b> statements (section <a href="#">4.2.1</a>)</li> <li>▶ Files may now be <b>SELECTed</b> with the “<b>NOT OPTIONAL</b>” designation in addition to “<b>OPTIONAL</b>” (section <a href="#">4.2.1</a>).</li> <li>▶ New <b>USAGES</b> of <b>BINARY-INT</b>, <b>BINARY-LONG-LONG</b> and <b>COMPUTATIONAL-6</b> (<a href="#">Figure 5-10</a> and section <a href="#">7.8.3</a>) were introduced.</li> <li>▶ The <b>LEFTLINE</b> screen attribute was added to the <b>SCREEN SECTION</b> (section <a href="#">5.6</a>).</li> <li>▶ New intrinsic functions were introduced: <ul style="list-style-type: none"> <li>○ <b>MODULE-CALLER-ID</b> (section <a href="#">6.1.7.47</a>)</li> <li>○ <b>MODULE-DATE</b> (section <a href="#">6.1.7.48</a>)</li> <li>○ <b>MODULE-FORMATTED-DATE</b> (section <a href="#">6.1.7.49</a>)</li> <li>○ <b>MODULE-ID</b> (section <a href="#">6.1.7.50</a>)</li> <li>○ <b>MODULE-PATH</b> (section <a href="#">6.1.7.51</a>)</li> <li>○ <b>MODULE-SOURCE</b> (section <a href="#">6.1.7.52</a>)</li> <li>○ <b>MODULE-TIME</b> (section <a href="#">6.1.7.53</a>)</li> </ul> </li> <li>▶ A new option - <b>WITH KEPT LOCK</b> (section <a href="#">6.1.9.2</a>) - was added to the <b>READ</b> verb.</li> <li>▶ <b>USE FOR DEBUGGING</b> is now supported (section <a href="#">6.1.4</a>)</li> <li>▶ The following changes were made to the <b>ACCEPT Statement</b> <ul style="list-style-type: none"> <li>● The <b>TIMEOUT</b> option was added to Format 4 (section <a href="#">6.4.1.4</a>).</li> <li>● The non-functional <b>CONVERSION</b> option was added to Format 4 (section <a href="#">6.4.1.4</a>).</li> <li>● The <b>LINE NUMBER</b> option (a synonym for <b>LINES</b>) and <b>COLS</b> option (a synonym for <b>COLUMNS</b>) and <b>ESCAPE KEY</b> options were added to Format 6 (section <a href="#">6.4.1.6</a>)</li> <li>● A new format – Format 7 – was introduced (section <a href="#">6.4.1.7</a>)</li> </ul> </li> <li>▶ The <b>ALTER</b> verb (section <a href="#">6.4.4</a>) is now supported [<i>Editorial Comment: this change was made only because NIST tests need it <b>and not because you should be using it!</b></i>]</li> <li>▶ Options (mnemonic-name, <b>STDCALL</b> and <b>STATIC</b>) were added to the <b>CALL</b> verb (section <a href="#">6.4.5</a>).</li> <li>▶ The non-functional <b>CONVERSION</b> option was added to Format 4 of the <b>DISPLAY</b> statement (section <a href="#">6.4.12.4</a>).</li> <li>▶ The <b>REVERSED</b> option for the <b>OPEN</b> statement is now supported syntactically, even though it is non-functional (section <a href="#">6.4.29</a>).</li> <li>▶ The <b>READY TRACE</b> (section <a href="#">6.4.32</a>) and <b>RESET TRACE</b> (section <a href="#">6.4.34</a>) statements were introduced.</li> <li>▶ A new option – <b>STATUS</b> – was added to the <b>STOP</b> verb (section <a href="#">6.4.42</a>).</li> <li>▶ The following built-in <u>named</u> subroutines were added: <ul style="list-style-type: none"> <li>● <b>C\$CALLEDBY</b> (section <a href="#">8.3.1.1</a>)</li> <li>● <b>C\$GETPID</b> (section <a href="#">8.3.1.6</a>)</li> <li>● <b>CBL_GET_CSR_POS</b> (section <a href="#">8.3.1.29</a>)</li> <li>● <b>CBL_GET_SCR_SIZE</b> (section <a href="#">8.3.1.30</a>)</li> </ul> </li> <li>▶ The following built-in <u>numbered</u> subroutines were added: <ul style="list-style-type: none"> <li>● <b>X"E4"</b> (section <a href="#">8.3.2.2</a>)</li> <li>● <b>X"E5"</b> (section <a href="#">8.3.2.3</a>)</li> </ul> </li> </ul>
1 <sup>st</sup>	17 Sept 2010	<ul style="list-style-type: none"> <li>▶ Introduced documentation for the hitherto undocumented “<b>COBCPY</b>” environment variable (sections <a href="#">8.1.4</a> and <a href="#">8.1.5</a>).</li> <li>▶ Corrected “section 0” broken hyperlinks in the document.</li> </ul>
	1 Apr 2010	Elaborated on the use of the <b>GLOBAL</b> clause in data item definitions (section <a href="#">5.3</a> ).
	23 Jan 2010	INITIAL RELEASE OF DOCUMENT – corresponds to version <b>06FEB2009</b> of OpenCOBOL 1.1



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# 1. Introduction

## 1.1. What is GNU COBOL?

This document describes the syntax, semantics and usage of the COBOL programming language as implemented by the current version of GNU COBOL, formerly known as OpenCOBOL.

GNU COBOL is an open-source COBOL compiler and runtime environment. The GNU COBOL compiler generates C code which is automatically compiled and linked. While originally developed for UNIX operating systems, GNU COBOL has also been successfully built for OSX computers or Windows computers utilizing the UNIX-emulation features of such tools as Cygwin and MinGW<sup>1</sup>. It has also been built as a truly native Windows application utilizing Microsoft's freely-downloadable Visual Studio Express package to provide the C compiler and linker/loader.

The principal developers of GNU COBOL are Keisuke Nishida and Roger While. They may be contacted at the GNU COBOL website - [www.GNU-COBOL.org](http://www.GNU-COBOL.org).

This document was intended to serve as a full-function reference and user's guide suitable for both those readers learning COBOL for the first time as well as those already familiar with some dialect of the COBOL language. The author of this document is Gary Cutler, who may be reached via postings at the [www.GNU-COBOL.org](http://www.GNU-COBOL.org) forum, or by email at [CutlerGL@gmail.com](mailto:CutlerGL@gmail.com).

## 1.2. Additional References and Documents

For those wishing to learn COBOL for the first time, I can strongly recommend the following resources.

If you like to hold a book in your hands, I strongly recommend "Murach's Structured COBOL", by Mike Murach, Anne Prince and Raul Menendez (2000) - ISBN 9781890774059. Mike Murach and his various writing partners have been writing outstanding COBOL textbooks for decades, and this text is no exception. It's an excellent book for those familiar with the concepts of programming in other languages, but unfamiliar with COBOL.

Would you prefer a web-based tutorial? Try the University of Limerick (Ireland) COBOL web site - <http://www.csis.ul.ie/cobol/>.

## 1.3. Introducing COBOL

If you already know a programming language, and that language isn't COBOL, chances are that language is Java, C or C++. You will find COBOL a much different programming language than those – sometimes those differences are a good thing and sometimes they aren't. The thing to remember about COBOL is this – it was designed to solve business problems. It was designed to do that in the 1950s.

COBOL was the first programming language to become standardized such that a COBOL program written on computer "A" made by company "X" would be able to be compiled and executed on computer "B" made by company "Y". This may not seem like such a big deal today, but it was a radical departure from all programming languages that came before it and even many that came after it.

The name "COBOL" actually says it all – COBOL is an acronym that stands for "COmmon Business Oriented Language". Note the fact that the word "common" comes before all others. The word "business" is a close second. Therein lies the key to COBOL's success.

### 1.3.1. "I Heard COBOL is a Dead Language!"

Phoenician is a dead language. Mohegan is a dead language. Sanskrit is a dead language. What makes these languages dead is the fact that no one speaks them anymore. COBOL is NOT a dead language, and despite pontifications that come down to us from the ivory towers of academia, it isn't even on life support.

<sup>1</sup> The MinGW approach is a personal favorite with the author of this manual because it creates a GNU COBOL compiler and runtime that require only a single MinGW DLL to be available to GNU COBOL tools and user programs. That DLL is freely distributable under the terms of the GNU General Public License. A MinGW build of GNU COBOL fits easily on and runs from a 128MB flash drive with no need to install any software onto the Windows computer that will be using it. Some functionality of the language, dealing with the sharing of files between concurrently executing GNU COBOL programs and record locking on certain types of files, is sacrificed however as the underlying operating system routines needed to implement them aren't available to Windows.

What made those other languages die is the fact that they became both obsolete and irrelevant. As the peoples that spoke them were overrun or superseded by other populations that eventually replaced them, no one saw any need to speak their languages.

COBOL is different. Certainly, there were more people that “spoke” COBOL back in the 1980s than there are now. Remember, however, the second word in COBOL’s acronym – business. Businesses are complex social and economic organisms that exist for but a single purpose – to make money. One of the approaches businesses take to satisfy that all-important survival trait is the avoidance of unnecessary expenses.

This avoidance of expense turns out to have been key to the survival of COBOL because those programmers of the 1980s (give or take a decade) were very busy programmers. Estimates are that as many as several hundred billion lines of COBOL code were written for businesses world-wide. Because of the first word in COBOL’s name (“Common”), as businesses replaced their older, slower and less-reliable computer systems with newer, faster and more-reliable ones, they found that the massive investment they had in their COBOL software inventory paid dividends by remaining functional on those new systems - many times with no changes needed whatsoever!

Unwilling to endorse change merely for the sake of change, businesses replaced COBOL code only when absolutely necessary and only when financially justifiable. That justification appeared to have come as the 20<sup>th</sup> century was nearing the end.

Written long before the end of the century was near, many COBOL applications used 2-digit years instead of four digit years because, when the programs were written, computer storage of any kind was expensive. Why should millions and millions of bytes of storage be wasted by all those “19” sequences when the software can just simply assume them? Since their software would suddenly think the current year was “1900” after the stroke of midnight, December 31<sup>st</sup> 1999, businesses knew they were going to have to do something about the “Y2K” (programmer “geek speak” for “Year 2000”) problem.

At last! Y2K was going to be the massive asteroid strike that finally killed off the COBOL dinosaur.

Unfortunately for those seeking the extinction of COBOL, that proved to be wishful thinking.

Always concerned with the bottom line, businesses actually analyzed the problems with their programs. Many applications were replaced with newer and “better” versions that used more appropriate (translation: more politically correct) languages and computer systems. BUT ... many applications were not replaced. These were the absolutely essential applications whose replacement would cripple the business if everything didn’t go absolutely perfectly. These COBOL applications were modified to use 4-digit years instead of 2-digit ones. At the same time, many of them received cosmetic “face lifts” to make their computer/human interfaces more acceptable, frequently with the help of modules developed in the newer languages.

The result is that even today, after the Y2K “extinction event”, there are, by some industry estimates, over 220 billion lines of COBOL code still running the businesses of the 21<sup>st</sup> century. A fact that is disturbing to some is that – just as tiny little furry mammals evolved to cope with the original “extinction event” holocaust – COBOL has also evolved into a leaner and meaner “animal” capable of competing in niches and providing services unthought-of back in 1968. That fact is confirmed by the fact that those lines of COBOL code being tracked by industry analysts are actually *growing* at the rate of about 4 billion a year.

Evolution, you see, is in COBOL’s DNA. Over time, COBOL evolved in form and function, first via work done by the American National Standards Institute (ANSI) and eventually through the efforts of the International Standards Organization (ISO).

The first widely-adopted standard for COBOL was published by ANSI in 1968<sup>2</sup>. Named the ANS68 standard, this version of COBOL was originally standardized for use primarily as the business programming tool of the US Defense Department; it quickly was adopted by other Government agencies and private businesses alike.

Subsequent standards published in 1974 and 1985 (ANS74 and ANS85, respectively) added new features and evolved the language toward adoption of the programmer-productivity tool of the time – “Structured Programming”.

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<sup>2</sup> To that point, in 1968 the US Government made it a requirement that any computer system sold to them must run a version of COBOL that adhered to the ANSI68 standard. The requirement that computers sold to the US Government had to support the current COBOL standard remained for many, many years.

As the 21<sup>st</sup> century dawned, programming had moved out of the board room and into the Game Room, the Living Room and even the Kitchen. As computers became more and more inexpensive they appeared in games, entertainment devices and appliances. Even the automobile became home to computers galore. These computers need software, and that software is written in the so-called “modern” languages.

Combined with Y2K, these trends became the impetus for COBOL to evolve even newer features and capabilities. The COBOL2002 standard<sup>3</sup> introduced object-oriented features and syntax that make the language more programmer-friendly to those trained by today’s programming curricula. The COBOL20xx standard, currently under development, carries the evolution forward to the point where a COBOL20xx implementation will be fully as “modern” as any other programming language.

Through all this evolution, however, care was taken with each new standard to protect the investment businesses (or anyone, for that matter) had in COBOL software. Generally, a new COBOL standard – once implemented and adopted by a business - required minimal, if any, changes to existing applications. When changes were necessary, those changes could frequently be made using tools that mechanically upgraded entire libraries of source code with little or no need for human intervention.

The GNU COBOL implementation of the COBOL language supports virtually the entire ANS85 standard as well as some significant features of the COBOL2002 standard, although the truly object-oriented features are not there (yet).

### 1.3.2. Programmer Productivity – The “Holy Grail”

Throughout the history of computer programming, the search for new ways to improve of the productivity of programmers has been the all-important consideration. Sometimes this search has taken the form of introducing new features in programming languages, or even new languages altogether. Sometimes it has evolved new ways of using the existing languages. Other than hobbyists, programming is an activity performed for money. Businesses abhor spending anything more than is absolutely necessary. Even government agencies try to spend as little money on projects as is absolutely necessary<sup>4</sup>.

The amount of programming necessary to accomplish a given task – including rework needed by any errors found during testing (*testing*: “that time during which an application is actually in production use attempting to serve the purpose for which it was designed” ☺) is the measure of *programmer productivity*. Anything that reduces that effort will therefore reduce the time spent in such activities therefore reducing the expense of same. When the expense of programming is reduced, programmer productivity is increased.

While many technological and procedural developments have made evolutionary improvements to programmer productivity, each of the following has been responsible for revolutionary improvements:

- ▶ The development of so-called “higher-level” programming languages that enable a programmer to specify in a single statement of the language an action that would have required many more separate statements in a prior programming language. The standardization of such languages, making them usable on a wide variety of computers and operating systems, was a key aspect of this development. COBOL was a pioneering development in this area, being one of the first higher-level languages and the first to become standardized.
- ▶ The establishment of programming techniques that make programs easier to read and therefore easier to understand. Not only do such techniques reduce the amount of rework necessary simply to make a program work as designed, but they also reduce the amount of time a programmer needs to study an existing program in order how to best adapt it to changing business requirements. The foremost development in this area was *structured programming*. Introduced in the late 1970s, this approach to programming spawned new programming languages (PASCAL, ALGOL, PL/1) designed around it. With the ANSI85 standard, COBOL embraced the principles espoused by structured programming mavens as well as any of the languages designed strictly around it.
- ▶ The establishment of programming techniques AND the introduction of programming language capabilities to facilitate the reusability of program code. Anything that supports *code reusability* can have a profound

<sup>3</sup> “Popular” names for COBOL standards no longer include an organization’s name, and now use Y2K-compliant 4-digit years.

<sup>4</sup> This is a religious issue because it is an assertion that – sadly – must be taken purely on faith; there is, unfortunately, all too little real-world evidence to support it. It makes sense though, so one can only hope it is true.

impact to the amount of time it takes to develop new applications or to make significant changes to existing ones. In recent years, object-oriented programming has been the industry “poster child” for code reusability. By enabling program logic and the data structures that logic manipulates to be encapsulated into easily stored and retrieved (and therefore “reusable”) modules called *classes*, the object-oriented languages such as Java, C++ and C# have become the favorites of academia. Since students are being trained in these technologies and only these, by and large, it’s no surprise that – today - object-oriented programming languages are the darlings of the industry.

The reality is, however, that good programmers have been practicing code reusability for more than a half-century. Up until recently, COBOL programmers have had some of the best code reusability tools available - they’ve been doing it with copybooks and subprograms rather than classes, methods and attributes but the net results have been similar. With the COBOL2002 standard and the improvements made by the COBOL20xx standard, the playing field is rapidly becoming leveled in this regard.

### 1.3.3. Notable COBOL/GNU COBOL Features

#### 1.3.3.1. Basic Program Readability

The most vociferous critics of COBOL always focus on the wordiness of the language, often citing the case of an infamous “Hello World” program as the “proof” that COBOL is so much more tedious to program in than more “modern” languages. This tedium is cited as such a significant impact to programmer productivity that – in their minds – the critics believe that COBOL can’t go away quickly enough for them.

Here are two different “Hello World” applications – one written in Java and the second in COBOL2002:

Java “Hello World”	COBOL2002 “Hello World” (Free-form Mode) <sup>5</sup>
<pre>Class HelloWorld {     public static void main(String[] args) {         System.out.println("Hello World!");     } }</pre>	<pre>identification division. program-id. HelloWorld. procedure division.     display "Hello World!".</pre>

Both programs could have been written on a single line, if desired, and both languages allow a programmer to use (or not use) indentation as they see fit to improve program readability. Sounds like a tie so far.

Let’s look at how much more “wordy” COBOL is than Java. Count the characters in the two programs. The Java program has 95 (not counting carriage returns and any indentation). The COBOL program has 89 (again, not counting carriage returns and indentation)! Technically, it could have been only 65 because the “identification division.” header is actually optional.

Clearly, “Hello World” doesn’t look any better in Java than it does in COBOL.

Let’s look at a different problem. Surely a program that asks a user to input a positive integer, generates the sum of all positive integers from 1 to that number and then prints the result will be MUCH easier to code in Java than in COBOL, right?

---

<sup>5</sup> One of the features of the COBOL2002 standard is its ability to allow programs to be coded in free-form mode, where line breaks and indentation are pretty much left to the discretion of the programmer. It wasn’t always this way, and the pre-2002 standards for COBOL are quite rigid when it comes to that sort of thing. Maybe the COBOL critics

You can be the judge.

Java Sum of Integers	COBOL2002 Sum of Integers (Free-form Mode) <sup>6</sup>
<pre>import java.util.Scanner; public class sumofintegers {     public static void main(String[] arg) {         System.out.println("Enter a positive integer");         Scanner scan=new Scanner(System.in);         int n=scan.nextInt();         int sum=0;         for (int i=1;i&lt;=n;i++) {             sum=sum+i;         }         System.out.println("The sum is "+sum);     } }</pre>	<pre>identification division. program-id. sumofintegers. data division. working-storage section. 01 n      binary-int. 01 i      binary-int. 01 sum binary-int. procedure division. display "Enter a positive integer" accept n perform varying i from 1 by 1 until i&gt;n     add i to sum end-perform display "The sum is " sum.</pre>

My familiarity with COBOL may be prejudicing my opinion, but it doesn't appear to me that the Java code is any simpler than the COBOL code. In case you're interested in character counts, the Java code comes in at 281 (not counting indentation characters). The COBOL code is 287 (263 without the "identification division." header).

The more complex the programming logic being implemented, the more concise the Java code will appear to be, even compared to 2002-standard COBOL. That conciseness comes with a price though – program code readability. Java (or C or C++ or C#) programs are generally intelligible only to trained programmers. COBOL programs can be quite intelligible to non-programmers, however. This is actually a side-effect of the wordiness of the language, where COBOL statements use natural English words to describe their actions. This inherent readability has come in handy many times throughout my career when I've had to learn obscure business (or legal) processes by reading COBOL program code that supports them.

The "modern" languages, like COBOL, also have their own "boilerplate" infrastructure overhead that must be coded in order to write the logic that is necessary in the program. Take for example the "**public static void main(String[] arg) {**" and "**import java.util.Scanner;**" statements. The critics tend to forget about this when they criticize COBOL for its structural "overhead."

When it first was developed, COBOL's easily-readable syntax made it profoundly different from anything that had been seen before. For the first time, it was possible to specify logic in a manner that was – at least to some extent – comprehensible even to non-programmers. Take for example, the following code written in FORTRAN – a language developed only a year before COBOL:

```
E = P * Q
I = I + E
```

With its original limitation on the length of variable names (one letter or a letter followed by a number), and its use of algebraic notation to express actions being taken, FORTRAN wasn't a particularly readable language, even by programmers. Compare this with the equivalent COBOL code:

```
MULTIPLY PRICE BY QUANTITY GIVING EXTENDED-AMOUNT
ADD EXTENDED-AMOUNT TO INVOICE-TOTAL
```

Clearly, even a non-programmer could at least conceptually understand what was going on! Over time, languages like FORTRAN evolved more robust variable names, and COBOL introduced a more formula-based syntactical capability for arithmetic operations, but FORTRAN was never as readable as COBOL.

Because of its inherent readability, I would MUCH rather be handed an assignment to make significant changes to a COBOL program about which I know nothing than to be asked to do the same with a C, C++, C# or Java program.

Those that argue that it is too boring/wasteful/time-consuming/insulting (pick one) to have to code a COBOL program "from scratch" are clearly ignorant of the following facts:

---

<sup>6</sup> One of the features of the COBOL2002 standard is its ability to allow programs to be coded in free-form mode, where line breaks and indentation are pretty much left to the discretion of the programmer. It wasn't always this way, and the pre-2002 standards for COBOL are quite rigid when it comes to that sort of thing. Maybe the COBOL critics

- ▶ Many systems have program-development tools available to ease the task of coding programs; those tools that concentrate on COBOL are capable of providing templates for much of the “overhead” verbiage of any program...
- ▶ Good programmers have – for decades – maintained their own skeleton “template” programs for a variety of program types; simply load a template into a text editor and you’ve got a good start to the program...
- ▶ Legend has it that there’s actually only been ONE program ever written in COBOL – all programs ever “written” thereafter were simply derivatives of that one!

### 1.3.3.2. COBOL Program Structure

COBOL programs are structured into four major areas of coding, each with its own purpose. These four areas are known as DIVISIONS.

Each DIVISION may consist of a variety of SECTIONs and each SECTION consists of one or more PARAGRAPHs. A PARAGRAPH consists of SENTENCEs, each of which consists of one or more STATEMENTS.

This hierarchical structure of program components standardizes the composition of all COBOL programs. Much of this manual describes the various divisions, sections, paragraphs and statements that may comprise any COBOL program.

*See Also...*

The Four Divisions of a Program <a href="#">1.5</a>	The DATA DIVISION 5
The IDENTIFICATION DIVISION 3	The PROCEDURE DIVISION 6
The ENVIRONMENT DIVISION 4	

### 1.3.3.3. Copybooks

A “copybook” is a segment of program code that may be utilized by multiple programs simply by having that program use the **COPY** statement to import that code into the program. This code may define files, data structures or procedural code.

Today’s current programming languages have a statement (usually, this statement is named “import”, “include” or “#include”) that performs this same function. What makes the COBOL copybook feature different than the “include” facility in current languages, however, is the fact that the COBOL **COPY** statement can edit the imported source code as it is being copied. This capability makes copybook libraries extremely valuable to making code reusable.

*See Also...*

The COPY Statement <a href="#">2.1.1</a>
--

### 1.3.3.4. Structured Data

COBOL introduced the concept of structured data back in the 1960s. Structured data is data which may be accessed as a single item or may be broken down into sub-items based upon their character position of occurrence within the structure. These structures called *group items*. At the bottom of any structure are data items that aren't broken down into sub-items. COBOL refers to these as *elementary items*.

### 1.3.3.5. Files

One of COBOL's main strengths is the wide variety of files it is capable of accessing. GNU COBOL programs, like those created with other COBOL implementations, need to have the structure of any files they will be reading and/or writing described to them. The highest-level characteristic of a file's structure is defined by specifying the **ORGANIZATION** (section) of the file, as follows:

<b>ORGANIZATION IS LINE SEQUENTIAL</b>	<p>These are files with the simplest of all internal structures. Their contents are structured simply as a series of data records, each terminated by a special end-of-record delimiter character. An ASCII line-feed character (hexadecimal 0A) is the end-of-record delimiter character used by any UNIX or pseudo-UNIX (MinGW, Cygwin, OSX) GNU COBOL build. A truly native Windows build would use a carriage-return, line-feed (hexadecimal 0D0A) sequence.</p> <p>Records in this type of file need not be the same length.</p> <p>Records must be read from or written to these files in a purely sequential manner. The only way to read (or write) record number 100 would be to have read (or written) records number 1 thru 99 first.</p> <p>When the file is written by a GNU COBOL program, the delimiter sequence will be automatically added to each data record as it is written to the file. <b>WRITES</b> to this type of file will be done using an implied “<b>BEFORE ADVANCING 1 LINE</b>” clause in the absence of an explicitly-specified <b>ADVANCING</b> clause.</p> <p>When the file is read, the GNU COBOL runtime system will strip the trailing delimiter sequence from each record and pad the data (to the right) with <b>SPACES</b> if the data just read is shorter than the area described for data records in the program. If the data is too long, it will be truncated and the excess will be lost.</p> <p>These files should not be defined to contain any exact binary data fields because the contents of those fields could inadvertently have the end-of-record sequence as part of their values – this would confuse the runtime system when reading the file, and it would interpret that value as an actual end-of-record sequence.</p>
<b>LINE ADVANCING</b> files	<p>These are files with an internal structure similar to that of the <b>LINE SEQUENTIAL</b> file. These files are defined (<u>without</u> an explicit <b>ORGANIZATION</b> specification) using the <b>LINE ADVANCING</b> clause on their <b>SELECT</b> statement.</p> <p>When this kind of file is written by a GNU COBOL program, the delimiter sequence will be automatically added to each data record as it is written to the file. <b>WRITES</b> to this type of file will be done using an implied “<b>AFTER ADVANCING 1 LINE</b>” clause in the absence of an explicitly-specified <b>ADVANCING</b> clause.</p> <p>Like <b>ORGANIZATION LINE SEQUENTIAL</b> files, these files should not be defined to contain any exact binary data fields because the contents of those fields could inadvertently have the end-of-record sequence as part of their values – this would confuse the runtime system when reading the file, and it would interpret that value as an actual end-of-record sequence.</p>
<b>ORGANIZATION IS RECORD BINARY</b> <b>SEQUENTIAL</b>	<p>These files also have a simple internal structure. Their contents are structured simply as an arbitrarily-long sequence of data characters. This sequence of data characters will be treated as a series of fixed-length data records simply by logically splitting the sequence of data characters up into a series of fixed-length segments each as long as the maximum record size defined in the program. There are no special end-of-record delimiter characters in the file and</p>

when the file is written to by a GNU COBOL program, no delimiter sequence is appended to the data.

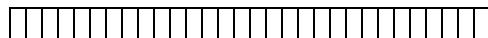
Records in this type of file are all the same physical length, except possibly for the very last record in the file, which may be shorter than the others. If variable-length logical records are defined to the program, the space occupied by each physical record in the file will occupy the maximum possible space.

So, if a file contains 1275 characters of data, and a program defines the structure of that file as containing 100-character records, then the file contents will consist of twelve (12) 100-character records with a final record containing only 75 characters.

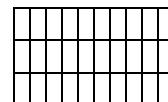
Even though it appears that it should be possible to locate and process any record in the file directly simply by calculating its starting character position based upon the program-defined record size, records must be still be read or written to these files in a purely sequential manner. The only way to read (or write) record number 100 would be to have read (or written) records number 1 thru 99 first.

When the file is read, the data is transferred into the program exactly as it exists in the file. In the event that a short record is read as the very last record, that record will be **SPACE** padded.

Care must be taken that programs reading such a file describe records whose length is exactly the same as that used by the programs that created the file. For example, the following shows the contents of a **RECORD BINARY SEQUENTIAL** file created by a program that wrote five 6-character records to it. The "A", "B", ... values and the background colors reflect the records that were written to the file:



Now, assume that another program reads this file, but described 10-character records rather than 6. Here are the records that program will read:



There may be times where this is exactly what you were looking for. More often than not, however, this is not desirable behavior. *Suggestion:* use a copybook to describe the record layouts of any file; this guarantees that multiple programs accessing that file will "see" the same record sizes and layouts.

These files can contain exact binary data fields because the contents of record fields are irrelevant to the reading process as there is no end-of-record delimiter.

#### ORGANIZATION IS RELATIVE

The contents of these files consist of a series of fixed-length data records prefixed with a four-byte record header. The record header contains the length of the data, in bytes. The byte-count does not include the four-byte record header.

Records in this type of file are all the same physical length. If variable-length logical records are defined to the program, the space occupied by each physical record in the file will occupy the maximum possible space.

This file organization was defined to accommodate either sequential or random processing. With a **RELATIVE** file, it is possible to read or write record 100 directly, without having to have first read or written records 1-99. The GNU COBOL runtime system uses the program-defined maximum record size to calculate a relative byte position in the file where the record header and data begin, and then transfers the necessary data to or from the program.

When the file is written by a GNU COBOL program, no delimiter sequence is appended to the data, but a record-length field is added to the beginning of each physical record.

When the file is read, the data is transferred into the program exactly as it exists in the file.

Care must be taken that programs reading such a file describe records whose length is exactly the same as that used by the programs that created the file. It won't be a pretty site when the

GNU COBOL runtime library ends up interpreting a four-byte ASCII character string as a record length when it transfers data from the file into the program!

*Suggestion:* use a copybook to describe the record layouts of any file; this guarantees that multiple programs accessing that file will “see” the same record sizes and layouts.

These files can contain exact binary data fields. The contents of record fields are irrelevant to the reading process as there is no end-of-record delimiter.

#### ORGANIZATION IS INDEXED

This is the most advanced file structure available to GNU COBOL programs. It’s not possible to describe the physical structure of such files because that structure will vary depending upon which advanced file-management facility was included into the GNU COBOL build you will be using (Berkeley Database [BDB], VBISAM, etc.). We will – instead – discuss the logical structure of the file.

There will be multiple structures stored for an **INDEXED** file. The first will be a data component, which may be thought of as being similar to the internal structure of a **RELATIVE** file. Data records may not, however, be directly accessed by their record number as would be the case with a **RELATIVE** file, nor may they be processed sequentially by their physical sequence in the file.

The remaining structures will be one or more index components. An index component is a data structure that (somehow) enables the contents of a field, called a *primary key*, within each data record (a customer number, an employee number, a product code, a name, etc.) to be converted to a record number so that the data record for any given primary key value can be directly read, written and/or deleted. Additionally, the index data structure is defined in such a manner as to allow the file to be processed sequentially, record-by-record, in ascending sequence of the primary key field values. Whether this index structure exists as a binary-searchable tree structure (btree), an elaborate hash structure or something else is pretty much irrelevant to the programmer – the behavior of the structure will be as it was just described. The runtime system will not allow two records to be written to an indexed file with the same primary key value.

The capability exists for an additional field to be defined as what is known as an *alternate key*. Alternate key fields behave just like primary keys, allowing both direct and sequential access to record data based upon the alternate key field values, with one exception. That exception is the fact that alternate keys may be allowed to have duplicate values, depending upon how the alternate key field is described to the GNU COBOL compiler.

There may be any number of alternate keys, but each key field comes with a disk space penalty as well as an execution time penalty. As the number of alternate key fields increases, it will take longer and longer to write and/or modify records in the file.

These files can contain exact binary data fields. The contents of record fields are irrelevant to the reading process as there is no end-of-record delimiter.

All files are initially described to a GNU COBOL program using a **SELECT** statement coded in the **FILE-CONTROL** paragraph of the **INPUT-OUTPUT SECTION** of the **ENVIRONMENT DIVISION**. In addition to defining a name by which the file will be referenced within the program, the **SELECT** statement will specify the name and path by which the file will be known to the operating system along with its **ORGANIZATION**, locking and sharing attributes.

A file description in the **FILE SECTION** of the **DATA DIVISION** will define the structure of records within the file, including whether or not variable-length records are possible and – if so – what the minimum and maximum length might be. In addition, the file description entry can specify file I/O block sizes.

#### See Also...

Defining the Characteristics of a File	<a href="#">4.2.1</a>
Describing the Structure of a File ( <b>FD/SD</b> )	<a href="#">5.1</a>

File Sharing	<a href="#">6.1.9.1</a>
Record Locking	<a href="#">6.1.9.2</a>

### 1.3.3.6. Table Handling

Other programming languages have arrays, COBOL has tables. They're basically the same thing. What makes COBOL tables special are two special statements that exist in the COBOL language – **SEARCH** and **SEARCH ALL**.

The first can search a table sequentially, stopping only when either a table entry matching one of any number of search conditions is found, or when all table entries have been checked against the search criteria and none matched any of those criteria.

The second can perform an extremely fast search against a table sorted by and searched against a “key” field contained in each table entry. The algorithm used for such a search is a binary search (also known as a half-interval search). This algorithm ensures that only a small number of entries in the table need to be checked in order to find a desired entry or to determine that the desired entry doesn’t exist in the table. The larger the table, the more effective this search becomes. For example, a table containing 32,768 entries will be able to locate a particular entry or will determine the entry doesn’t exist by looking at no more than fifteen (15) entries! The algorithm is explained in detail in the **SEARCH ALL** documentation.

#### *See Also...*

Defining Tables 0	The <b>SEARCH</b> Statement <a href="#">6.4.38.1</a>
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### 1.3.3.7. Sorting and Merging Data

The COBOL language includes a powerful **SORT** statement that can sort large amounts of data according to arbitrarily complex key structures. This data may originate from within the program or may be contained in one or more external files. The sorted data may be written automatically to one or more output files or may be processed, record-by-record in the sorted sequence.

A special form of the **SORT** statement also exists just to sort the data that resides in a table. This is particularly useful if you wish to use **SEARCH ALL** against the table.

A companion statement – **MERGE**– can combine the contents of multiple files together, provided those files are all sorted in a similar manner according to the same key structure(s). The resulting output will consist of the contents of all of the input files, merged together and sequenced according to the common key structure(s). The output of a **MERGE** may be written automatically to one or more output files or may be processed internally by the program.

#### *See Also...*

The <b>MERGE</b> Statement <a href="#">6.4.25</a>	The <b>SORT</b> Statement (File Sort) <a href="#">6.4.40.1</a>
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### 1.3.3.8. String Manipulation

There have been programming languages designed specifically for the processing of text strings, and there have been programming languages designed for the sole purpose of performing high-powered numerical computations. Most programming languages fall somewhere in the middle, between these two extremes. COBOL is no exception, although it does include some very powerful string manipulation capabilities; GNU COBOL actually has even more string-manipulation capabilities than many other COBOL implementations.

#### *See Also...*

Concatenate Two Or More Strings	<b>CONCATENATE</b> Intrinsic Function	<a href="#">6.1.7.9</a>
	<b>STRING</b> Statement	<a href="#">6.4.43</a>
Conversion Of A Numeric Time Or Date To A Formatted Character String	<b>LOCATE-TIME</b> Intrinsic Function	<a href="#">6.1.7.35</a>
	<b>LOCATE-DATE</b> Intrinsic Function	<a href="#">6.1.7.32</a>
Convert A Binary Value To Its Corresponding Character In The Program’s Characterset	CHAR Intrinsic Function; add 1 to argument before invoking the function; The description of the <b>CHAR</b> function shows a technique that utilizes the <b>MOVE</b> statement that will accomplish the same thing without the need of adding 1 to the numeric argument value first	<a href="#">6.1.7.7</a>

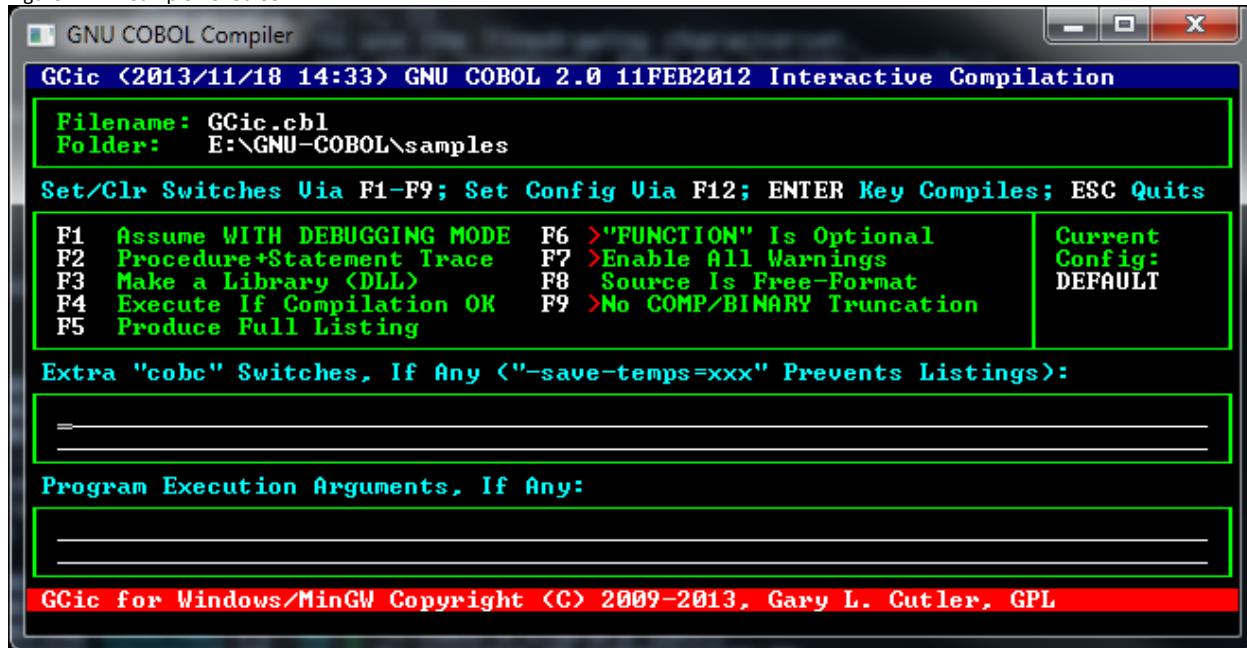
Convert A Character String To Lower-Case	<b>LOWER-CASE</b> Intrinsic Function	<a href="#">6.1.7.39</a>
	<b>C\$TOLOWER</b> Built-in Subroutine	<a href="#">8.3.1.13</a>
	<b>CBL_TOLOWER</b> Built-in Subroutine	<a href="#">8.3.1.40</a>
Convert A Character String To Upper-Case	<b>UPPER-CASE</b> Intrinsic Function	<a href="#">6.1.7.87</a>
	<b>C\$TOUPPER</b> Built-in Subroutine	<a href="#">8.3.1.14</a>
	<b>CBL_TOUPPER</b> Built-in Subroutine	<a href="#">8.3.1.41</a>
Convert A Character String To Only Printable Characters, Changing Any Non-Printable Characters To A Default (".") Or Programmer-Specified Replacement Character.	<b>C\$PRINTABLE</b> Built-in Subroutine	<a href="#">8.3.1.11</a>
Convert A Character To Its Numeric Value In The Program's Characterset	<b>ORD</b> Intrinsic Function; subtract 1 from the result; The description of the <b>ORD</b> function shows a technique that utilizes the <b>MOVE</b> statement that will accomplish the same thing without the need of adding 1 to the numeric argument value first	<a href="#">6.1.7</a>
Count Occurrences Of Substrings In A Larger String	<b>INSPECT</b> Statement with <b>TALLYING</b> Option	<a href="#">6.4.24</a>
Decode A Formatted Numeric String Back To A Numeric Value (For Example, Decode "\$12,342.19-" To A -12342.19 Value)	<b>NUMVAL</b> Intrinsic Function	<a href="#">6.1.7.54</a>
	<b>NUMVAL-C</b> Intrinsic Function (handles currency-formatted strings)	<a href="#">6.1.7.59</a>
Determine The Length Of A String Or Data-Item Capable Of Storing Strings	<b>LENGTH</b> Intrinsic Function	<a href="#">6.1.7.31</a>
	<b>BYTE-LENGTH</b> Intrinsic Function	<a href="#">6.1.7.6</a>
Extract A Substring Of A String Based On Its Starting Character Position And Length	Use of a reference modifier on the string field.	<a href="#">6.1.3</a>
Format A Numeric Item For Output, Including Thousands-Separators ("," In The USA), Currency Symbols ("\$" In The USA), Decimal Points, Credit/Debit Symbols, Leading Or Trailing Sign Characters	<b>MOVE</b> Statement with picture-symbol editing applied to the receiving field	<a href="#">5.3</a> and <a href="#">6.4.26</a>
Justification (Left, Right Or Centered) Of A String Field	<b>C\$JUSTIFY</b> built-in subroutine	<a href="#">8.3.1.6</a>
Monoalphabetic Substitution Of One Or More Characters In A String With Different Characters	<b>INSPECT</b> Statement with <b>CONVERTING</b> Option	<a href="#">6.4.24</a>
	<b>TRANSFORM</b> Statement	<a href="#">6.4.47</a>
	<b>SUBSTITUTE</b> Intrinsic Function	<a href="#">6.1.7.77</a>
	<b>SUBSTITUTE-CASE</b> Intrinsic Function	<a href="#">6.1.7.78</a>
Parse A String, Breaking It Up Into Substrings Based Upon One Or More Delimiting Character Sequences; These Delimiters May Be Single Characters, Multiple-Character Strings Or Multiple Consecutive Occurrences Of Either	<b>UNSTRING</b> Statement	<a href="#">6.4.49</a>
Removal Of Leading Or Trailing Spaces From A String	<b>TRIM</b> Intrinsic Function	<a href="#">6.1.7.83</a>
Substitution Of A Single Substring With Another Of The Same Length, Based Upon The Substrings Starting Character	<b>MOVE</b> Statement with a reference modifier on the "receiving" field	<a href="#">6.1.3</a> and <a href="#">6.4.26.1</a>

Position And Length	
Substitution Of One Or More Substrings In A String With Replacement Substrings <u>Of The Same Length</u> , Regardless Of Where They Occur	<b>INSPECT Statement with REPLACING Option</b> <a href="#">6.4.24</a>
	<b>SUBSTITUTE Intrinsic Function</b> <a href="#">6.1.7.77</a>
	<b>SUBSTITUTE-CASE Intrinsic Function</b> <a href="#">6.1.7.78</a>
Substitution Of One Or More Substrings In A String With Replacement Substrings <u>Of A Potentially Different Length</u> , Regardless Of Where They Occur	<b>SUBSTITUTE Intrinsic Function</b> <a href="#">6.1.7.77</a>
	<b>SUBSTITUTE-CASE Intrinsic Function</b> <a href="#">6.1.7.78</a>

### 1.3.3.9. Textual-User Interface (TUI) Features

The COBOL2002 standard formalizes extensions to the COBOL language that allow for the definition and processing of text-based screens, as is a typical function on mainframe computers. GNU COBOL implements virtually all the screen-handling features described by COBOL2002. Here is an example of such a screen as it might appear in the console window of a Windows computer:

Figure 1-1 - A Sample TUI Screen



Screens such as this<sup>7</sup> are defined in the **SCREEN SECTION** of the **DATA DIVISION**. Once defined, screens are used at run-time via the **ACCEPT** and **DISPLAY** statements.

The COBOL2002 standard only covers textual-user interface (TUI) screens and not the more-advanced graphical-user interface (GUI) screen design and processing capabilities built into most modern operating systems. There are subroutine-based packages available that can do full GUI development, but none are open-source.

#### See Also...

Defining Screens [5.6](#)

The ACCEPT Statement (Screen Data) [6.4.1.4](#)

The DISPLAY Statement (Screen Data) [6.4.12.4](#)

<sup>7</sup> This screen comes from the program named GCic – a full-screen front-end to the GNU COBOL compiler – the source code of which is included as a sample in this manual. See section [10.4](#) for the listing of the program.

## 1.4. Syntax Description Conventions

Syntax of the GNU COBOL language will be described in this manual with conventions familiar to COBOL programmers, with a few coloring conventions thrown in to aid in readability and interpretation. The following is a description of those syntactical-description techniques:

Black	Syntactical elements that are part of the GNU COBOL language (including required punctuation symbols, operators and so on) will appear in black. Other colors such as red and blue will be used to highlight those elements that are merely part of the syntax description.
<b>UPPERCASE</b>	COBOL language keywords and implementation-dependent names (the so-called “reserved words” of the COBOL language) will appear in <b>BOLD UPPERCASE</b> .
<b><u>UNDERLINING</u></b>	reserved words that are <b><u>UNDERLINED</u></b> are required in whatever syntactical context they are shown. If a reserved word is not underlined, it is optional and its presence or absence has no effect on the program.
<i>lowercase-italic</i>	Generic terms representing substitutable items will be shown in <i>italic lowercase</i> .
<b>[ optional-syntax ]</b>	<b>Red Square brackets</b> are used to enclose optional syntax. Any clauses not enclosed in square brackets are mandatory. These are also used sometimes in conjunction with the ellipsis (...) to indicate an optional syntactical item that could be repeated.
<b>choice-1   choice-2</b>	Simple choices may be indicated with a <b>red vertical bar</b> separating them. Although not typically used in COBOL syntactical diagrams, this convention is an effective alternative that may be used when square brackets would make a syntax diagram too complicated. For example, <b>THRU   THROUGH</b> would indicate that either of the required reserved words <b>THRU</b> or <b>THROUGH</b> may be used.
<b>{ choice-1 choice-2 }</b>	<b>Red braces</b> are used to enclose choices. <b>Exactly one</b> of the choices contained within the braces must be selected. These are also used sometimes in conjunction with the ellipsis (...) to indicate a choice of syntactical items that may be repeated.
...	A <b>red three-dot sequence</b> (called an “ellipsis”) may appear following <b>[ ], { }</b> or <i>lowercase italic entries</i> to indicate that the syntax element preceding the ellipsis may occur multiple times.
Shaded Areas	Shaded areas are used to highlight syntax elements that are <u>recognized</u> by the GNU COBOL compiler but will either have no effect on the generated code or will have a compiler warning issued announcing that feature is unsupported. Such elements are either present in the GNU COBOL language to facilitate the porting of programs from other COBOL environments, reflect syntax elements that are not yet fully implemented or syntax elements that have become obsolete.

## 1.5. General GNU COBOL Program Format

### 1.5.1. Source Line Format

#### 1.5.1.1. Fixed Format Mode

Prior to the COBOL2002 standard, source statements in COBOL programs were oriented around 80-column punched cards. This means that each source line in a COBOL program consisted of five different “areas”, defined by their column number.

This structure is enforced by GNU COBOL when the compiler is operating in **Fixed Format Mode**; Fixed Format Mode is the default mode in effect when the compiler begins execution.

Column Numbers	Area Name	Usage
1-6	Sequence Number Area	<p>Historically back in the days when punched-cards were used to submit COBOL program source to a COBOL compiler, this part of a COBOL statement was reserved for a six-digit sequence number.</p> <p>While the contents of this area are ignored by COBOL compilers, it existed so that a program actually punched on 80-character cards could – if the card deck were dropped on the floor – be run through a card sorter machine and restored to its proper sequence. Of course, this isn’t necessary today; if truth be told, it hasn’t been necessary for a long time.</p> <p>See Section <a href="#">9.1</a> for a discussion of how this area tends to be used today.</p>
7	Indicator Area	<p>Column 7 serves as an indicator in which one of five possible values will appear – space, “D” (or “d”), “-“ (dash), “/” or “*”. The vast majority of COBOL source file lines have a space in this position. The values “D”, “*” and “/” are three different types of “comment” indicators, telling the compiler to (normally) ignore this source line.</p> <p>A value of “-“ served as a continuation character in the event that a literal value, reserved word or programmer-defined name needed to be split across two lines of code. This is/was rarely used and – when it does – is/was almost always used to continue an alphanumeric literal (character string).</p>
8-11	“Area A”	Language DIVISION, SECTION and paragraph section headers must begin in Area A, as must the level numbers 01, 77 in data description entries and the “FD” and “SD” file and SORT description headers.
12-72	“Area B”	All other COBOL programming language components are coded in these columns.
73-80	Program Name Area	<p>This is another area of COBOL statements that is ignored by COBOL compilers. This part of every statement also hails back to the day when programs were punched on cards – it was expected that the name of the program (or at least the first 8 characters of it) would be punched here so that – if a dropped COBOL source deck contained more than one program, that handy card sorter machine could be used to first separate the cards by program name and then sort them by sequence number.</p> <p>Today’s COBOL compilers (including GNU COBOL) simply ignore anything past column 73</p>

The GNU COBOL compiler (cdbc) operates in fixed format mode by default (you may explicitly specify the “-fixed” switch, if you wish, but that is the default mode), unless you specify otherwise in one of the following ways:

- ▶ You run the compiler with the “-free” switch to turn on free-format mode.
- ▶ You use the “>>SET SOURCEFORMAT AS FREE” CDF directive to turn on free-format mode
- ▶ You use the “>>SOURCE FORMAT IS FREE” CDF directive to turn on free format mode

*See Also...*

Coding Comments in Programs <a href="#">1.6</a>	The Compiler Directing Facility (CDF) <a href="#">2.2</a>
Alphanumeric Literals <a href="#">1.8.2</a>	

### 1.5.1.2. Free Format Mode

As of the COBOL2002 standard, a second mode now exists for COBOL source code statements – Free Format Mode.

In this mode of operation, GNU COBOL statements may each be up to 255 characters long, with no specific requirements as to what should appear in which columns.

The GNU COBOL compiler (cobic) can be commanded to operate in free format mode in any of the following ways:

- ▶ You run the compiler with the “-free” switch
- ▶ You use the **>>SET SOURCEFORMAT AS FREE** CDF directive to turn on free-format mode
- ▶ You use the **>>SOURCE FORMAT IS FREE** CDF directive to turn on free format mode

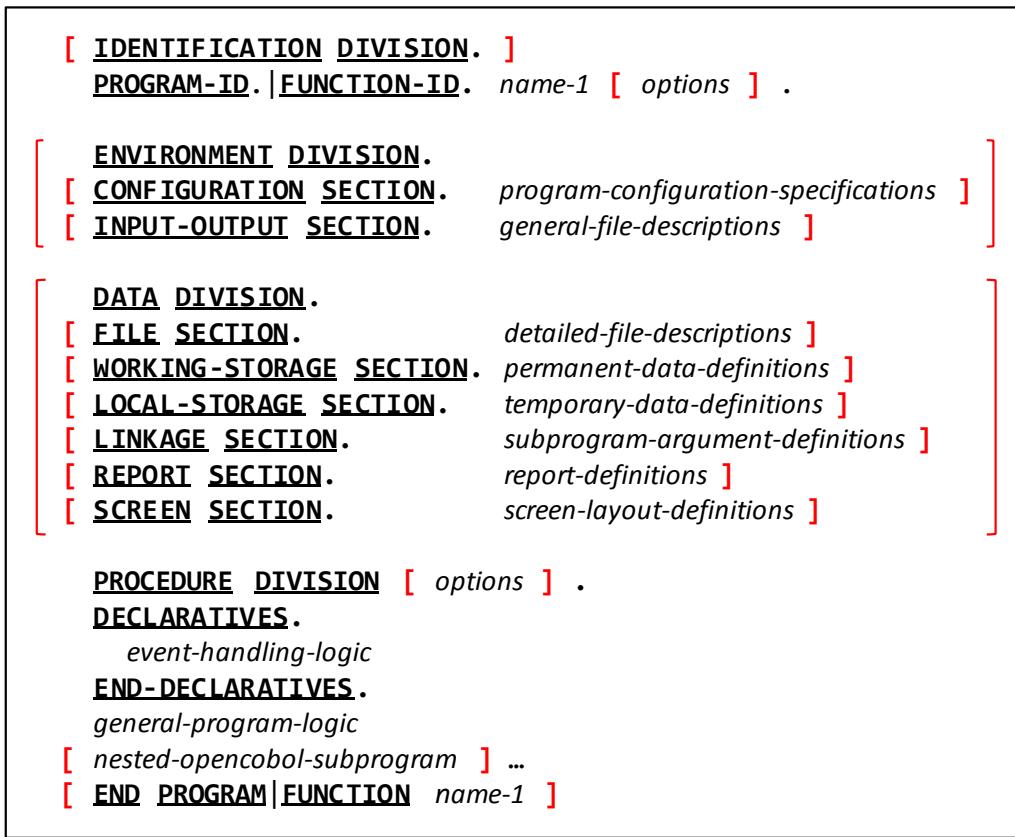
Using **>>SET** and **>>SOURCE** directives in your source code, you may switch back and forth between fixed and free format mode at will.

*See Also...*

Coding Comments in Programs <a href="#">1.6</a>	The Compiler Directing Facility (CDF) <a href="#">2.2</a>
Alphanumeric Literals <a href="#">1.8.2</a>	

### 1.5.2. Program Structure

Figure 1-2 – General Format of a GNU COBOL Program



What you see here is the general format of a GNU COBOL program. Each program consists of up to four DIVISIONS (major groupings of language statements that all relate to a common purpose). Not all divisions are needed in every program, but they must be specified in the order shown when they are used.

This general program structure looks quite intimidating, but bear in mind that each DIVISION and SECTION you see here serves a very specific function, and it is rare to find a program that needs each and every one of those functions!

1. A single file of COBOL source code may contain:
  - a. A portion of a program; these files are known as copybooks
  - b. A single program. In this case, the **END PROGRAM / END FUNCTION** statement is optional.
  - c. Multiple programs, separated from one another by **END PROGRAM / END FUNCTION** statements. The final program in such a source code file need not have an **END PROGRAM / END FUNCTION** statement.
2. Program “B” may be *nested* inside program “A” by including program B’s source code at the end of program A’s **PROCEDURE DIVISION** without an intervening **END PROGRAM A / END FUNCTION A** statement. For now, that’s all that will be said about nesting. Regardless of how many programs comprise a single GNU COBOL source file (see #1c), only a single output executable program will be generated from that source file when the file is compiled.
3. Here is a brief summary of the purpose of each DIVISION in a program:

DIVISION	Purpose
<b>IDENTIFICATION</b>	The <b>IDENTIFICATION DIVISION</b> provides basic identification of the program (or function) by giving it a name. While the <b>IDENTIFICATION DIVISION</b> is required in all programs, the actual “ <b>IDENTIFICATION DIVISION</b> ” header – as of the COBOL2002 standard – is not.
<b>ENVIRONMENT</b>	The <b>ENVIRONMENT DIVISION</b> defines the external computer environment in which the program will be operating. This includes defining any files that the program may be accessing.
<b>DATA</b>	The <b>DATA DIVISION</b> is used to define all data that will be processed by a program.
<b>PROCEDURE</b>	The <b>PROCEDURE DIVISION</b> contains all executable program code.

#### See Also...

Copybooks <a href="#">1.3.3.3</a>	The <b>IDENTIFICATION DIVISION</b> 3
Subprograms Subroutines vs Functions <a href="#">7.1</a>	The <b>ENVIRONMENT DIVISION</b> 4
Details Of Nested Subprograms <a href="#">7.6</a>	The <b>DATA DIVISION</b> 5
	The <b>PROCEDURE DIVISION</b> 6

## 1.6. In-Program Documentation (i.e. “Comments”)

The following chart documents how comments may be imbedded into GNU COBOL program source to provide documentation.

Type of Comment	When in “FIXED” Mode...	When in “FREE” Mode...
Blank lines	Blank lines may be inserted as desired.	Blank lines may be inserted as desired.
Full-line comments	An entire source line will be treated as a comment (and will be ignored by the compiler) by coding an asterisk (“*”) in column seven (7).	An entire source line will be treated as a comment (and will be ignored by the compiler) by coding the sequence “*>”, starting in any column, as the first non-blank characters on the line.
Full-line comments with form-feed	An entire source line will be treated as a comment by coding a slash (“/”) in column seven (7). In addition, most COBOL compilers capable of generating source program listings will issue a form-feed in the listing so that the “/” line is at the top of a new page of the listing. The GNU COBOL compiler (cobic) does <u>not</u> support this form-feed behavior, although it does treat “/” lines as comments. The GNU COBOL Interactive Compiler, or GCic, <u>does</u> support this form-feed behavior when it generates program source listings! GCic is a GNU COBOL program that provides a full-screen front-end to the actual GNU COBOL compiler. You can see a screenshot of it in section <a href="#">1.3.9</a> .	There is no FREE-mode equivalent to “/”.

Type of Comment	When in “FIXED” Mode...	When in “FREE” Mode...
Partial-line comments	Any text following the character sequence “*>” on a source line will be treated as a comment. The “*” must appear in column seven (7) or beyond.	Any text following the character sequence “*>” on a source line will be treated as a comment. The “*” may appear in any column.
Comments that may be treated as code (typically for debugging purposes)	By coding a “D” in column 7 (upper- or lower-case), an otherwise valid GNU COBOL source line will be treated as a comment by the compiler.	By specifying the character sequence “>>D” (upper- or lower-case) as the first non-blank characters on a source line, an otherwise valid GNU COBOL source line will be treated as a comment by the compiler.
	Such statements may be compiled either by specifying the “-fdebugging-line” switch on the GNU COBOL compiler or by adding the “WITH DEBUGGING MODE” clause to the SOURCE-COMPUTER paragraph.	

*See Also...*The SOURCE-COMPUTER Paragraph [4.1.1](#)Sample Program Listing: GCic [9.4](#)

## 1.7. Use of Commas and Semicolons

A comma (“,”) or a semicolon (“;”) may be inserted into a GNU COBOL program to improve readability at any spot where white space would be legal (except, of course, within alphanumeric literals). These characters are always optional.

The use of comma characters can cause “confusion” to a COBOL compiler if the **DECIMAL POINT IS COMMA** clause is used in **SPECIAL-NAMES**. The following statement, which calls a subroutine passing it two arguments (the numeric constants 1 and 2):

```
CALL "SUBROUTINE" USING 1,2
```

would – with **DECIMAL POINT IS COMMA** in effect – actually be interpreted as a subroutine call with ONE argument (the non-integer numeric constant 1.2).

*See Also...*The SPECIAL-NAMES Paragraph [4.1.4](#)

## 1.8. Use of Literals

Literals are constant values that will not change during the execution of a program. There are two fundamental types of literals – numeric and alphanumeric.

### 1.8.1. Numeric Literals

Numeric literals are numeric constants which may be used as array subscripts, as values in arithmetic expressions, or in any procedural statement where a numeric value may be used. Numeric literals may take any of the following forms:

- ▶ Integers such as 1, 56, 2192 or -54.
- ▶ Non-integer fixed point values such as 1.12 or -2.95.
- ▶ Floating-point values using “Enn” notation such as 9.92E25 (representing  $9.92 \times 10^{25}$ ) or 5.7E-14 (representing  $5.7 \times 10^{-14}$ ). Both the mantissa (the number before the E) and the exponent (the number after the E) may be explicitly specified as positive (with a +), negative or unsigned (and therefore implicitly positive). A floating-point literal’s value must be within the range  $-1.7 \times 10^{308}$  to  $+1.7 \times 10^{308}$  with no more than 15 decimal digits of precision.
- ▶ Hexadecimal numeric literals such as H”1F” ( $1F_{16} = 31_{10}$ ), h’22’ ( $22_{16} = 34_{10}$ ) or H’DEAD’ ( $DEAD_{16} = 57005_{10}$ ). The H character may either be upper- or lower-case and either single quote (‘) or double-quote (“) characters may be used. Hexadecimal numeric literals are limited to a maximum value of H’FFFFFFFFFFFFFF’ (a 64-bit value).

## 1.8.2. Alphanumeric Literals

Alphanumeric literals are character strings suitable for display on a computer screen, printing on a report, transmission through a communications connection or storage in **PICTURE X** or **PICTURE A** data items. These are NOT valid for use in arithmetic expressions unless they can first be converted to their numeric computational equivalent via the **NUMVAL** and **NUMVAL-C** intrinsic functions.

Alphanumeric literals may take any of the following forms:

- ▶ Any sequence of characters enclosed by a pair of single-quote (') characters or a pair of double-quote ("") characters constitutes a *string literal*. The double-quote character ("") may be used as a data character within an apostrophe-delimited string literal, and an apostrophe may be used as a data character within a double-quote-delimited string literal. If an apostrophe character must be included as a data character within an apostrophe-delimited string literal, express that character as two consecutive apostrophes (""). If a double-quote character must be included as a data character within a double-quote-delimited string literal, express that character as two consecutive double-quotes ("").
- ▶ A literal formed according to the same rules as for a string literal (above), but prefixed with the letter "Z" (upper- or lower-case) constitutes a *zero-delimited string literal*. These literals differ from ordinary string literals in that they will be explicitly terminated with a byte of hexadecimal value 00. This facilitates the "sharing" of such literals with C programs<sup>8</sup>.
- ▶ A hexadecimal literal such as X"4A4B4C" (4A4B4C<sub>16</sub> = the ASCII string 'JKL'), x'20' (20<sub>16</sub> = a space) or X'30313233' (30313233<sub>16</sub> = the ASCII string '0123'). The "X" character may either be upper- or lower-case and either single quote (') or double-quote ("") characters may be used. These hexadecimal alphanumeric literals should always consist of an even number of hexadecimal digits, because each character is represented by eight bits worth of data (2 hex digits). Hexadecimal alphanumeric literals may be of almost unlimited length.

Alphanumeric literals too long to fit on a single line may be continued to the next line in one of two ways:

1. If you are using Fixed Format Mode, the alphanumeric literal can be run right up to and including column 72. The literal may then be continued on the next line anywhere after column 11 by coding another quote or apostrophe (whichever was used to begin the literal originally). The continuation line must also have a hyphen (-) coded in the indicator area (column 7). Here is an example:

1	2	3	4	5	6	7	8
12345678901234567890123456789012345678901234567890123456789012345678901234567890							
01 LONG-LITERAL-VALUE-DEMO      PIC X(60) VALUE "This is a long 1							
"iteral that must							
" be continued."							

2. Regardless of whether the compiler is operating in Fixed or Free Format Mode, GNU COBOL allows alphanumeric literals to be broken up into separate fragments. These fragments have their own beginning and ending quote/apostrophe characters and are "glued together" at compilation time using "&" characters. No continuation indicator is needed. Here's an example:

1	2	3	4	5	6	7	8
1234567890123456789012345678901234567890123456789012345678901234567890							
01 LONG-LITERAL-VALUE-DEMO      PIC X(60) VALUE "This is a" &							
" long literal that must " &							
"be continued."							

If your program is using Free Format Mode, there's less need to continue long alphanumeric literals because statements may be as long as 255 characters.

Numeric literals may be split across lines just as alphanumeric literals are, using either of the above techniques and both reserved and user-defined words can be split across lines too (using the first technique). The continuation of numeric literals and user-defined/reserved words is provided merely to provide compatibility with older COBOL versions and programs, but should not be used with new programs – it just makes for ugly-looking programs.

<sup>8</sup> In the C programming language, strings must be terminated with a null byte (X'00').

**See Also...**

Fixed-Format Source Code <a href="#">1.5.1.1</a>	The <b>NUMVAL</b> Intrinsic Function <a href="#">6.1.14.58</a>
Defining a Data Item's <b>PICTURE</b> <a href="#">5.2.1.6</a>	The <b>NUMVAL-C</b> Intrinsic Function <a href="#">6.1.14.59</a>

## 1.9. Use of Figurative Constants

Figurative constants are reserved words that may be used in lieu of certain literals. In general, a figurative constant may be freely used anywhere its corresponding value could have been used; when used, their value is interpreted were an arbitrarily long sequence of the characters in question.

The following chart lists the GNU COBOL figurative constants and their respective equivalent values.

Figure 1-3 - Figurative Constants

Figurative Constant	Type of Literal	Equivalent Value
<b>ZERO, ZEROS, ZEROES</b>	Numeric	0
<b>SPACE, SPACES</b>	Alphanumeric	Blank
<b>QUOTE, QUOTES</b>	Alphanumeric	Double-quote character(s)
<b>LOW-VALUE, LOW-VALUES</b>	Alphanumeric	The character whose value in the programs collating sequence is lowest. If a program is using the ASCII collating sequence, this will represent a sequence of characters comprised entirely of 0-bits.
<b>HIGH-VALUE, HIGH-VALUES</b>	Alphanumeric	The character whose value in the programs collating sequence is highest. If a program is using the ASCII collating sequence, this will represent a sequence of characters comprised entirely of 1-bits.
<b>NULL</b>	Alphanumeric	A character comprised entirely of zero-bits (regardless of the programs collating sequence).

## 1.10. User-Defined Names

When you write GNU COBOL programs, you'll need to create a variety of names to represent various aspects of the program, the programs data and the external environment in which the program is running.

User-defined names may be composed from the characters "A" through "Z" (upper- and/or lower-case), "0" through "9", dash ("–") and underscore ("\_"). User-defined names may neither start nor end with hyphen or underscore characters.

With the exception of [procedure names](#), user-defined names must contain at least one letter.

When user-defined names are created as names for data, they will be referenced in this document under the term [identifier](#).

## 1.11. Use of LENGTH OF

Alphanumeric literals and identifiers may optionally be prefixed with the clause "**LENGTH OF**". In such cases, the literal actually is a numeric literal with a value equal to the number of bytes in the alphanumeric literal. For example, the following two GNU COBOL statements both display the same result (27):

**LENGTH OF** [ *numeric-literal-1* *identifier-1* ]

```
01 Demo-Identifier      PIC X(27).  *> This is a 27-character data-item
.
.
.
DISPLAY LENGTH OF "This is a LENGTH OF Example"
DISPLAY LENGTH OF Demo-Identifier
DISPLAY 27
```

The **LENGTH OF** clause on a *literal* or *identifier* reference may generally be used anywhere a numeric literal might be specified, with the following exceptions:

1. In place of a literal on a **DISPLAY** statement.
2. As part of a **WRITE** or **RELEASE** statement's **FROM** clause.
3. As part of the **TIMES** clause of a **PERFORM**.

## 2. The GNU COBOL Compiler Directing Facility [CDF]

The Compiler Directing Facility is a means of controlling the compilation of GNU COBOL programs , providing a mechanism for dynamically setting or resetting certain compiler switches, introducing new source code from one or more source code libraries, making dynamic source code modifications or conditionally processing / ignoring source statements.

When the compiler is operating in FIXED mode, all CDF statements must begin in column eight (8) or beyond.

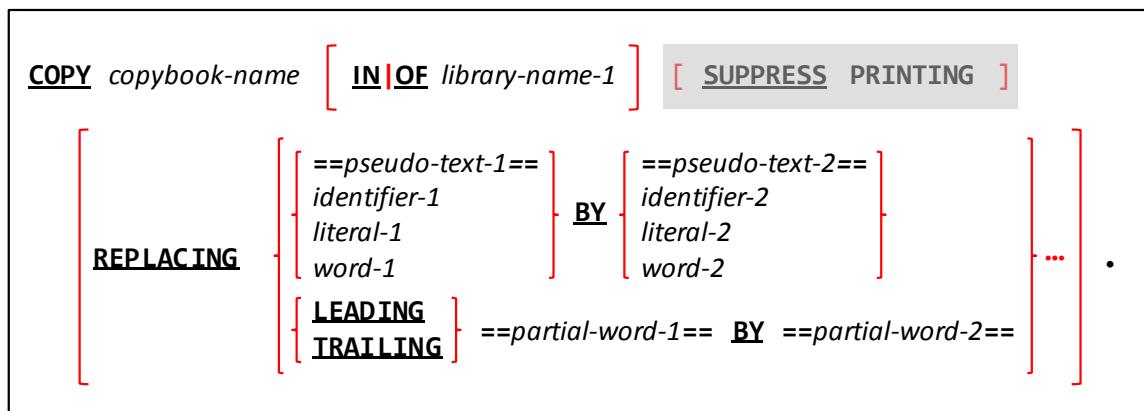
There are two types of supported CDF statements in GNU COBOL – Text Manipulation Statements and Compiler Directives.

### 2.1. Text Manipulation Statements

CDF text manipulation statements are used to introduce new code into programs either with or without changes, or may be used to modify existing statements already in the program.

#### 2.1.1. The COPY Statement

Figure 2-1 - COPY Syntax



COPY statements are used to import copybooks into a program.

GNU COBOL completely supports the use of copybooks. These are separate source files containing **ANY GNU COBOL SYNTAX WHATSOEVER**, including other CDF statements.

1. **COPY** statements may be used anywhere within a COBOL program where the code contained within the copybook would be syntactically valid.
2. The syntax diagram above places great emphasis on a period at the end of the **COPY** statement and any **REPLACING** clauses it may have. A period is absolutely mandatory at the end of every **COPY** statement, even if the **COPY** statement occurs within the scope of a command where a period might appear disruptive (such as within the scope of an **IF...END-IF** sequence; the period on the **COPY** command will not, however, affect the command scope in which the **COPY** occurs).
3. All **COPY** statements are resolved and the contents of the corresponding copybooks inserted into the program source code before the actual compilation process begins.
4. The optional “**REPLACING**” clause allows any reserved words (*word-1, word-2*), data items (*identifier-1, identifier-2*), literals (*literal-1, literal-2*) or whitespace-delimited phrases to be replaced. Any number of such substitutions may be made as a copybook is included into a program.

See Also...

Copybooks [1.3.3.3](#)

How the Compiler Finds Copybooks [8.1.5](#)

#### 2.1.2. The REPLACE Statement

**Format 1:**

Figure 2-2 - REPLACE (Format 1) Syntax

```

REPLACE [ ALSO ] [ [ LEADING ] [ TRAILING ] ==partial-word-1== BY ==partial-word-2== ] .

```

**Format 2:**

Figure 2-3 - REPLACE (Format 2) Syntax

```

REPLACE [ LAST ] OFF .

```

The **REPLACE** statement provides a mechanism for changing all or part of one or more GNU COBOL statements.

1. The syntax diagrams above place great emphasis on a period at the end of the **REPLACE**. A period is absolutely mandatory at the end of every **REPLACE** statement, even if the **REPLACE** statement occurs within the scope of a command where a period might appear disruptive (such as within the scope of an **IF...END-IF** sequence; the period on the **REPLACE** command will not, however, affect the command scope in which the **REPLACE** occurs).
2. The **REPLACE** statement can be used to make changes to program source code in much the same way as the **REPLACING** option of the **COPY** statement can.
3. Once a Format 1 **REPLACE** statement is encountered in the compilation unit, it will remain in-effect – continuing to make those source code changes it specifies – until one of the following occurs:
  - a. Another Format 1 **REPLACE** is encountered; in such a case, the change rules defined by the former Format 1 **REPLACE** will be replaced by those defined by the new **REPLACE**, unless the newly-encountered **REPLACE** statement includes the “**ALSO**” keyword; in this instance, the **REPLACE** currently in-effect will be “remembered” and then replaced by one combining the effects of the currently in-effect **REPLACE** and the new one.
  - b. A Format 2 **REPLACE** is encountered. If the Format 2 **REPLACE** includes the “**LAST**” keyword, the currently in-effect **REPLACE** will be terminated and the most-recently “remembered” **REPLACE** will be re-activated. If the Format 2 **REPLACE** does not include the “**LAST**” keyword, the currently in-effect **REPLACE** will be terminated and all “remembered” prior **REPLACES** will be discarded; no further changes will be made until such a point as another Format 1 **REPLACE** (if any) is encountered.
  - c. The last line of source code in the compilation unit has been processed.

## 2.2. CDF Directives

Compiler Directing Facility directives, or statements, are denoted by the presence of a “>>” character sequence as part of the statement name itself – are used to influence the process of program compilation.

### 2.2.1. The >>DEFINE Directive

Figure 2-4 - &gt;&gt;DEFINE Syntax

```

>>DEFINE [ CONSTANT ] cdf-variable-1 AS [ [ OFF ] [ PARAMETER ] [ literal-1 ] [ OVERRIDE ] ]

```

Use **>>DEFINE** to create CDF variables and (optionally) assign them either literal or environment variable values.

1. CDF variables defined in this way become undefined once an **END PROGRAM** or **END FUNCTION** directive is encountered in the input source.

2. The **>>DEFINE** statement is one way to create CDF variables that may be processed by other CDF statements such as **>>IF**. The **>>SET** statement provides another way to create them.
3. CDF variable names follow the rules for standard GNU COBOL user-defined names, and may not duplicate any CDF reserved word. CDF variable names may duplicate COBOL reserved words, provided the **CONSTANT** option is not specified, but such names are not recommended.
4. The **CONSTANT** option, valid only in conjunction with *literal-1*, defines a CDF variable that may be used within your regular COBOL code as if it were a literal value. Without the **CONSTANT** option, the CDF variable may only be referenced on other CDF statements.
5. The **OFF** option is used to create a variable without assigning it any value.
6. The **PARAMETER** option is used to create a variable whose value is that of the environment variable of the same name. Note that this value assignment occurs at compilation time, not program execution time.
7. The “*literal-1*” option is used to specify a numeric or alphanumeric literal, as previously discussed.
8. In the absence of the **OVERRIDE** option, *cdf-variable-1* must not yet have been **DEFINED**.
9. When the **OVERRIDE** option is specified, *cdf-variable-1* will be created with the specified value, if it had not yet been **DEFINED**, or it will be re-**DEFINED** with the new value if it had already been **DEFINED**.

#### 10. See Also...

Literals [1.8](#)

The **>>SET** CDF Statement [2.2.3](#)

User-defined Names [1.10](#)

## 2.2.2. The **>>IF** Directive

Figure 2-5 - **>>IF** Syntax

```
>>IF constant-conditional-expression-1
  [ program-source-lines-1 ]
  [ >>ELIF constant-conditional-expression-1
    [ program-source-lines-2 ] ...
  [ >>ELSE
    [ program-source-lines-n ] ...
  >>END-IF
```

Conditionally process or ignore COBOL source statements and/or CDF text-manipulation statements depending upon the value of one or more conditional expressions based upon CDF variables.

1. Each **>>IF** statement must be terminated by an **>>END-IF** statement.
2. There may be any number of **>>ELIF** clauses following an **>>IF**, including zero.

3. The syntax of a *constant-conditional expression* is as follows:

Figure 2-6 - **>>IF** constant-conditional-expression Format

```
{ cdf-variable-1 } IS [ NOT ] { DEFINED
                                SET
                                cdf-relational-operator [ cdf-variable-2 ]
                                literal-2 }
```

4. The *text-1*, *text-2* and *text-n* entries represent lines of source code that may consist of any number of GNU COBOL statements and/or CDF text-manipulation statements (including none at all). Currently, *text-1*, *text-2* and *text-n* should not contain any CDF compiler directives (“>>” statements).
5. Each *constant-conditional-expression* will be evaluated in the sequence in which they are coded in the **>>IF** statement and any **>>ELIF** clauses that may be present until one evaluates to **TRUE**. Once one of them evaluates to **TRUE**, the corresponding *text* block of statements will be processed by the compiler and all others within the scope of the **>>IF** statement will be skipped. If none of them evaluate to **TRUE**, the *text-n* block of statements (following the **>>ELSE** clause) will be processed by the compiler and all others within the scope of the **>>IF**

statement will be skipped. If none of the *constant-conditional-expressions* evaluate to **TRUE** and there is no **>>ELSE** clause, then none of the *text* blocks of statements within the scope of the **>>IF** will be processed by the compiler.

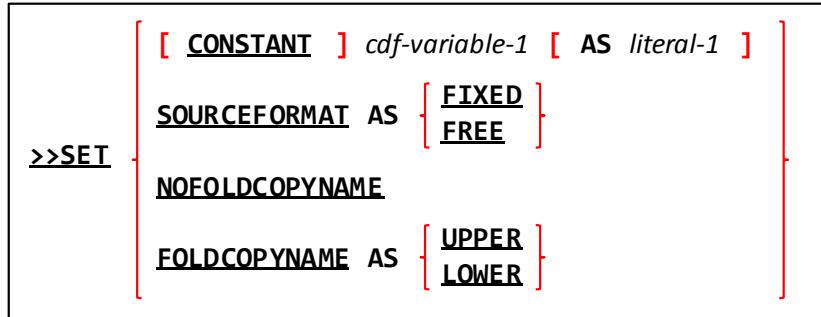
6. The following rules pertain to *constant-conditional-Expressions*
  - a. The **DEFINED** option tests for whether *variable-1* has been defined, but not yet assigned a value (**>>DEFINE ... OFF**); use the **NOT** option to test for the variable not being defined.
  - b. The **SET** option tests for whether *variable-1* has been given a value, either via a **>>SET** statement or via a **>>DEFINE** without the **OFF** option.
  - c. Two CDF variables, two literals or a single CDF variable and a single literal may be compared against each other using a relational operator. Unlike the standard GNU COBOL **IF** statement, multiple comparisons cannot be “**AND**”ed or “**OR**”ed together; you may nest a second **>>IF** inside the first, however, to simulate an “**AND**” and an “**OR**” may be simulated via the **>>ELIF** option. Valid relational operators are as follows (you may use either words or symbols):

<b><u>GREATER THAN OR EQUAL TO</u></b>	<b>&gt;=</b>
<b><u>GREATER THAN</u></b>	<b>&gt;</b>
<b><u>LESS THAN OR EQUAL TO</u></b>	<b>&lt;=</b>
<b><u>LESS THAN</u></b>	<b>&lt;</b>
<b><u>EQUAL TO</u></b>	<b>=</b>

**<>** (meaning “not equal”)

### 2.2.3. The **>>SET** Directive

Figure 2-7 - **>>SET** Syntax



The **>>SET** statement provides an alternate means of performing the actions of the **>>DEFINE** and **>>SOURCE** statements, as well as a means of controlling the “-free”, “-fixed” and “-ffold-copy” compiler switches from within program source code itself.

1. CDF variables defined in this way become undefined once an **END PROGRAM** or **END FUNCTION** directive is encountered in the input source.
2. The **FOLDCOPYNAME** option provides the equivalent of specifying the compiler “-ffold-copy=xxx” switch, where “xxx” is either “**UPPER**” or “**LOWER**”.
3. The **NOFOLDCOPYNAME** option turns off the effect of either the **>>SET FOLDCOPYNAME** statement or the “-ffold-copy” switch.
4. If the “**CONSTANT**” option is used, the “**AS**” option must also be used.
5. The remaining options of the **>>SET** statement provide equivalent functionality to the **>>DEFINE** and **>>SOURCE** statements, as shown in the following table:

>>SET Statement	Equivalent >>DEFINE or >>SOURCE Statement
<b>&gt;&gt;SET</b> <i>cdf-variable</i>	<b>&gt;&gt;DEFINE</b> <i>cdf-variable</i> <b>AS OFF</b>
<b>&gt;&gt;SET</b> <i>cdf-variable</i> <b>AS</b> <i>literal-1</i>	<b>&gt;&gt;DEFINE</b> <i>cdf-variable</i> <b>AS</b> <i>literal-1</i>
<b>&gt;&gt;SET</b> <b>CONSTANT</b> <i>cdf-variable-1</i> <b>AS</b> <i>literal-1</i>	<b>&gt;&gt;DEFINE</b> <b>CONSTANT</b> <i>cdf-variable-1</i> <b>AS</b> <i>literal-1</i>
<b>&gt;&gt;SET</b> <b>SOURCEFORMAT</b> <b>AS</b> <b>FIXED</b>	<b>&gt;&gt;SOURCE</b> <b>FORMAT IS FIXED</b> ; sets the “-fixed” compiler switch
<b>&gt;&gt;SET</b> <b>SOURCEFORMAT</b> <b>AS</b> <b>FREE</b>	<b>&gt;&gt;SOURCE</b> <b>FORMAT IS FREE</b> ; sets the “-free” compiler switch

*See Also...*Compiler Switches Reference [8.1.2](#)

## 2.2.4. The >>SOURCE Directive

Figure 2-8 - &gt;&gt;SOURCE Syntax

```
>>SOURCE FORMAT IS [ FIXED ]
```

The **>>SOURCE** statement puts the compiler into FIXED or FREE source-code format mode. This, in effect, provides yet another mechanism for controlling the “-free” and “-fixed” compiler switches.

1. You may switch between **FIXED** and **FREE** mode as desired.
2. You may also use the **>>SET** statement to perform this function.
3. If the compiler is already in the specified mode, this statement will have no effect.

*See Also...*The **>>SET** CDF Statement [2.2.3](#)Compiler Switches Reference [8.1.2](#)

## 2.2.5. The >>TURN Directive

Figure 2-9 - &gt;&gt;TURN Syntax

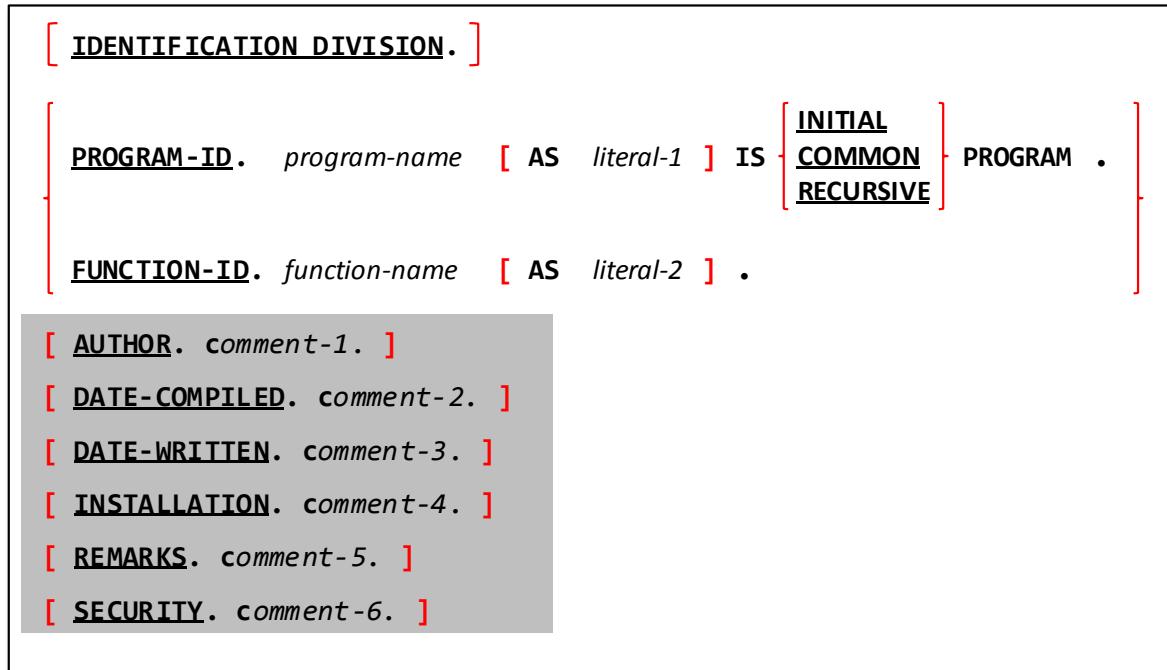
```
>>TURN { exception-name-1 [ file-name-1 ] ... } ... CHECKING [ ON [ WITH LOCATION ] ]
```

The **>>TURN** statement, while accepted syntactically, is currently non-functional.



### 3. IDENTIFICATION DIVISION

Figure 3-1 - IDENTIFICATION DIVISION Syntax



The **IDENTIFICATION DIVISION** provides basic identification of the program by giving it a name, and optionally defining some high-level characteristics.

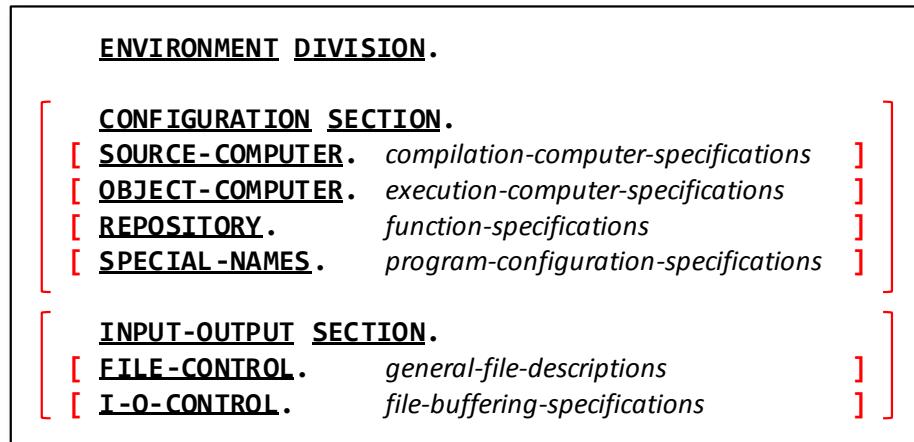
1. While the actual **IDENTIFICATION DIVISION** header is optional, the **PROGRAM-ID / FUNCTION-ID** clause is not.
2. The **AUTHOR**, **DATE-COMPILED**, **DATE-WRITTEN**, **FUNCTION-ID**, **INSTALLATION**, **PROGRAM-ID**, **REMARKS** and **SECURITY** clauses may be specified in any sequence. These clauses are supported by GNU COBOL only to provide compatibility with programs written for the ANS1974 (or earlier) standards. As of the ANS1985 standard, these clauses have been obsolete and should not be used in new programs.  
The “**-Wobsolete**” compilation switch will cause the GNU COBOL compiler to issue warnings messages if these (or any other obsolete syntax) is used in a program.
3. Both *literal-1* and *literal-2* must be actual alphanumeric literals and may not be figurative constants.
4. The **PROGRAM-ID** and **FUNCTION-ID** clause serve to identify the program to the external (i.e. operating system) environment. If there is no **AS** clause present, the program-name or function-name will serve as that external identification. If there is an **AS** clause specified, that specified literal will serve as the external identification. For the remainder of this document, that “external identification” will be referred to as the *primary entry-point name*.
5. The **INITIAL**, **COMMON** and **RECURSIVE** clauses are used only within subprograms serving as subroutines. The **COMMON** clause should be used only within subprograms that are nested subprograms. The **INITIAL** clause, if specified, guarantees the subprogram will be in its initial (i.e. compiled) state each and every time it is executed, not just the first time. The **COMMON** clause may only be specified within a nested subprogram. A nested subprogram declared as **COMMON** may be called from any nested program in the source file being compiled, not just those “above” it in the nesting structure. The **RECURSIVE** clause, if any, marks a subprogram as being able to invoke itself. User-defined functions are always **RECURSIVE**.

#### *See Also...*

Subprograms Subroutines vs Functions <a href="#">7.1</a>	Recursive Subprogramming <a href="#">7.7</a>
Details Of Nested Subprograms <a href="#">7.6</a>	

## 4. ENVIRONMENT DIVISION

Figure 4-1 - ENVIRONMENT DIVISION Syntax

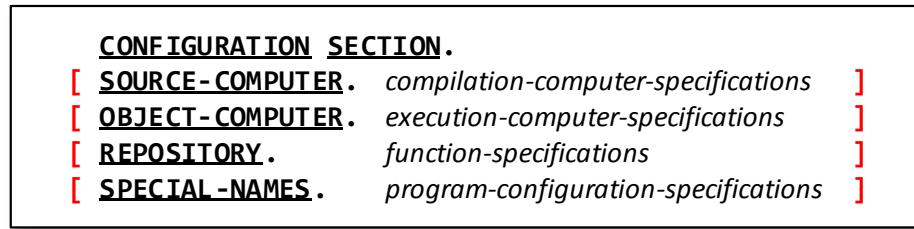


The **ENVIRONMENT DIVISION** defines the external computer environment in which the program will be operating. This includes defining any files that the program may be accessing.

1. If none of the features provided by the **ENVIRONMENT DIVISION** are required by a program, the **ENVIRONMENT DIVISION** may be omitted from the program.

### 4.1. CONFIGURATION SECTION

Figure 4-2 - CONFIGURATION SECTION Syntax



The **CONFIGURATION DIVISION** defines the computer system upon which the program is being compiled and executed and also specifies any special environmental configuration or compatibility characteristics.

1. The **CONFIGURATION SECTION** is not allowed in a nested subprogram – nested programs will inherit the **CONFIGURATION SECTION** settings of their parent program.
2. If none of the features provided by the **CONFIGURATION SECTION** are required by a program, the entire **CONFIGURATION SECTION** may be omitted from the program.
3. The sequence in which the **CONFIGURATION SECTION** paragraphs are specified is irrelevant.

*See Also...*

Details Of Nested Subprograms [7.6](#)

#### 4.1.1. SOURCE-COMPUTER Paragraph

Figure 4-3 - SOURCE-COMPUTER Paragraph Syntax



The **SOURCE-COMPUTER** paragraph defines the computer upon which the program is being compiled and provides one way in which debugging code imbedded within the program may be activated.

1. The **SOURCE-COMPUTER** paragraph is not allowed in a nested subprogram – nested programs will inherit the **SOURCE-COMPUTER** settings of their parent program.

2. The value specified for *computer-name* is irrelevant, provided it is a valid COBOL word that does not match any GNU COBOL reserved word. The *computer-name* may include spaces. This need not match the *computer-name* used with the **OBJECT-COMPUTER** paragraph, if any
3. The **WITH DEBUGGING MODE** clause, if present, will signal the compiler that debugging lines – normally treated as comments - are to be compiled.
4. Even without the **WITH DEBUGGING MODE** clause, it is still possible to compile debugging lines. Debugging lines may also be compiled by specifying the “-fdebugging-line” switch to the GNU COBOL compiler.

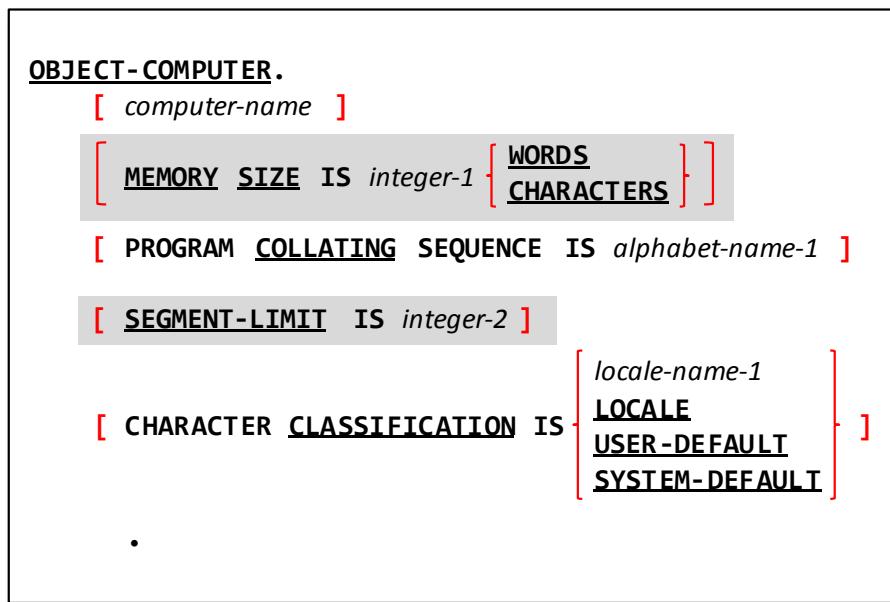
**5. See Also...**

Coding Comments in Programs [1.6](#)

Details Of Nested Subprograms [7.6](#)

## 4.1.2. OBJECT-COMPUTER Paragraph

Figure 4-4 - OBJECT-COMPUTER Paragraph Syntax



The **OBJECT-COMPUTER** paragraph describes the computer upon which the program will execute. This paragraph is not merely documentation.

1. The value specified for *computer-name*, if any, is irrelevant provided it is a valid COBOL word that does not match any GNU COBOL reserved word. The *computer-name* may include spaces. This need not match the *computer-name* used with the **SOURCE-COMPUTER** paragraph, if any
2. The **OBJECT-COMPUTER** paragraph is not allowed in a nested subprogram – nested programs will inherit the **OBJECT-COMPUTER** settings of their parent program.
3. The **MEMORY SIZE** and **SEGMENT-LIMIT** clauses are supported for compatibility purposes, but are non-functional in GNU COBOL.
4. The **PROGRAM COLLATING SEQUENCE** clause allows you to specify a customized character collating sequence to be used when alphanumeric values are compared to one another. Data will still be stored in the characterset native to the computer, but the logical sequence in which characters are ordered for comparison purposes can be altered from that inherent to the computer’s native characterset. The *alphabet-name-1* you specify needs to be defined in the **SPECIAL-NAMES** paragraph.
5. If no **PROGRAM COLLATING SEQUENCE** clause is specified, the collating sequence implied by the characterset native to the computer (usually ASCII) will be used.
6. The optional **CHARACTER CLASSIFICATION** clause may be used to specify a locale for the environment in which the program will be executing, for the purpose of influencing the uppercase and lowercase mappings of characters for the **UPPER-CASE** and **LOWER-CASE** intrinsic functions and the classification of characters for the **ALPHABETIC**, **ALPHABETIC-LOWER** and **ALPHABETIC-UPPER** class tests.

The definitions of these classes will be taken from the cultural convention specification (LC\_CTYPE) from the specified locale.

The meanings of the four locale specifications are as follows:

- ▶ *locale-name-1* references a **LOCALE** definition that must occur within the **SPECIAL-NAMES** paragraph.
- ▶ The keyword **LOCALE** refers to the current locale (in effect at the time the program is executed)
- ▶ The keyword **USER-DEFAULT** references the default locale specified for the user currently executing this program.
- ▶ The keyword **SYSTEM-DEFAULT** denotes the default locale specified for the computer upon which the program is executing.

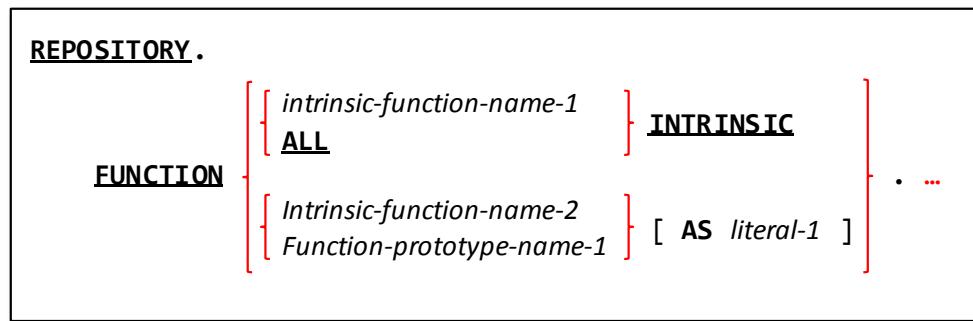
Absence of a **CHARACTER CLASSIFICATION** clause will cause character classification to occur according to the rules for the computer's native character set (ASCII, EBCDIC, ...).

#### *See Also...*

The <b>SPECIAL-NAMES</b> Paragraph	<a href="#">4.1.4</a>	<b>UPPER-CASE</b> Intrinsic Function	<a href="#">6.1.7.87</a>
Class Tests	<a href="#">6.1.4.2.2</a>	Details Of Nested Subprograms	<a href="#">7.6</a>
<b>LOWER-CASE</b> Intrinsic Function	<a href="#">6.1.7.39</a>		

### 4.1.3. REPOSITORY Paragraph

Figure 4-5 - REPOSITORY Paragraph Syntax



The **REPOSITORY** paragraph provides a mechanism for controlling access to the various built-in intrinsic functions and any user-defined functions that your program will be using.

1. The **REPOSITORY** paragraph is not allowed in a nested subprogram – nested programs will inherit the **REPOSITORY** settings of their parent program.
2. The “**INTRINSIC**” clause allows you to flag one or more (or **ALL**) built-in intrinsic functions as being usable without the need to code the keyword “**FUNCTION**” in front of the function names.
3. As an alternative to using the “**FUNCTION ALL INTRINSIC**” clause, you may instead compile your GNU COBOL programs using the “**-ffunctions-all**” switch.
4. The *function-prototype-name-1* option is required to specify the name of a user-defined function your program will be using. Optionally, should you desire, you may specify an alias name by which you will reference that user-defined function. Should you wish, you may also use the “**AS**” clause to provide an alias name for a built-in intrinsic function.

The following example accomplishes these objectives:

- ▶ It enables all intrinsic functions to be specified without the use of the “**FUNCTION**” keyword.
- ▶ It names two user-defined functions that will be used by the program: “**MY-FUNCTION-1**” and “**USER-DEFINED-FUNCTION-NUMBER-2**”
- ▶ It specifies the alias names “**SIGMA**” for the intrinsic function “**STANDARD-DEVIATION**” and “**UDF2**” for “**USER-DEFINED-FUNCTION-NUMBER-2**”.

#### **REPOSITORY.**

```

FUNCTION ALL INTRINSIC.
FUNCTION MY-FUNCTION-1.
FUNCTION USER-DEFINED-FUNCTION-NUMBER-2 AS "UDF2".
FUNCTION STANDARD-DEVIATION AS "SIGMA".

```

**A SPECIAL NOTE ABOUT USER-DEFINED FUNCTIONS** – because you must name a user-defined function that your program will be using in the **REPOSITORY** paragraph, you may always reference that function from your program's **PROCEDURE DIVISION** without needing to use the "FUNCTION" keyword.

*See Also...*

Intrinsic Functions [6.1.7](#)

Details Of Nested Subprograms [7.6](#)

User-defined Functions [7.4.2](#)

#### 4.1.4. SPECIAL-NAMES Paragraph

Figure 4-6 - SPECIAL-NAMES Paragraph Syntax

<p><b>SPECIAL-NAMES.</b></p> <pre>[ CALL-CONVENTION integer-1 IS mnemonic-name-1 ] [ CONSOLE IS CRT ] [ CRT STATUS IS identifier-1 ] [ CURRENCY SIGN IS literal-1 ] [ CURSOR IS identifier-2 ] [ DECIMAL-POINT IS COMMA ] [ EVENT STATUS IS identifier-3 ] [ LOCALE locale-name-1 IS literal-2 ] ... [ NUMERIC SIGN IS TRAILING SEPARATE ] [ SCREEN CONTROL IS identifier-4 ] [ device-name-1 IS mnemonic-name-2 ] ... [ feature-name-1 IS mnemonic-name-3 ] ... [ alphabet-name-clause ] ... [ class-definition-clause ] ... [ switch-definition-clause ] ... [ symbolic-characters-clause ] ... .</pre>	<p>The <b>SPECIAL-NAMES</b> paragraph provides a means for specifying various program and operating environment configuration options.</p> <ol style="list-style-type: none"> <li>1. The <b>SPECIAL-NAMES</b> paragraph is not allowed in a nested subprogram – nested programs will inherit the <b>SPECIAL-NAMES</b> settings of their parent program.</li> <li>2. The various clauses that may be specified within the <b>SPECIAL-NAMES</b> paragraph may be coded in any order.</li> <li>3. Only the final clause specified within the <b>SPECIAL-NAMES</b> paragraph should be terminated with a period.</li> <li>4. The <b>CALL-CONVENTION</b> clause allows a decimal integer, representing a series of ON/OFF switch settings, to be associated with a mnemonic name which may then be coded on <b>CALL</b> statements. The switch settings defined by this mnemonic will then control how the linkage to the subroutine (invoked by the <b>CALL</b> statement that references <i>mnemonic-name-1</i>) will be handled.</li> </ol>
---	---

5. The **CONSOLE IS CRT** clause, if specified, will cause any **DISPLAY** or **ACCEPT** statements lacking explicit "UPON" clauses to be treated as full-screen **DISPLAYs** or **ACCEPTs**.
6. If the **CRT STATUS** clause is not specified, an implicit **COB-CRT-STATUS** identifier (with a **PICTURE** of 9(4)) will be allocated for the purpose of receiving screen **ACCEPT** statuses. If it is specified, then *identifier-1* must be defined in the program as a **PIC 9(4)** field.
7. The **CURRENCY SIGN** clause may be used to define any single character as the currency sign used in **PICTURE** symbol editing. The default currency sign is a dollar-sign (\$).
8. The **CURSOR IS** clause allows you to specify a 4- or 6-character data item into which the cursor screen location at the time a screen **ACCEPT** is satisfied. The value will be returned as rrcc or rrrccc, depending upon the length of the specified *identifier-2*, where "rr" and "rrr" represent the row number (starting at zero) and "cc" and "ccc" represent the column number (also starting at zero). There is no default data item allocated for this data if the **CURSOR IS** clause is not specified.

9. The **DECIMAL POINT IS COMMA** clause reverses the definition of the "," and "." characters when they are used as **PICTURE** editing symbols and numeric literals. This can have unwanted side-effects.
10. The **LOCALE** clause may be used to associate external OS-defined locale names (*literal-6*) with an internal name (*locale-name-1*) that may then be referenced within the program. Locale names are defined by the Operating System and/or C compiler GNU COBOL will be utilizing on your computer.

The following table provides a list of possible locale codes, for example, that would be available on a Windows computer running a GNU COBOL that was built utilizing the MinGW Unix-emulator and the GNU C compiler (gcc):

Figure 4-7 – Typical Locale Codes

af_ZA	be_BY	en_CA	es_MX	ga_IE	kk_KZ	nl_NL	si_LK	tn_ZA
am_ET	bg_BG	en_GB	es_NI	gbz_AF	kl_GL	nn_NO	sk_SK	tr_IN
ar_AE	bn_IN	en_IE	es_PA	gl_ES	kn_IN	ns_ZA	sl_SI	tr_TR
ar_BH	bo_BT	en_IN	es_PE	gsw_FR	ko_KR	oc_FR	sma_NO	tt_RU
ar_DZ	bo_CN	en_JM	es_PR	gu_IN	kok_IN	or_IN	sma_SE	ug_CN
ar_EG	br_FR	en_MY	es_PY	ha_Latn_NG	ky_KG	pa_IN	smj_NO	uk_UA
ar_IQ	bs_Cyril_BA	en_NZ	es_SV	he_IL	lb LU	pl_PL	smj_SE	ur_PK
ar_JO	bs_Latin_BA	en_PH	es_US	hi_IN	lo_LA	ps_AF	smn_FI	uz_Cyril_UZ
ar_KW	ca_ES	en SG	es_UY	hr_BA	lt_LT	pt_BR	sms_FI	uz_Latin_UZ
ar_LB	cs_CZ	en_TT	es_VE	hr_HR	lv_LV	pt_PT	sq_AL	vi_VN
ar LY	cy_GB	en_US	et_EE	hu_HU	mi_NZ	qut_GT	sr_Cyril_BA	wen_DE
ar_MA	da_DK	en_ZA	eu_ES	hy_AM	mk_MK	quiz_BO	sr_Cyril_CS	wo_SN
ar_OM	de_AT	en_ZW	fa_IR	id_ID	ml_IN	quiz_EC	sr_Latin_BA	xh_ZA
ar_QA	de_CH	es_AR	fi_FI	ig_NG	mn_Cyrl_MN	quiz_PE	sr_Latin_CS	yo_NG
ar_SA	de_DE	es_BO	fil_PH	ii_CN	mn_Mong_CN	rm_CH	sv_FI	zh_CN
ar_SY	de_LI	es_CL	fo_FO	is_IS	moh_CA	ro_RO	sv_SE	zh_HK
ar_TN	de LU	es_CO	fr_BE	it_CH	mr_IN	ru_RU	sw_KE	zh_MO
ar YE	dsb_DE	es_CR	fr_CA	it_IT	ms_BN	rw_RW	syr_SY	zh SG
arn_CL	dv_MV	es_DO	fr_CH	iu_Cans_CA	ms_MY	sa_IN	ta_IN	zh_TW
as_IN	el_GR	es_EC	fr_FR	iu_Latin_CA	mt_MT	sah RU	te_IN	zu_ZA
az_Cyril_AZ	en_029	es_ES	fr_LU	ja_JP	nb_NO	se_FI	tg_Cyril TJ	
az_Latin_AZ	en_AU	es_GT	fr_MC	ka_GE	ne_NP	se_NO	th_TH tk_TM	
ba_R	en_BZ	es_HN	fy_NL	kh_KH	nl_BE	se_SE	tmz_Latin_DZ	

11. The **NUMERIC SIGN IS TRAILING SEPARATE** specification causes all signed numeric **USAGE DISPLAY** data items to be created as if the **SIGN IS TRAILING SEPARATE CHARACTER** clause was included in their definitions.
12. While the **SCREEN CONTROL** and **EVENT STATUS** clauses are clearly noted at compilation time as being unsupported, the **CURSOR IS** clause is not; currently, however, it appears to be non-functional at runtime.
13. The "*device-name IS mnemonic-name-2*" clause allows you to specify an alternate name for one of the built-in GNU COBOL device names specified before the "IS". The list of device names built-into GNU COBOL, and the physical device associated with that name, are as follows:

Figure 4-8 - Built-In GNU COBOL Device Names

Built-In GNU COBOL Device Name	Associated Actual Device
<b>CONSOLE</b>	This is the (screen-mode) display of the PC or Unix system
<b>STDIN</b> <b>SYSIN</b> <b>SYSIPT</b>	Standard system input (pipe 0). On a PC or UNIX system, this is typically the keyboard. Can be specified to a GNU COBOL program from a file by adding the sequence " <b>0&lt;filename</b> " to the end of the programs execution command.
<b>PRINTER</b> <b>STDOUT</b> <b>SYSLIST</b> <b>SYSLST</b> <b>SYSOUT</b>	Standard system output (pipe 1). On a PC or UNIX system, this is typically the display. Can be sent to a file by adding the sequence " <b>1&gt;filename</b> " to the end of the programs execution command.
<b>STDERR</b> <b>SYSERR</b>	Standard system error output (pipe 2). On a PC or UNIX system, this is typically the display. Can be sent to a file by adding the sequence " <b>2&gt;filename</b> " to the end of the programs execution command.

14. The "*feature-name-1 IS mnemonic-name-3*" clause allow for mnemonic names to be assigned to up to the 13 printer channel (i.e. vertical page positioning) position feature names "**C01**" through "**C12**" and "**CSP**". Once a channel position has been assigned a mnemonic name, statements of the form "**WRITE record-name AFTER**

**ADVANCING** *mnemonic-name-3*<sup>9</sup> may be coded to write the specified print record at the channel position assigned to mnemonic-name-3.

Printers supporting channel positioning are generally mainframe-type line printers. When writing to printers that do not support channel positioning, a formfeed will be issued to the printer.

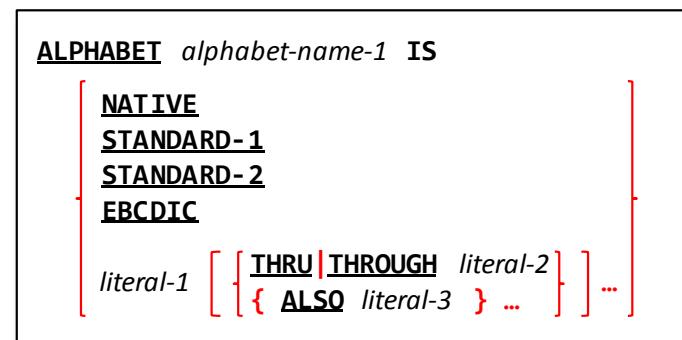
The **CSP** positioning option stands for “No Spacing”. Testing on a MinGW build of GNU COBOL shows that this too results in a formfeed being issued.

#### See Also...

Using Commas and Semicolons <a href="#">1.7</a>	The ACCEPT Statement (Screen Data) <a href="#">6.4.1.4</a>
<b>OBJECT-COMPUTER</b> And <b>LOCALEs</b> <a href="#">4.1.2</a>	The <b>CALL</b> Statement <a href="#">6.4.5</a>
Defining a Data Item's <b>PICTURE</b> <a href="#">5.2.1.6</a>	Details Of Nested Subprograms <a href="#">7.6</a>

### 4.1.4.1. The alphabet-name Clause

Figure 4-9 - The SPECIAL-NAMES "alphabet-name" Clause

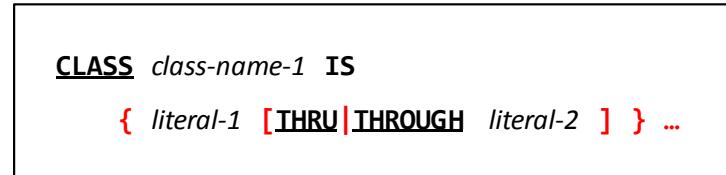


The **ALPHABET** clause provides a means for relating a name to a specified character code set or collating sequence, including those you define yourself using the “*literal-1*” option. You may specify an alphanumeric literal for any of the *literal-1*, *literal-2* or *literal-3* specifications. You may also specify any of the figurative constants SPACE, SPACES, ZERO, ZEROS, ZEROES, QUOTE, QUOTES, HIGH-VALUE, HIGH-VALUES, LOW-VALUE or LOW-VALUES.

1. The reserved word “**THROUGH**” may be used interchangeably with “**THRU**”.

### 4.1.4.2. The class-name Clause

Figure 4-10 - The SPECIAL-NAMES "class-name" Clause



User-defined classes are defined using the **CLASS** clause.

1. The reserved word **THROUGH** may be used interchangeably with **THRU**.
2. Both *literal-1* and *literal-2* must be alphanumeric literals of length 1.
3. The literal(s) specified on that clause define the possible characters that may be found in a data item's value in order to be considered part of the class.

For example, the following defines a class called “Hexadecimal”, the definition of which specifies the only characters that may be present in an alphanumeric data item if that data item is to be part of the “Hexadecimal” class:

```

CLASS Hexadecimal IS '0' THRU '9'
      'A' THRU 'F'
      'a' THRU 'f'

```

4. See section for an example of how this user-defined class might be used.

<sup>9</sup> **BEFORE ADVANCING** is possible also. See the **WRITE** statement in section [6.2.50](#) for additional information.

*See Also...*

Class Tests	<a href="#">6.1.4.2.2</a>
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### 4.1.4.3. The switch-definition Clause

Figure 4-11 - The SPECIAL-NAMES "switch-definition" Clause

<pre>switch-name-1 [ IS mnemonic-name-1 ]   [ [ ON STATUS IS condition-name-1       OFF STATUS IS condition-name-2 ] ... ]</pre>
--

The *switch-definition* clause associates a *condition-name* with a run-time execution switch so that the status of that switch may be tested from within a program.

1. The valid switch-names are **SWITCH-0** through **SWITCH-15**.
2. If the program is compiled with the “-fsyntax-extension” compiler switch, the switch names “**SW0**” through “**SW15**” are also valid; they correspond to “**SWITCH-0**” through “**SWITCH-15**”, respectively.
3. At execution time, each switch will be associated with an environment variable named “**COB\_SWITCH\_n**”, where “n” will have the value “0” through “15”. Any of these sixteen environment variables that have the value “ON” (regardless of upper- or lower-case value) will be considered to be set “on”. Any of these sixteen environment variables having no value at all or a value other than “ON” will be considered “off”.
4. Each specified switch must have at least one of a “IS mnemonic-name”, **ON STATUS** or an **OFF STATUS** option defined for it (otherwise there will be no way to reference the switch from within a GNU COBOL program).
5. The “IS mnemonic-name” syntax provides a means for setting the switch to either an **ON** or **OFF** value via the **SET** statement.
6. The **ON STATUS** and **OFF STATUS** syntax provides a way of associating a condition-name with either the on or off status of the switch, so that status may be tested at execution time via the **IF** statement.

*See Also...*

Condition Names	<a href="#">6.1.4.2.1</a>
-----------------	---------------------------

The IF Statement	<a href="#">6.2.21</a>
------------------	------------------------

Switch-Status Conditions	<a href="#">6.1.4.2.4</a>
--------------------------	---------------------------

The SET SWITCH Statement	<a href="#">6.4.39.7</a>
--------------------------	--------------------------

### 4.1.4.4. The symbolic-characters clause

Figure 4-12 - The SPECIAL-NAMES "symbolic-characters" Clause

**SYMBOLIC CHARACTERS**

<pre>{ { symbolic-character-1 } ... ARE { integer-1 } ... }   [ IN alphabet-name-1 ]</pre>
--

The **SYMBOLIC CHARACTERS** clause may be used to define your own figurative constants.

1. The word **IS** may be substituted for the word **ARE**, if desired.
2. There must be exactly as many *integer-1* values specified after the word **ARE** (or **IS**) as there are *symbolic-character-1* names specified before it.
3. Each symbolic character name will be associated with the corresponding “*integer-1*”th character in the alphabet named in the **IN** clause. The integer values are selecting characters from the alphabet by their ordinal position and not by their numeric value; thus, an integer of 15 will select the 15<sup>th</sup> character in the specified alphabet, regardless of the actual numeric value of the bit pattern that constitutes that character.
4. If no *alphabet-name-1* is specified, the systems native charset will be assumed.

The following two code examples define the same set of figurative constant names for five ASCII control characters (assuming that ASCII is the system’s native charset). The two examples are identical in their effects, even though the manner in which the figurative constants are defined is different.

**SPECIAL-NAMES.**

```
SYMBOLIC CHARACTERS NUL IS 1
                      SOH IS 2
                      BEL IS 8
                      DC1 IS 18
                      DC2 IS 19.
```

**SPECIAL-NAMES.**

```
SYMBOLIC CHARACTERS NUL SOH BEL DC1 DC2
                      ARE   1   2   8   18  19.
```

## 4.2. INPUT-OUTPUT SECTION

Figure 4-13 - INPUT-OUTPUT SECTION Syntax

**INPUT-OUTPUT SECTION.**

<b>FILE-CONTROL.</b>	<i>general-file-descriptions</i>	[ ]
<b>I-O-CONTROL.</b>	<i>file-buffering-specifications</i>	[ ]

The **INPUT-OUTPUT** section provides for the definition of any files the program will be accessing as well as control of the I/O buffering process against those files.

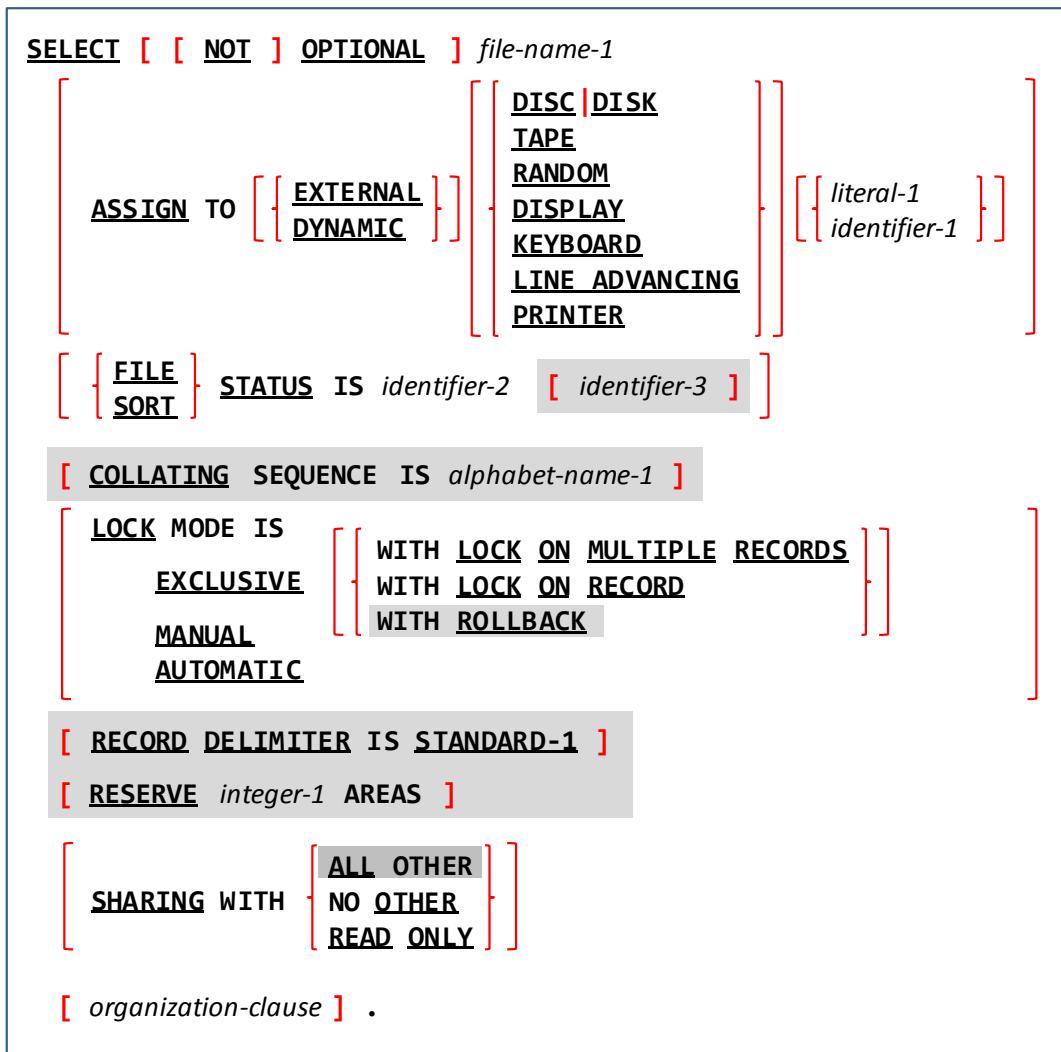
1. If the compiler “config” file you are using has “relaxed-syntax-check” set to “yes”, the **FILE-CONTROL** and **I-O-CONTROL** paragraphs may be specified without the **INPUT-OUTPUT SECTION** header having been specified.
2. If the program uses no files, it needs neither a **FILE-CONTROL** or **I-O-CONTROL** paragraph.

*See Also...*

GNU COBOL “config” Files	<a href="#">8.1.6</a>
--------------------------	-----------------------

#### 4.2.1. File SELECT Statement

Figure 4-14 – File SELECT Statement Syntax



The **SELECT** statement of the **FILE-CONTROL** paragraph creates a definition of a file and links that COBOL definition to the external operating system environment.

What is shown here are those clauses of the **SELECT** statement that are common to all types of files.

Upcoming sections will discuss special **SELECT** clauses that only pertain to certain types of files.

1. The **COLLATING SEQUENCE**, **RECORD DELIMITER**, **RESERVE** and **SHARING WITH ALL OTHER** clauses, as well as the specification of a secondary **FILE-STATUS** field and **LOCK MODE ... WITH ROLLBACK**, while syntactically recognized, are not currently supported by GNU COBOL.
2. The **OPTIONAL** clause, to be used only for files that will be used to provide input data to the program, indicates the file may or may not actually be available at run-time. Attempts to **OPEN** an **OPTIONAL** file when the file does not exist will receive a special non-fatal file status value (see status 05 in [Figure 4-15](#) below) indicating the file is not available; a subsequent attempt to **READ** that file will return an **AT END** (end-of-file) condition. Optionally, files may be designated as **NOT OPTIONAL**, if desired. This is useful when specifying the “**-foptional-file**” compiler switch.
3. The *file-name-1* value that you specify will be the name by which you will reference the file within your program. This name should be formed according to the rules for user-defined names.
4. The **EXTERNAL** option flags the file as being sharable with other GNU COBOL programs that include the same **SELECT** statement. Those other programs must either be executed as subprograms from this one or must execute this one as a subprogram. Once an **EXTERNAL** file has been **OPENed** by one of the programs **SELECTing** the **EXTERNAL** file, that file is available for **READING**, **WRITEing** and the like from any of the programs that share it. Similarly, once one program **CLOSEs** the file, no other program sharing that file may access the file further unless the file is re-**OPENed**.

5. The **DYNAMIC** option specifies that the actual pathname of the file being **SELECTed** will be specified at execution time as the contents of *identifier-1*. If you use the **DYNAMIC** option, you must specify *identifier-1*. If you specify *identifier-1* on the **SELECT**, the **DYNAMIC** option will be assumed if not specified.
6. Optionally, you may define the type of device the file will be assigned to, as follows.
  - a. The **DISK** and **DISC** devices (the two are synonymous with one another) are typically used in conjunction with a “*literal-1*” or “*identifier-1*” option. If neither the “*literal-1*” nor “*identifier-1*” option is provided, the **SELECT** will reference a file named “*file-name-1*” in whatever folder is current at the time the file is **OPENed**.
  - b. The **TAPE** and **RANDOM** devices behave in a manner similar to **DISC** (or **DISK**) and are included into GNU COBOL to facilitate the compilation of COBOL source from other COBOL implementations.
  - c. The **KEYBOARD**, **DISPLAY** and **PRINTER** devices refer to the PC keyboard and display and **STDOUT** devices, respectively. When either *literal-1* or *identifier-1* are specified with these device types, the effect will be the same as if **DISC** or **DISK** had been used. When neither *literal-1* nor *identifier-1* are used, these devices will be associated with the **STDIN (KEYBOARD)** and **STDOUT (DISPLAY or PRINTER)** devices, respectively (see [Figure 4-8](#)).
  - d. A file **ASSIGNED** to the **PRINTER** device must be defined with an **ORGANIZATION IS LINE SEQUENTIAL** (if no **ORGANIZATION** is specified, **LINE SEQUENTIAL** will be assumed).
  - e. The **LINE ADVANCING** device defines the file as a special form of **LINE SEQUENTIAL** file. When this device is used, either *literal-1* or *identifier-1* must be specified.
7. The “*identifier-1*” option references an alphanumeric data item, the contents of which at the time the file is **OPENed** will define the path and filename of the actual data file to be processed.
8. If the “*literal-1*” option is used on the **ASSIGN** clause, it defines the linkage of the COBOL file to an actual operating system file as follows:
  - a. If an environment variable named “**DD\_***literal-1*” exists, its value will be treated as the full path/filename of the file. If not, then ...
  - b. If an environment variable named “**dd\_***literal-1*” exists, its value will be treated as the full path/filename of the file. If not, then ...
  - c. If an environment variable named “*literal-1*” exists, its value will be treated as the full path/filename of the file. If not, then...
  - d. The literal itself will be treated as the full path/filename to the file.

This behavior will be influenced by the “filename-mapping” setting in the config file you are using when compiling your programs. The behavior stated above applies only if “filename-mapping: yes” is in-effect. If “filename-mapping: no” is used, only the last option (treating the literal itself as the full name of the file) is possible.
9. The **FILE STATUS** or **SORT STATUS** clause (they are both equivalent and only one or the other, if any, should be specified) is used to specify the name of a **PIC 9(2)** data item into which an I/O status code will be saved after every I/O verb that is executed against the file. This does not actually allocate the data item – you still need to allocate the item yourself somewhere in the **DATA DIVISION**.
10. Possible status codes that can be returned to a **FILE STATUS** data item are as follows:

Figure 4-15 – FILE STATUS Values

Status Value	Meaning	Status Value	Meaning
00	Success	39	Conflicting attribute
02	Success (Duplicate Record Key Written)	41	File already OPEN
05	Success (Optional File Not Found)	42	File not OPEN
07	Success (No Unit)	43	Read not done
10	End of file reached if <b>READING</b> forward or beginning-of-file reached if <b>READING</b> backward	44	Record overflow
14	Out of key range	46	READ error

21	Key invalid
22	Attempt to duplicate key value
23	Key not found
30	Permanent I/O error
31	Inconsistent filename
34	Boundary violation
35	File not found
37	Permission denied
38	Closed with lock

47	OPEN INPUT denied
48	OPEN OUTPUT denied
49	OPEN I-O denied
51	Record locked
52	End of page
57	LINAGE specifications invalid
61	File sharing failure
91	File not available

11. The **LOCK** and **SHARING** clauses define the conditions under which this file will be usable by other programs executing concurrently with this one.

#### See Also...

Types of Files <a href="#">1.3.3.5</a>	The <b>OPEN</b> Statement <a href="#">6.4.29</a>
User-defined Names <a href="#">1.10</a>	The <b>READ</b> Statement <a href="#">6.4.31</a>
File Sharing <a href="#">6.1.9.1</a>	Compiler Switches Reference <a href="#">8.1.2</a>
Record Locking <a href="#">6.1.9.2</a>	GNU COBOL “config” Files <a href="#">8.1.6</a>
Handling End-of-File Conditions (AT END) <a href="#">6.1.12.1</a>	

### 4.2.1.1. SELECT Without an “organization-clause”

A SELECT statement coded without an ORGANIZATION explicitly coded will be handled as if the following ORGANIZATION clause had been specified:

```
ORGANIZATION IS RECORD BINARY SEQUENTIAL
ACCESS MODE IS SEQUENTIAL
PADDING CHARACTER IS " "
```

### 4.2.1.2. ORGANIZATION SEQUENTIAL Files

Figure 4-16 - SELECT “organization-options” For SEQUENTIAL Files

[ **ORGANIZATION IS ] RECORD BINARY SEQUENTIAL**

[ **ACCESS MODE IS SEQUENTIAL ]**

Files declared as **ORGANIZATION RECORD BINARY SEQUENTIAL** will consist of records with no explicit end-of-record delimiter character sequences; records in such files are “delineated” by a calculated byte-offset (based on record length) into the file .

1. The keyword “**ORGANIZATION**” is optional to provide compatibility with those (few) COBOL implementations that consider that word to be optional. Most COBOL implementations do require the word **ORGANIZATION**, so it should be used in new programs.
2. These files cannot be prepared with any standard text-editing or word processing software as all such programs will imbed delimiter characters at the end of records. Such files may contain either **USAGE DISPLAY** or **USAGE COMPUTATIONAL** (of any variety) data since no character sequence can be accidentally interpreted as an end-of-record delimiter.
3. Both fixed- and variable-length record formats are supported. Variable-length records will always be written in their maximum size, however.
4. Specifying **ORGANIZATION IS RECORD BINARY SEQUENTIAL** is the same as specifying **ORGANIZATION SEQUENTIAL**.
5. The **ACCESS MODE IS SEQUENTIAL** clause is optional because, if absent, it will be assumed anyway for this type of file. The internal structure of **RECORD BINARY SEQUENTIAL** files is such that the data in those files can only be

- processed in a sequential manner; in order to read the 100<sup>th</sup> record in such a file, for example, you first must read records 1 through 99.
6. **SEQUENTIAL** files are processed using the **CLOSE**, **COMMIT**, **DELETE**, **MERGE**, **OPEN**, **READ**, **REWRITE**, **SORT**, **UNLOCK** and **WRITE** statements.

*See Also...*

Types of Files	<a href="#">1.3.3.5</a>	The <b>OPEN</b> Statement	<a href="#">6.4.29</a>
Storage Format of Data ( <b>USAGE</b> )	<a href="#">5.2.1.11</a>	The <b>READ</b> Statement	<a href="#">6.4.31</a>
Handling End-of-File Conditions ( <b>AT END</b> )	<a href="#">6.1.12.1</a>	The <b>REWRITE</b> Statement	<a href="#">6.4.36</a>
The <b>CLOSE</b> Statement	<a href="#">6.4.7</a>	The <b>SORT</b> Statement (File Sort)	<a href="#">6.4.40.1</a>
The <b>COMMIT</b> Statement	<a href="#">6.4.8</a>	The <b>UNLOCK</b> Statement	<a href="#">6.4.48</a>
The <b>DELETE</b> Statement	<a href="#">6.4.11</a>	The <b>WRITE</b> Statement	<a href="#">6.4.50</a>
The <b>MERGE</b> Statement	<a href="#">6.4.25</a>		

#### 4.2.1.3. ORGANIZATION LINE SEQUENTIAL Files

Figure 4-17 - SELECT "organization-options" for LINE SEQUENTIAL Files

```
[ ORGANIZATION IS ] LINE SEQUENTIAL
[ ACCESS MODE IS SEQUENTIAL ]
[ PADDING CHARACTER IS { literal-1 | identifier-1 } ]
```

Files declared as **ORGANIZATION LINE** **SEQUENTIAL** will consist of records terminated by an end-of-record delimiter character or character sequence.

1. The keyword “**ORGANIZATION**” is optional to provide compatibility with those (few) COBOL implementations that consider that word to be optional. Most COBOL implementations do require the word **ORGANIZATION**, so it should be used in new programs.
2. This is the only **ORGANIZATION** valid for files that are assigned to the **PRINTER** device.
3. These files could be prepared with any standard text-editing or word processing software capable of writing text files. Such files should not contain any **USAGE COMPUTATIONAL** or **BINARY** (of any variety) data since such fields could accidentally contain byte sequences that could be interpreted as an end-of-record delimiter.
4. Both fixed- and variable-length record formats are supported.
5. The end-of-record delimiter sequence will be X’0A’ (an ASCII line-feed character) or a X’0D0A’ (an ASCII carriage-return/line-feed sequence).
6. The **PADDING CHARACTER** clause, while syntactically recognized, is currently non-functional.
7. When reading a **LINE SEQUENTIAL** file, records in excess of the size implied by the file’s FD will be truncated while records shorter than that size will be padded to the right with **SPACES**.
8. The **ACCESS MODE IS SEQUENTIAL** clause is optional because, if absent, it will be assumed anyway for this type of file. The internal structure of **LINE SEQUENTIAL** files is such that the data in those files can only be processed in a sequential manner; in order to read the 100<sup>th</sup> record in such a file, for example, you first must read records 1 through 99.
9. Files ASSIGNED to **PRINTER** or **CONSOLE** should be specified as **ORGANIZATION LINE SEQUENTIAL**.
10. **LINE SEQUENTIAL** files are processed using the **CLOSE**, **COMMIT**, **DELETE**, **MERGE**, **OPEN**, **READ**, **REWRITE**, **SORT**, **UNLOCK** and **WRITE** statements.

*See Also...*

Types of Files	<a href="#">1.3.3.5</a>	The <b>OPEN</b> Statement	<a href="#">6.4.29</a>
Storage Format of Data ( <b>USAGE</b> )	<a href="#">5.2.1.11</a>	The <b>READ</b> Statement	<a href="#">6.4.31</a>

Handling End-of-File Conditions (AT END) <a href="#">6.1.12.1</a>	The REWRITE Statement <a href="#">6.4.36</a>
The CLOSE Statement <a href="#">6.4.7</a>	The SORT Statement (File Sort) <a href="#">6.4.40.1</a>
The COMMIT Statement <a href="#">6.4.8</a>	The UNLOCK Statement <a href="#">6.4.48</a>
The DELETE Statement <a href="#">6.4.11</a>	The WRITE Statement <a href="#">6.4.50</a>
The MERGE Statement <a href="#">6.4.25</a>	

## ORGANIZATION RELATIVE Files

Figure 4-18 - SELECT “organization options” For RELATIVE Files

[ <b>ORGANIZATION</b> IS ]	<b>RELATIVE</b>
	[ <b>SEQUENTIAL</b> ]
[ <b>ACCESS MODE</b> IS	[ <b>DYNAMIC</b> ]
	[ <b>RANDOM</b> ]
[ <b>RELATIVE KEY</b> IS <i>identifier-1</i> ]	

**RELATIVE** files are files with an internal organization such that records may be processed in a sequential manner based upon their physical location in the file or in a random manner by allowing records to be read, written or updated by specifying the relative record number in the file.

1. The keyword “**ORGANIZATION**” is optional to provide compatibility with those (few) COBOL implementations that consider that word to be optional. Most COBOL implementations do require the word **ORGANIZATION**, so it should be used in new programs.
2. **ORGANIZATION RELATIVE** files cannot be assigned to **CONSOLE**, **DISPLAY**, **LINE ADVANCING** or **PRINTER**.
3. The **RELATIVE KEY** clause is optional only if **ACCESS MODE SEQUENTIAL** is specified.
4. While records in a **ORGANIZATION RELATIVE** file may be defined as having variable-length records, the file will be structured in such a manner as to reserve the maximum possible space for each record.
5. An **ACCESS MODE** of **SEQUENTIAL** indicates that the records of the file will be processed in a sequential manner, according to their physical sequence in the file.

An **ACCESS MODE** of **RANDOM** means that records will be processed in random sequence by specifying their record number in the file every time the file is read or written.

A **DYNAMIC ACCESS MODE** indicates the program will switch back and forth between **SEQUENTIAL** and **RANDOM** mode during execution. The file starts out initially in **SEQUENTIAL** mode when first **OPENed** but the program may use the **START** verb to switch between the other two access modes.

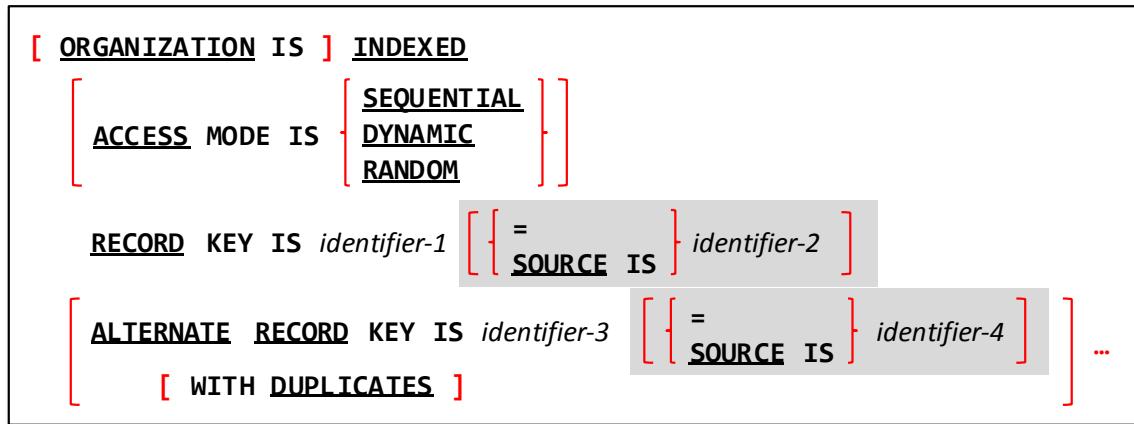
6. The default **ACCESS MODE** is **SEQUENTIAL**.
7. The **RELATIVE KEY** data item is a numeric data item that cannot be a field within records of this file. Its purpose is to return the current relative record number of a **RELATIVE** file that is being processed in **SEQUENTIAL** access mode and to be a retrieval key that specifies the relative record number to be read or written when processing a **RELATIVE** file in **RANDOM** access mode.
8. **RELATIVE** files are processed using the **CLOSE**, **COMMIT**, **DELETE**, **MERGE**, **OPEN**, **READ**, **REWRITE**, **SORT**, **START**, **UNLOCK** and **WRITE** statements.

### See Also...

Types of Files <a href="#">1.3.3.5</a>	The READ Statement <a href="#">6.4.31</a>
Handling End-of-File Conditions (AT END) <a href="#">6.1.12.1</a>	The REWRITE Statement <a href="#">6.4.36</a>
The CLOSE Statement <a href="#">6.4.7</a>	The SORT Statement (File Sort) <a href="#">6.4.40.1</a>
The COMMIT Statement <a href="#">6.4.8</a>	The START Statement <a href="#">6.2.41</a>
The DELETE Statement <a href="#">6.4.11</a>	The UNLOCK Statement <a href="#">6.4.48</a>
The MERGE Statement <a href="#">6.4.25</a>	The WRITE Statement <a href="#">6.4.50</a>
The OPEN Statement <a href="#">6.4.29</a>	

#### 4.2.1.4. ORGANIZATION INDEXED Files

Figure 4-19 - SELECT “organization options” For INDEXED Files



**INDEXED** files, like **RELATIVE** files, may have their records processed either sequentially or in a random manner. Unlike **RELATIVE** files, however, the actual location of a record in an **INDEXED** file is based upon the value(s) of one or more alphanumeric fields within records of the file.

For example, an **INDEXED** file containing product data might use the product identification code as a **RECORD KEY**. This means you may read, write or update the “A6G4328”th record or the “Z8X7723”th record directly, based upon the product id value of those records!

1. The keyword “**ORGANIZATION**” is optional to provide compatibility with those (few) COBOL implementations that consider that word to be optional. Most COBOL implementations do require the word **ORGANIZATION**, so it should be used in new programs.
2. **ORGANIZATION INDEXED** files cannot be assigned to **CONSOLE**, **DISPLAY**, **LINE ADVANCING** or **PRINTER**.
3. The specification of so-called “split keys”, while syntactically recognized (the “= / **SOURCE IS**” clauses), are not currently supported by GNU COBOL.
4. An **ACCESS MODE** of **SEQUENTIAL** indicates that the records of the file will be processed in a sequential manner with respect to the values of the **RECORD KEY** or an **ALTERNATE RECORD KEY**.

An **ACCESS MODE** of **RANDOM** means that records will be processed in random sequence by accessing the record with specific **RECORD KEY** or **ALTERNATE RECORD KEY** values.

**DYNAMIC ACCESS MODE** allows the file will be processed either in **RANDOM** or **SEQUENTIAL** mode; the program may switch between the two modes as needed. The **START** verb is used to make the switch between modes.

5. The default **ACCESS MODE** is **SEQUENTIAL**.
6. The **PRIMARY KEY** clause defines the field(s) within the record used to provide the primary access to records within the file. No two records may have the same **PRIMARY KEY** field value.
7. The **ALTERNATE RECORD KEY** clause, if used, defines an additional field within the record that provides an alternate means of directly accessing records or an additional field by which the file’s contents may be processed sequentially. You have the choice of allowing records to have duplicate alternate key values, if necessary.
8. There may be multiple **ALTERNATE RECORD KEY** clauses, each defining an additional alternate key for the file.
9. **INDEXED** files are processed using the **CLOSE**, **COMMIT**, **DELETE**, **MERGE**, **OPEN**, **READ**, **REWRITE**, **SORT**, **START**, **UNLOCK** and **WRITE** statements.

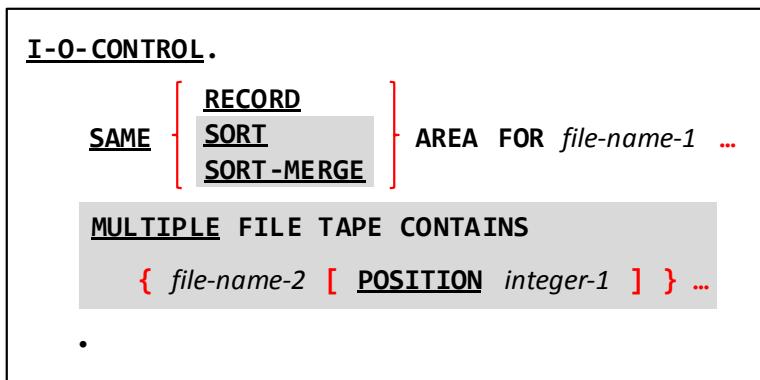
#### See Also...

Types of Files <a href="#">1.3.3.5</a>	The <b>READ</b> Statement <a href="#">6.4.31</a>
Handling End-of-File Conditions ( <b>AT END</b> ) <a href="#">6.1.12.1</a>	The <b>REWRITE</b> Statement <a href="#">6.4.36</a>
The <b>CLOSE</b> Statement <a href="#">6.4.7</a>	The <b>SORT</b> Statement (File Sort) <a href="#">6.4.40.1</a>

The <b>COMMIT</b> Statement <a href="#">6.4.8</a>	The <b>START</b> Statement <a href="#">6.2.41</a>
The <b>DELETE</b> Statement <a href="#">6.4.11</a>	The <b>UNLOCK</b> Statement <a href="#">6.4.48</a>
The <b>MERGE</b> Statement <a href="#">6.4.25</a>	The <b>WRITE</b> Statement <a href="#">6.4.50</a>
The <b>OPEN</b> Statement <a href="#">6.4.29</a>	

## 4.2.2. I-O-CONTROL Paragraph

Figure 4-20 - I-O-CONTROL Paragraph Syntax



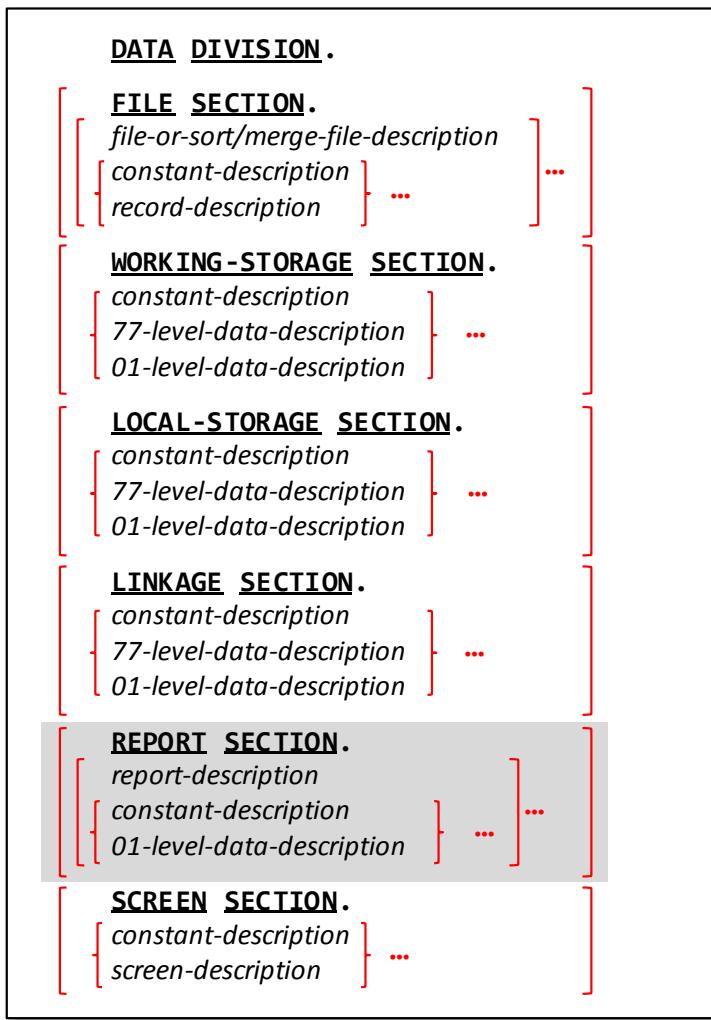
The **I-O-CONTROL** Paragraph can be used to optimize certain aspects of file processing.

1. The **SAME SORT AREA** and **SAME SORT-MERGE AREA** clauses are non-functional. The **SAME RECORD AREA** is functional, however.
2. The **MULTIPLE FILE TAPE** clause is obsolete and is therefore recognized but not functional.
3. The **SAME RECORD AREA** clause allows you to specify that multiple files should share the same input and output memory buffers. These buffers can sometimes get quite large, and by having multiple files share the same buffer memory you may significantly cut down the amount of memory the program is using (thus making "room" for more procedural code or data). If you do use this feature, take care to ensure that no more than one of the specified files are ever **OPEN** simultaneously.



## 5. DATA DIVISION

Figure 5-1 - General DATA DIVISION Format



The **DATA DIVISION** is used to define all data that will be processed by a program. The contents of the various sections are as follows:

### FILE SECTION

Provides a detailed specification as to the blocking characteristics and record layouts of each SELECTed file.

### WORKING-STORAGE SECTION

Definitions of the various internal data items used by the program.

### LOCAL-STORAGE SECTION

Similar to WORKING-STORAGE, but describes data within a subprogram that will be dynamically allocated and initialized (automatically) each time the subprogram is executed (WORKING-STORAGE is automatically initialized only the 1<sup>st</sup> time a subprogram is executed).

### LINKAGE SECTION

Describes data within a subprogram that serves as input arguments to or output arguments from the subprogram.

### REPORT SECTION

Describes the layout of printed reports as well as many of the functional aspects of the generation of reports.

### SCREEN SECTION

Describes the visual layout of entire screens.

1. Any **SECTIONs** that are used must be specified in the order shown. If no **DATA DIVISION** sections are needed, the **DATA DIVISION** header itself may be omitted.
2. The **REPORT SECTION** is syntactically recognized but will – if used – be rejected as unsupported. GNU COBOL does not support the RWCS<sup>10</sup> (it does support the **LINAGE** clause in an FD, however).
3. **LOCAL-STORAGE** cannot be used in nested subprograms.

#### *See Also...*

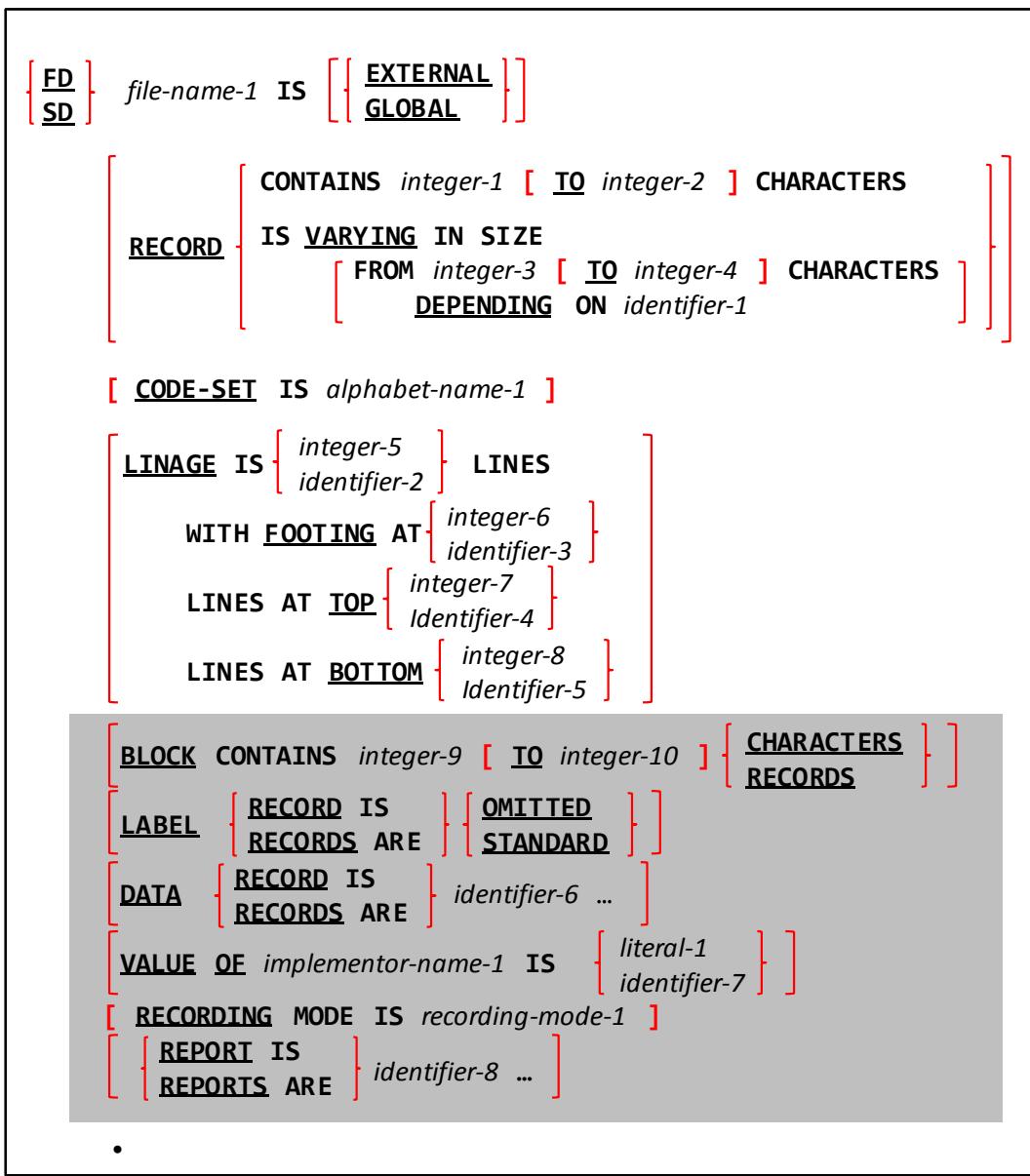
A Sample GNU COBOL Screen	<a href="#">1.3.3.9</a>	Defining Screens	<a href="#">5.2.2</a>
Defining Data Items	<a href="#">5.2</a>		

<sup>10</sup> Report-Writer Control System

## 5.1. File Or Sort/Merge File Descriptions

Every file that has been **SELECTed** in the **FILE-CONTROL** paragraph must be described in the **FILE SECTION** of the **DATA DIVISION**. Files destined for use as sort/merge work files must be described with a Sort/Merge File Description (**SD**) while every other file is described with a File Description (**FD**). Each of these descriptions will be followed with at least one Record Description.

Figure 5-2 - File Description (FD) and Sort Description (SD) Syntax



There must be a detailed description for every file **SELECTed** in your program. These detailed descriptions will be coded in the **FILE SECTION**.

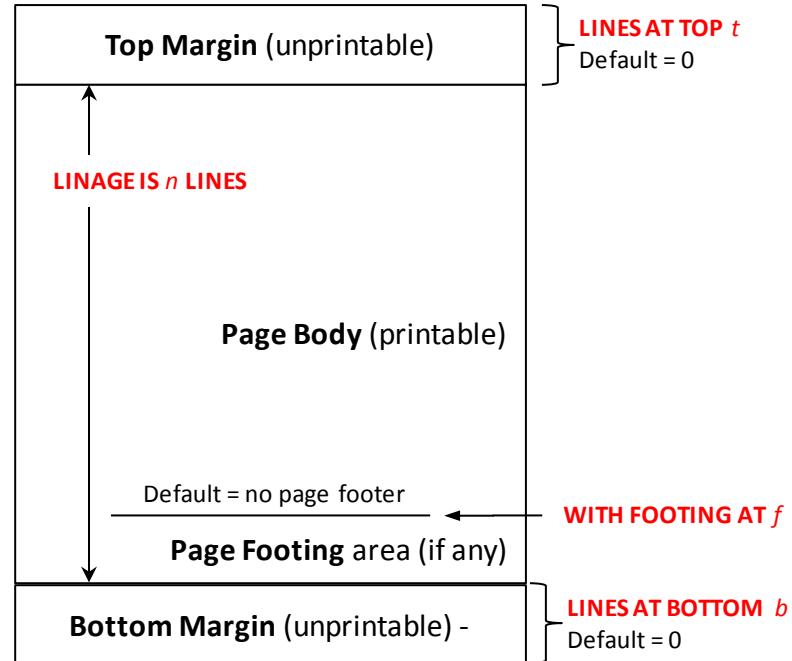
1. A file description for a file used as a sort/merge work file must be specified as an **SD**. The descriptions of all other files must be specified as **FDs**.
2. The name specified as *file-name-1* must exactly match the name specified on the file's **SELECT** statement.
3. By specifying the **EXTERNAL** clause, the file description is capable of being shared between all programs executed from the same execution thread, provided the file description is coded (with an **EXTERNAL** clause) in each program requiring it. This sharing allows the file to be **OPENed**, read and/or written and **CLOSEd** in different programs. This sharing applies to the record descriptions subordinate to the file description too.
4. By specifying the **GLOBAL** clause, the file description is capable of being shared between a program and any nested subprograms within it, provided the file description is coded (with a **GLOBAL** clause) in each program

- requiring it. This sharing allows the file to be **OPENed**, read and/or written and **CLOSEd** in different programs. Separately compiled programs cannot share a **GLOBAL** file description, but they can share an **EXTERNAL** file description. This sharing applies to the record descriptions subordinate to the file description too.
5. The **RECORD CONTAINS** and **RECORD IS VARYING** clauses are ignored (with a warning message issued) when used with **LINE SEQUENTIAL** files. With other file organizations these mutually-exclusive clauses define the length of data records within the file. The data item specified as *identifier-1* must be defined within one of the record descriptions of *file-name-1*.
  6. The **CODE-SET**, clause allows a custom alphabet (defined in the **SPECIAL-NAMES** paragraph of the **CONFIGURATION SECTION**) to be associated with a file. This clause is valid only when used with **RECORD BINARY SEQUENTIAL** or **LINE SEQUENTIAL** files.
  7. The **REPORT IS** clause is syntactically recognized but will cause an error since the Report Writer Control System (RWCS) is not currently supported by GNU COBOL.
  8. The **BLOCK CONTAINS** clause is syntactically recognized by the GNU COBOL compiler, but is currently non-functional.
  9. The **LABEL RECORD**, **DATA RECORD**, **RECORDING MODE** and **VALUE OF** clauses are obsolete. If used, they will have no impact on the generated code. The identifiers specified on the **DATA RECORD** clause will be verified as being defined within the program, but the compiler won't care whether they are actually specified as records of the file or not.
  10. The **LINAGE** clause can only be specified for **ORGANIZATION RECORD BINARY SEQUENTIAL** or **ORGANIZATION LINE SEQUENTIAL** files. It cannot be used within an **SD**. If used on an **ORGANIZATION RECORD BINARY SEQUENTIAL** file, the definition of that file will be implicitly changed to **LINE SEQUENTIAL**.

11. The **LINAGE** clause is used to specify the logical boundaries (in terms of numbers of lines) of various areas on a printed page, as shown in [Figure 5-3](#).

This page structure – once defined – can be automatically enforced by the the **WRITE** statement.

Figure 5-3- LINAGE-specified Page Structure



12. The following special rules apply only to sort/merge work files (**SDs**):
  - a. Sort/merge work files should be assigned to **DISK** (or **DISC**).
  - b. **SORTs** and **MERGEs** will be performed in memory, if the amount of data being sorted allows.
  - c. Should actual disk work files be necessary due to the amount of data being **SORTed** or **MERGED**, they will be automatically allocated to disk in a folder defined by the **TMPDIR**, **TMP** or **TEMP** environment variables. These disk files will be automatically purged upon **SORT** / **MERGE** termination. They will also be purged if the program terminates abnormally before the **SORT** or **MERGE** finishes. Should you ever need to know, temporary sort/merge work files will be named "cob\*.tmp".

- d. If you specify a specific filename in the sort/merge work file's **SELECT**, it will be ignored.

**See Also...**

The <b>SPECIAL-NAMES</b> Paragraph <a href="#">4.1.4</a>	The <b>OPEN</b> Statement <a href="#">6.4.29</a>
Defining File Characteristics ( <b>SELECT</b> ) <a href="#">4.2.1</a>	The <b>SORT</b> Statement (File Sort) <a href="#">6.4.40.1</a>
Describing Record Layouts <a href="#">5.1.1</a>	The <b>WRITE</b> Statement <a href="#">6.4.50</a>
The <b>CLOSE</b> Statement <a href="#">6.4.7</a>	Execution-time Environment Variables <a href="#">8.2.4</a>
The <b>MERGE</b> Statement <a href="#">6.4.25</a>	

### 5.1.1. Record Descriptions

Every file description must be followed by at least one record description. If there are multiple record descriptions present, the one with the longest length will define the size of the record buffer into which **READ** statements deliver data read from the file and from which **WRITE** statements take the data to be written to the file. The various record descriptions for a file description implicitly share that one common record buffer (thus, they provide different ways to view the structure of data that can exist within the file). Record buffers can be shared between files by using the **SAME RECORD AREA** clause within the **I-O-CONTROL** paragraph of the **ENVIRONMENT DIVISION**.

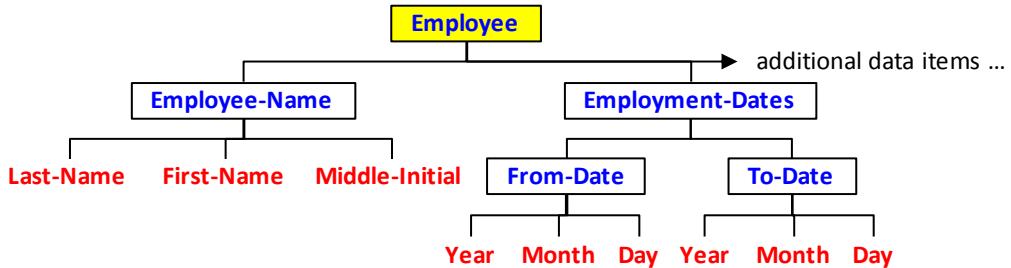
Record descriptions for all files take the form of 01-level data items that are coded immediately following the file description. These data items are constructed according to all the rules specified for defining non **SCREEN SECTION** data items, except that the **VALUE** clause may not be used.

**See Also...**

Sharing Record Buffers Between Files <a href="#">4.2.2</a>	Defining Records And Their Fields <a href="#">5.2.1</a>
--	---

### 5.2. Describing Data Items

GNU COBOL data items, like those of other COBOL implementations, are described in a hierarchical manner. This accommodates the fact that data items frequently need to be able to be broken up into subordinate items. Take for example, the following logical layout of a portion of a data item named "Employee":



The "Employee" data item consists of two subordinate data items – an "Employee-Name" and an "Employment-Dates" data item (presumably there would be a lot of others too, but we don't care about them right now). As the diagram shows, each of those data items are – in turn – broken down into subordinate data items. This hierarchy of data items can get rather "deep", and GNU COBOL has no problem dealing with it.

In GNU COBOL, data items that are broken down into other data items are referred to as **group items**, while those that aren't broken down are called **elementary items**. A group item that doesn't belong to any other data item (the one at the top of a chart like this one) is called a **record**. In the chart above, the names of all the elementary items are shown in red (without a box around it), the names of all the group items are shown in blue (with a box around it) and the record data item's box is shaded yellow.

GNU COBOL uses the concept of a "level number" to indicate the level at which a data item occurs in a data structure such as the example shown above. Then these data items are defined, they are all defined together with a number in the range 1-49 specified in front of their names. Over the years, a convention has come to exist among COBOL

programmers that level numbers are always coded as two-digit numbers – they don't have to be specified as two-digit numbers, but every example you see in this document will take that approach!

The record data item (the one at the top) always has a level number of **01**. After that, you may assign level numbers as you wish (01 – 02 – 03 – 04 - ..., 01 – 05 – 10 – 15 - ..., etc.) as you see fit, as long as you follow these simple rules:

1. Every data item at the same “level” of a hierarchy diagram such as the one you see here (if you were to make one which you rarely – if ever – will once you get used to this concept) must have the same level number.
2. Every level uses a level number that is strictly greater than the one used in the prior (next higher) level.
3. You never use a level number greater than 49.

So, the definition of these data items in a GNU COBOL program would go something like this:

```
01 Employee
  05 Employee-Name
    10 Last-Name
    10 First-Name
    10 Middle-Initial
  05 Employment-Dates
    10 From-Date
      15 Year
      15 Month
      15 Day
    10 To-Date
      15 Year
      15 Month
      15 Day
```

The indentation is purely at the discretion of the programmer to make things easier for humans to read (the compiler couldn't care less). Historically, COBOL implementations that required Fixed Format Mode source programs required that the “01” level begin in Area A and that everything else begin in Area B. GNU COBOL only requires that all data definition syntax occur in columns 8-72. In Free Format Mode, of course, there aren't even those limitations.

The coding example shown above is incomplete – it only describes the data item names and their hierarchical relationships to one other. In addition, any valid data item definitions will also need to describe what type of data is to be contained in a data item (Numeric? Alphanumeric? Alphabetic?), how much data can “fit” and a multitude of other characteristics.

*See Also...*

Fixed-Format Source Code [1.5.1.1](#)

Defining Data Items [5.2](#)

### 5.2.1. Defining non-SCREEN SECTION Data Items

Figure 5-4 – Non-SCREEN SECTION Data Item Description Syntax

```

level-number [ [ Identifier-1 ] ] IS [ EXTERNAL ]
[ FILLER ] [ GLOBAL ]

[ ANY LENGTH ]
[ BASED ]
[ BLANK WHEN ZERO ]
[ JUSTIFIED RIGHT ]
[ OCCURS integer-1 [ TO integer-2 ] TIMES [ DEPENDING ON identifier-2 ]
  [ [ ASCENDING ] [ DESCENDING ] KEY IS identifier-3 ]
  [ INDEXED BY identifier-4 ] ]

[ PICTURE picture-string ]
[ REDEFINES identifier-2 ]
[ RENAMES identifier-3 [ THRU | THROUGH identifier-4 ] ]
[ SIGN IS [ LEADING ] [ TRAILING ] [ SEPARATE CHARACTER ] ]
[ SYNCHRONIZED [ [ LEFT ] ] ]
[ USAGE IS data-item-usage ]
[ VALUE IS [ ALL ] literal-1 ]
.
```

The syntax skeleton shown here describes the manner in which data items are defined in all **DATA DIVISION** sections except the **SCREEN SECTION**.

1. The only valid level numbers are 01-49, 66, 77, 78 and 88. Level numbers 01 through 49 are used to define data items that may be part of a hierarchical structure of data items. Level number 01 can also be used to define a constant – an item with an unchangeable value specified at compilation time. Level numbers 66, 77, 78 and 88 all have special uses, and are covered in upcoming sections (the “See Also” table at the end of this section provides links to those discussions).
2. Not specifying an *identifier-name-1* or **FILLER** immediately after the level number has the same effect as if **FILLER** were specified. A data item named **FILLER** cannot be referenced directly; these items are generally used to specify an unused portion of the total storage allocated to a group item.
3. By specifying the **EXTERNAL** clause, the data item is capable of being shared between all programs executed from the same execution thread, provided the data item is coded (with an **EXTERNAL** clause) in each program requiring it.
4. By specifying the **GLOBAL** clause, the data item is capable of being shared between a program and any nested subprograms within it, provided the data item is coded (with a **GLOBAL** clause) in each program requiring it.
5. The **EXTERNAL** clause may only be specified at the 77 or 01 level.
6. An **EXTERNAL** item must have a data name (i.e. *identifier-1*) and that name cannot be **FILLER**.

7. **EXTERNAL** cannot be combined with **GLOBAL**, **REDEFINES** or **BASED**.
8. Every data item description must be terminated with a period.

*See Also...*

Describing Record Layouts <a href="#">5.1.1</a>	Defining Level-77 Data Items <a href="#">5.2.5</a>
Defining Screens <a href="#">5.2.2</a>	Defining Level 78 Constants <a href="#">5.2.6</a>
Defining Level-01 Constants <a href="#">5.2.3</a>	Defining Level-88 Condition Names <a href="#">5.2.7</a>
Defining Level-66 <b>RENAMES</b> Data Items <a href="#">5.2.4</a>	

### 5.2.1.1. ANY LENGTH Clause

1. Data items declared with the **ANY LENGTH** attribute have no fixed compile-time length. Such items may only be defined in the **LINKAGE SECTION** of a subprogram as they may only serve as subroutine argument descriptions. **ANY LENGTH** items must have a **PICTURE** clause that specifies exactly one A, X or 9 symbol.
2. The **ANY LENGTH** and **BASED** clauses cannot be used together in the same data item description.

**ANY LENGTH**

### 5.2.1.2. BASED Clause

1. Data items declared with **BASED** are allocated no storage at compilation time. At run-time, the **ALLOCATE** or **SET ADDRESS** verbs are used to allocate space for and (optionally) initialize such items.
2. The **BASED** and **ANY LENGTH** clauses cannot be used together in the same data item description.
3. The **BASED** clause may only be used on level 01 and level 77 data items.

**BASED***See Also...*

The <b>ALLOCATE</b> Statement <a href="#">6.4.3</a>	The <b>SET ADDRESS</b> Statement <a href="#">6.4.39.3</a>
---	---

### 5.2.1.3. BLANK WHEN ZERO Clause

1. The **BLANK WHEN ZERO** clause can only be used with a **PIC 9 USAGE DISPLAY** data item; it will cause that item's value to be automatically transformed into SPACES if a value of 0 is ever **MOVED** to the item.

**BLANK WHEN ZERO**

### 5.2.1.4. JUSTIFIED Clause

1. The **JUSTIFIED RIGHT** clause, valid only on an alphabetic (**PIC A**) or alphanumeric (**PIC X**) data item, will cause values shorter than the length of the data item to be right-justified and space-filled when they are **MOVED** into the data item (the default behavior is to left-justify and space fill).
2. The word **JUSTIFIED** may be abbreviated as **JUST**.

**JUSTIFIED RIGHT**

### 5.2.1.5. OCCURS Clause

- The **OCCURS** clause is used to create a data structure called a *table*<sup>11</sup> that repeats multiple times. For example:

```
05 QUARTLY-REVENUE OCCURS 4 TIMES PIC 9(7)V99.
```

Will allocate the following:

QUARTLY-REVENUE (1)	QUARTLY-REVENUE (2)	QUARTLY-REVENUE (3)	QUARTLY-REVENUE (4)
---------------------	---------------------	---------------------	---------------------

Each occurrence is referenced using the subscript syntax (a numeric literal, arithmetic expression or numeric identifier enclosed within parenthesis) shown in the diagram. The **OCCURS** clause may be used at the group level too, in which case the entire group structure repeats, as follows:

```
05 X OCCURS 3 TIMES.
```

```
10 A      PIC X(1).
10 B      PIC X(1).
10 C      PIC X(1).
```

	X (1)			X (2)			X (3)		
	A (1)	B (1)	C (1)	A (2)	B (2)	C (2)	A (3)	B (3)	C (3)

- The optional **DEPENDING ON** clause can be added to an **OCCURS** to create a variable-length table. Such tables will be allocated out to the maximum size specified as *integer-2*. At execution time the value of *identifier-2* will determine how many of the table elements are accessible.
- See the documentation of the **SEARCH**, **SEARCH ALL** and **SORT** verbs for explanations of the **KEY** and **INDEXED BY** clauses.
- The **OCCURS** clause cannot be specified in a data description entry that has a level number of 01, 66, 77, or 88.

### 5.2.1.6. PICTURE Clause

- The word **PICTURE** may be abbreviated as **PIC**.

- The **PICTURE** clause defines the class (numeric, alphabetic or alphanumeric) of the data that may be contained by the data item being defined. A **PICTURE** also (sometimes in conjunction with **USAGE**) defines the amount of storage reserved for the data item. The three basic class-specification **PICTURE** symbols have the following uses:

Figure 5-5 - Data Class-Specification PICTURE Symbols (A/X/9)

Basic Symbol	Meaning and Usage
9	Defines a spot reserved for a single decimal digit. The actual amount of storage occupied will depend on the specified <b>USAGE</b> .
A	Defines a place reserved for a single alphabetic character ("A"-“Z”, "a"-“z”). Each "A" represents a single byte of storage.
X	Defines a place reserved for a single character of storage. Each "X" represents a single byte of storage.

**PICTURE** *picture-string*

These three symbols are used repeatedly in a **PICTURE** clause to define how many of each class of data may be contained within the field. For example:

PIC 9999      Allocates a data item that can store four-digit positive numbers (we'll see shortly how negative

<sup>11</sup> Other programming languages with which you might be familiar refer to this sort of structure as an *array*.

values can be accounted for). If the **USAGE** of the field is **DISPLAY** (the default), four bytes of storage will be allocated and each byte may contain the character "0", "1", "2", ..., "8" or "9". There is no run-time enforcement of the fact that only digits are allowed. A compilation-time WARNING will be issued if literal value that violates the digits-only rule is **MOVED** to the field. A run-time violation is detectable using a class condition test.

- PIC 9(4) Identical to the above – a repeat count enclosed within parenthesis can be used with any **PICTURE** symbols that allows repetition.
- PIC X(10) This data item can hold a string of any ten characters.
- PIC A(10) This data item can hold a string of any ten letters. There is no enforcement of the fact that only letters are allowed, but a violation is detectable via a class condition test.
- PIC AA9(3)A This is exactly the same as specifying X(6), but it documents the fact that values should be two letters followed by 3 digits followed by a single letter. There is no enforcement and no capability of detecting violations other than a “brute force” check by character position.

Data items containing “A” or “X” **PICTURE** symbols cannot be used in arithmetic calculations.

In addition to the above [Figure 5-6](#) shows the numeric option **PICTURE** symbols that may be used with “**PIC 9**” Data Items

Figure 5-6 - Numeric Option PICTURE Symbols (P/S/V)

Numeric Option Symbol	Meaning and Usage
P	<p>Defines an implied digit position that will be considered to be a 0 when the data item is referenced at run-time. This symbol is used to allow data items that will contain very large values to be allocated using less storage by assuming a certain number of trailing zeros (one per “P”) to exist at the end of values.</p> <p>All computations and other operations performed against such a data item will behave as if the zeros were actually there.</p> <p>When values are stored into such a field they will have the digit positions defined by the “P” symbols stripped from the values as they are stored.</p> <p>For example, let’s say you need to allocate a data item that contains however many millions of dollars of revenue your company has in gross revenues this year:</p> <p><b>01 Gross-Revenue PIC 9(9).</b></p> <p>In which case 9 bytes of storage will be reserved. The values 000000000 thru 999999999 will represent the gross-revenues. But, if only the <u>millions</u> are tracked (meaning the last six digits are always going to be 0), you could define the field as:</p> <p><b>01 Gross-revenue PIC 9(3)P(6).</b></p> <p>Whenever Gross-Revenue is referenced in the program, the actual value in storage will be treated as if each P symbol (6 of them, in this case) were a zero.</p> <p>If you wanted to store the value 128 million into that field, you would do so as if the “P”s were “9”s:</p> <p><b>MOVE 128000000 TO Gross-Revenue.</b></p>
S	This symbol, which if used must be the very first symbol in the <b>PICTURE</b> value, indicates that negative values are possible for this data item. Without an “S”, any negative values stored into this data item via a <b>MOVE</b> or arithmetic statement will have the negative sign stripped from it (in effect becoming the absolute value).
V	This symbol is used to define where an implied decimal-point (if any) is located in a numeric item. Just as there may only be a single decimal point in a number so may there be no more than one “V” in a <b>PICTURE</b> . Implied decimal points occupy no space in storage – they just specify how values are used. For example, if the value “1234” is in storage in a field defined as PIC 999V9, that value would be treated as 123.4 in any statements that referenced it.

3. GNU COBOL supports all standard COBOL PICTURE editing symbols, namely "\$", comma, asterisk (\*), decimal-point, CR, DB, + (plus), - (minus), "B", "0" (zero) and "/", as follows:

Figure 5-7 - Numeric Editing PICTURE Symbols

Editing Symbol	Meaning and Usage																							
- (minus)	<p>This symbol must be used either at the very beginning of a <b>PICTURE</b> or at the very end. If “-” is used, none of “+”, “CR” or “DB” may be used. It is used to edit numeric values.</p> <p>Multiple consecutive “-” symbols are allowed only at the very beginning of the field. This is called a <i>floating minus sign</i>.</p> <p>Each “-” symbol will count as one character position in the size of the data item.</p> <p>If only a single “-” symbol is specified, that symbol will be “replaced” by a “-” if the value moved to the field is negative, or a <b>SPACE</b> otherwise.</p> <p>If a floating minus sign is used, think of the editing process as if it worked like this:</p> <ol style="list-style-type: none"> <li>1. Determine what the edited value would be if each “-” were actually a “9”.</li> <li>2. Locate the digit in the edited result that corresponds to the right-most “-” and scan the edited value back to the left from that point until you come to a “0” that has nothing but “0” characters to the left of it.</li> <li>3. Replace that “0” with a “-” if the value moved to the field is negative or a <b>SPACE</b> otherwise.</li> <li>4. Replace all remaining “0” characters to the left of that position by <b>SPACES</b>.</li> </ol> <p>Some examples (the symbol <b>b</b> denotes a space):</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">If this value...</th> <th style="text-align: center;">...is moved to a field with this PICTURE...</th> <th style="text-align: center;">... this value in storage will result:</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">17</td> <td style="text-align: center;">-999</td> <td style="text-align: center;">b017</td> </tr> <tr> <td style="text-align: center;">-17</td> <td style="text-align: center;">-999</td> <td style="text-align: center;">-017</td> </tr> <tr> <td style="text-align: center;">265</td> <td style="text-align: center;">----99</td> <td style="text-align: center;">bbbb265</td> </tr> <tr> <td style="text-align: center;">-265</td> <td style="text-align: center;">----99</td> <td style="text-align: center;">bbb-265</td> </tr> <tr> <td style="text-align: center;">51</td> <td style="text-align: center;">999-</td> <td style="text-align: center;">051b</td> </tr> <tr> <td style="text-align: center;">-51</td> <td style="text-align: center;">999-</td> <td style="text-align: center;">051-</td> </tr> </tbody> </table>			If this value...	...is moved to a field with this PICTURE...	... this value in storage will result:	17	-999	b017	-17	-999	-017	265	----99	bbbb265	-265	----99	bbb-265	51	999-	051b	-51	999-	051-
If this value...	...is moved to a field with this PICTURE...	... this value in storage will result:																						
17	-999	b017																						
-17	-999	-017																						
265	----99	bbbb265																						
-265	----99	bbb-265																						
51	999-	051b																						
-51	999-	051-																						
\$ <sup>12</sup>	<p>This symbol must be only be used at the very beginning of a <b>PICTURE</b> except that a “+” or “-” may appear to the left of it. It is used to edit numeric values.</p> <p>Multiple consecutive “\$” symbols are allowed. This is called a <i>floating currency symbol</i>.</p> <p>Each “\$” symbol will count as one character position in the size of the data item.</p> <p>If only a single “\$” symbol is specified, that symbol will be inserted into the edited value at that position unless there are so many significant digits to the field value that the position occupied by the “\$” is needed to represent a leading non-zero digit. In such cases, the “\$” will be treated as a “9”.</p> <p>If a floating currency sign is used, think of the editing process as if it worked like this:</p> <ol style="list-style-type: none"> <li>1. Determine what the edited value would be if each “\$” were actually a “9”.</li> <li>2. Locate the digit in the edited result that corresponds to the right-most “\$” and scan the edited value back to the left from that point until you come to a “0” that has nothing but “0” characters to the left of it.</li> <li>3. Replace that “0” with a “\$”.</li> <li>4. Replace all remaining “0” characters to the left of that position by <b>SPACES</b>.</li> </ol> <p>Some examples (the symbol <b>b</b> denotes a space):</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">If this value...</th> <th style="text-align: center;">...is moved to a field with this PICTURE...</th> <th style="text-align: center;">... this value in storage will result:</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">17</td> <td style="text-align: center;">\$999</td> <td style="text-align: center;">\$017</td> </tr> <tr> <td style="text-align: center;">265</td> <td style="text-align: center;">\$\$\$\$99</td> <td style="text-align: center;">bbb\$265</td> </tr> </tbody> </table>			If this value...	...is moved to a field with this PICTURE...	... this value in storage will result:	17	\$999	\$017	265	\$\$\$\$99	bbb\$265												
If this value...	...is moved to a field with this PICTURE...	... this value in storage will result:																						
17	\$999	\$017																						
265	\$\$\$\$99	bbb\$265																						

<sup>12</sup> The default currency sign used is “\$”. Other countries use different currency signs. The **SPECIAL-NAMES** paragraph allows any symbol to be defined as a currency symbol. If the currency sign is defined to the character ‘#’, for example, then you would use the ‘#’ character as a **PICTURE** editing symbol.

Editing Symbol	Meaning and Usage														
* (asterisk)	<p>This symbol must be only be used at the very beginning of a <b>PICTURE</b> except that a "+" or "-" may appear to the left of it. It is used to edit numeric values.</p> <p>Multiple consecutive "*" symbols are not only allowed, but are the typical usage. This is called a <i>floating check protection symbol</i>.</p> <p>Each "*" symbol will count as one character position in the size of the data item.</p> <p>Think of the editing process as if it worked like this:</p> <ol style="list-style-type: none"> <li>1. Determine what the edited value would be if each "*" were actually a "9".</li> <li>2. Locate the digit in the edited result that corresponds to the right-most "*" and scan the edited value back to the left from that point until you come to a "0" that has nothing but "0" characters to the left of it.</li> <li>3. Replace that "0" with a "*".</li> <li>4. Replace all remaining "0" characters to the left of that position by "*" also.</li> </ol> <p>An example:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>If this value...</th> <th>...is moved to a field with this PICTURE...</th> <th>... this value in storage will result:</th> </tr> </thead> <tbody> <tr> <td>265</td> <td>*****99</td> <td>****265</td> </tr> </tbody> </table>			If this value...	...is moved to a field with this PICTURE...	... this value in storage will result:	265	*****99	****265						
If this value...	...is moved to a field with this PICTURE...	... this value in storage will result:													
265	*****99	****265													
,	<p>(comma)<sup>13</sup> Each comma (,) in the <b>PICTURE</b> string represents a character position into which the character "," will be inserted. This character position is counted in the size of the item. The "," symbol is a "smart symbol" capable of masquerading as the <i>floating</i> symbol to its left and right should there be insufficient digits of precision to the numeric value being edited to require the insertion of a "," character.</p> <p>For example (the symbol b denotes a space):</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>If this value...</th> <th>...is moved to a field with this PICTURE...</th> <th>... this value in storage will result:</th> </tr> </thead> <tbody> <tr> <td>17</td> <td>\$,\$,\$,\$99</td> <td>bbbbbbb\$17</td> </tr> <tr> <td>265</td> <td>\$,\$,\$,\$99</td> <td>bbbbbbb\$265</td> </tr> <tr> <td>1456</td> <td>\$,\$,\$,\$99</td> <td>bbbb\$1,456</td> </tr> </tbody> </table>			If this value...	...is moved to a field with this PICTURE...	... this value in storage will result:	17	\$,\$,\$,\$99	bbbbbbb\$17	265	\$,\$,\$,\$99	bbbbbbb\$265	1456	\$,\$,\$,\$99	bbbb\$1,456
If this value...	...is moved to a field with this PICTURE...	... this value in storage will result:													
17	\$,\$,\$,\$99	bbbbbbb\$17													
265	\$,\$,\$,\$99	bbbbbbb\$265													
1456	\$,\$,\$,\$99	bbbb\$1,456													
.	<p>(period)<sup>13</sup> This symbol inserts a decimal point into the edited value at the point where an implied decimal point exists in the value. It is used to edit numeric values. Note that the period specified at the end of every data item definition IS NOT treated as an editing symbol!</p> <p>An example:</p> <pre>01 Edited-Value      PIC 9(3).99. 01 Payment          PIC 9(3)V99  VALUE 152.19. ... MOVE Payment TO Edited-Value. DISPLAY Edited-Value.</pre> <p>Will display 152.19</p>														
/ (slash)	<p>This symbol – usually used when editing dates for printing – inserts a "/" character into the edited value. The inserted "/" character will occupy a byte of storage in the edited result.</p> <p>An example:</p> <pre>01 Edited-Date      PIC 99/99/9999. ... MOVE 08182009 TO Edited-Date. DISPLAY Edited-Date.</pre> <p>The displayed value will be 08/18/2009.</p>														

<sup>13</sup> If **DECIMAL-POINT IS COMMA** is specified in the **SPECIAL-NAMES** paragraph, the meanings and usages of the "." and "," characters will be reversed

Editing Symbol	Meaning and Usage																					
+ (plus)	<p>This symbol must be used either at the very beginning of a <b>PICTURE</b> or at the very end. If “+” is used, none of “-”, “CR” or “DB” may be used. It is used to edit numeric values.</p> <p>Multiple consecutive “+” symbols are allowed only at the very beginning of the field. This is called a <i>floating plus sign</i>.</p> <p>Each “+” symbol will count as one character position in the size of the data item. If only a single “+” symbol is specified, that symbol will be replaced by a “-” if the value moved to the field is negative, or a “+” otherwise.</p> <p>If a floating plus sign is used, think of the editing process as if it worked like this:</p> <ol style="list-style-type: none"> <li>1. Determine what the edited value would be if each “+” were actually a “9”.</li> <li>2. Locate the digit in the edited result that corresponds to the right-most “+” and scan the edited value back to the left from that point until you come to a “0” that has nothing but “0” characters to the left of it.</li> <li>3. Replace that “0” with a “-“ if the value moved to the field is negative or a “+” otherwise.</li> <li>4. Replace all remaining “0” characters to the left of that position by <b>SPACES</b>.</li> </ol> <p>Some examples (the symbol <b>b</b> denotes a space):</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">If this value...</th><th style="text-align: center;">...is moved to a field with this PICTURE...</th><th style="text-align: center;">... this value in storage will result:</th></tr> </thead> <tbody> <tr> <td style="text-align: center;">17</td><td style="text-align: center;">+999</td><td style="text-align: center;">+017</td></tr> <tr> <td style="text-align: center;">-17</td><td style="text-align: center;">+999</td><td style="text-align: center;">-017</td></tr> <tr> <td style="text-align: center;">265</td><td style="text-align: center;">+++++99</td><td style="text-align: center;">bbb+265</td></tr> <tr> <td style="text-align: center;">-265</td><td style="text-align: center;">+++++99</td><td style="text-align: center;">bbb-265</td></tr> <tr> <td style="text-align: center;">51</td><td style="text-align: center;">999+</td><td style="text-align: center;">051+</td></tr> <tr> <td style="text-align: center;">-51</td><td style="text-align: center;">999-</td><td style="text-align: center;">051-</td></tr> </tbody> </table>	If this value...	...is moved to a field with this PICTURE...	... this value in storage will result:	17	+999	+017	-17	+999	-017	265	+++++99	bbb+265	-265	+++++99	bbb-265	51	999+	051+	-51	999-	051-
If this value...	...is moved to a field with this PICTURE...	... this value in storage will result:																				
17	+999	+017																				
-17	+999	-017																				
265	+++++99	bbb+265																				
-265	+++++99	bbb-265																				
51	999+	051+																				
-51	999-	051-																				
0 (zero)	<p>This symbol inserts a “0” character into the edited value. The inserted “0” character will occupy a byte of storage in the edited result.</p> <p>An example:</p> <pre>01 Edited-Phone-Number    PIC 9(3)B9(3)B9(4). ... MOVE 5185551212 TO Edited-Phone-Number. DISPLAY Edited-Phone-Number.</pre> <p>The displayed value will be <b>518 555 1212</b>.</p>																					
B	<p>This symbol inserts a <b>SPACE</b> character into the edited value. The inserted <b>SPACE</b> character will occupy a byte of storage in the edited result.</p> <p>An example:</p> <pre>01 Edited-Phone-Number    PIC 9(3)B9(3)B9(4). ... MOVE 5185551212 TO Edited-Phone-Number. DISPLAY Edited-Phone-Number.</pre> <p>The displayed value will be <b>518 555 1212</b>.</p>																					
CR	<p>This symbol must be used only at the very end of a <b>PICTURE</b>. If “CR” is used, none of “-”, “+” or “DB” may be used. It is used to edit numeric values.</p> <p>Multiple “CR” symbols are not allowed in one <b>PICTURE</b> clause.</p> <p>A “CR” symbol will count as two character positions in the size of the data item.</p> <p>If the value moved into the field is negative, the characters “CR” will be inserted into the edited value, otherwise two <b>SPACES</b> will be inserted.</p> <p>Some examples (the symbol <b>b</b> denotes a space):</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">This value...</th><th style="text-align: center;">...is moved to a field with this PICTURE...</th><th style="text-align: center;">...resulting in this value in storage:</th></tr> </thead> <tbody> <tr> <td style="text-align: center;">17</td><td style="text-align: center;">99CR</td><td style="text-align: center;">17bb</td></tr> <tr> <td style="text-align: center;">-17</td><td style="text-align: center;">99CR</td><td style="text-align: center;">17CR</td></tr> </tbody> </table>	This value...	...is moved to a field with this PICTURE...	...resulting in this value in storage:	17	99CR	17bb	-17	99CR	17CR												
This value...	...is moved to a field with this PICTURE...	...resulting in this value in storage:																				
17	99CR	17bb																				
-17	99CR	17CR																				

Editing Symbol	Meaning and Usage											
DB	<p>This symbol must be used only at the very end of a <b>PICTURE</b>. If “DB” is used, none of “-”, “+” or “CR” may be used. It is used to edit numeric values.</p> <p>Multiple “DB” symbols are not allowed in one PICTURE clause.</p> <p>A “DB” symbol will count as two character positions in the size of the data item.</p> <p>If the value moved into the field is negative, the characters “DB” will be inserted into the edited value, otherwise two <b>SPACES</b> will be inserted.</p> <p>Some examples (the symbol <b>b</b> denotes a space):</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="background-color: black; color: white;">This value...</th><th style="background-color: black; color: white;">...is moved to a field with this PICTURE...</th><th style="background-color: black; color: white;">...resulting in this value in storage:</th></tr> </thead> <tbody> <tr> <td>17</td><td>99DB</td><td>17bb</td></tr> <tr> <td>-17</td><td>99DB</td><td>b17DB</td></tr> </tbody> </table>			This value...	...is moved to a field with this PICTURE...	...resulting in this value in storage:	17	99DB	17bb	-17	99DB	b17DB
This value...	...is moved to a field with this PICTURE...	...resulting in this value in storage:										
17	99DB	17bb										
-17	99DB	b17DB										
Z	<p>This symbol must be only be used at the very beginning of a <b>PICTURE</b> except that a “+” or “-” may appear to the left of it. It is used to edit numeric values.</p> <p>Multiple consecutive “Z” symbols are not only allowed, but are the typical manner in which this editing symbol is used. This is called a <i>floating zero suppression</i>.</p> <p>Each “Z” symbol will count as one character position in the size of the data item.</p> <p>Think of the editing process as if it worked like this:</p> <ol style="list-style-type: none"> <li>1. Determine what the edited value would be if each “Z” were actually a “9”.</li> <li>2. Locate the digit in the edited result that corresponds to the right-most “Z” and scan the edited value back to the left from that point until you come to a “0” that has nothing but “0” characters to the left of it.</li> <li>3. Replace that “0” with a <b>SPACE</b>.</li> <li>4. Replace all remaining “0” characters to the left of that position by <b>SPACES</b>.</li> </ol> <p>Some examples (the symbol <b>b</b> denotes a space):</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="background-color: black; color: white;">This value...</th><th style="background-color: black; color: white;">...is moved to a field with this PICTURE...</th><th style="background-color: black; color: white;">...resulting in this value in storage:</th></tr> </thead> <tbody> <tr> <td>17</td><td>Z999</td><td>b017</td></tr> <tr> <td>265</td><td>ZZZZZ99</td><td>bbbb265</td></tr> </tbody> </table>			This value...	...is moved to a field with this PICTURE...	...resulting in this value in storage:	17	Z999	b017	265	ZZZZZ99	bbbb265
This value...	...is moved to a field with this PICTURE...	...resulting in this value in storage:										
17	Z999	b017										
265	ZZZZZ99	bbbb265										

No more than one editing symbol may be used in a floating manner in the same **PICTURE** clause.

4. Numeric data items containing editing symbols are referred to as numeric edited fields. Such data items may receive values in the various arithmetic statements but may not be used as sources of data in those same statements. The statements in question are **ADD**, **COMPUTE**, **DIVIDE**, **MULTIPLY** and **SUBTRACT**.

#### See Also...

The <b>SPECIAL-NAMES</b> Paragraph <a href="#">4.1.4</a>	The <b>COMPUTE</b> Statement <a href="#">6.4.9</a>
Storage Format of Data ( <b>USAGE</b> ) <a href="#">5.2.1.11</a>	The <b>DIVIDE</b> Statement <a href="#">6.4.13</a>
Class Tests <a href="#">6.1.4.2.2</a>	The <b>MULTIPLY</b> Statement <a href="#">6.4.27</a>
The <b>ADD</b> Statement <a href="#">6.4.2</a>	The <b>SUBTRACT</b> Statement <a href="#">6.4.44</a>

### 5.2.1.7. REDEFINES Clause

1. The **REDEFINES** clause causes *identifier-1* (the data item in which the REDEFINES clause is specified) to occupy the same physical storage space as *identifier-2*, so that storage may be defined in a different manner with a (probably) different structure. The following must all be true in order to use **REDEFINES**:
  - a. The level number of *identifier-2* must be the same as that of *identifier-1*.
  - b. The level number of *identifier-2* (and *identifier-1*) cannot be 66, 78 or 88.

**REDEFINES** *identifier-2*

- c. If "n" represents the level number of *identifier-2* (and *identifier-1*), then no other data items with level number "n" may be defined between *identifier-1* and *identifier-2*.
- d. The total allocated size of *identifier-1* must be the same as the total allocated size of *identifier-2*.
- e. No **OCCURS** clause may be defined on *identifier-2*. There may – however – be items defined with **OCCURS** clauses subordinate to *identifier-2*.
- f. No **VALUE** clause may be defined on *identifier-2*. No data items subordinate to *identifier-2* may have **VALUE** clauses, with the exception of level-88 condition names.

### 5.2.1.8. RENAMES Clause

The **RENAMES** clause regroups previously defined items by specifying alternative, possibly overlapping, groupings of elementary data items in a record.

**RENAMES** *identifier-3* [ **THRU** | **THROUGH** *identifier-4* ]

*See Also...*

Defining Level-66 **RENAMES** Data Items [5.2.4](#)

### 5.2.1.9. SIGN Clause

1. The **SIGN** clause, allowable only for **USAGE DISPLAY** numeric data items, specifies how an "S" symbol will be interpreted in a data item's **PICTURE** clause. Without the **SEPARATE CHARACTER** option, the sign of the data item's value will be encoded by transforming the last (**TRAILING**) or first (**LEADING**) digit as follows:

**SIGN IS** { **LEADING** } [ **TRAILING** ] [ **SEPARATE CHARACTER** ]

Figure 5-8 - Sign-Encoding Characters

First/Last Digit	Encoded Value For POSITIVE	Encoded Value For NEGATIVE
0	0	p
1	1	q
2	2	r
3	3	s
4	4	t
5	5	u
6	6	v
7	7	w
8	8	x
9	9	y

If the **SEPARATE CHARACTER** clause is used, then an actual "+" or "-" sign will be inserted into the field's value as the first (**LEADING**) or last (**TRAILING**) character.

2. When **SEPARATE CHARACTER** is specified, the "S" symbol in the data item's **PICTURE** must be counted when determining the data item's size.

*See Also...*

Defining a Data Item's **PICTURE** [5.2.1.6](#)

### 5.2.1.10. SYNCHRONIZED Clause

- The **SYNCHRONIZED** clause (which may be abbreviated as **SYNC**) optimizes the storage of binary numeric items to store them in such a manner as to make it as fast as possible for the CPU to fetch them. This synchronization is performed as follows:

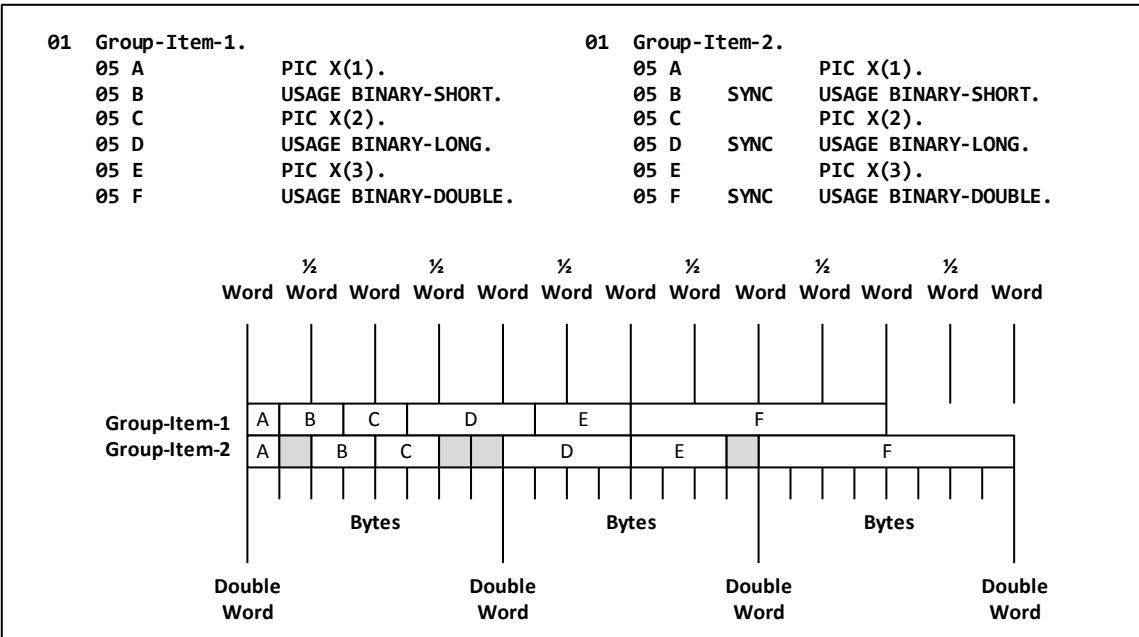
**SYNCHRONIZED**

[ { **LEFT** } ] [ { **RIGHT** } ]

- If the binary item occupies one byte of storage, no synchronization is performed.
- If the binary item occupies two bytes of storage, the binary item is allocated at the next half-word boundary.
- If the binary item occupies four bytes of storage, the binary item is allocated at the next word boundary.
- If the binary item occupies four bytes of storage, the binary item is allocated at the next word boundary.

[Figure 5-9](#) provides an example of a group item's storage allocation with and without using **SYNCHRONIZED**.

Figure 5-9 - Effect of the SYNCHRONIZED Clause



The grey blocks represent the unused “slack” bytes that are allocated in the **Group-Item-2** structure because of the **SYNC** clauses.

The **LEFT** and **RIGHT** options to the **SYNCHRONIZED** clause are recognized for syntactical compatibility with other COBOL implementations, but are otherwise non-functional.

### 5.2.1.11. USAGE Clause

- The following table summarizes the various possible **USAGE** specifications:

**USAGE IS** *data-item-usage*

Figure 5-10 - Summary of USAGE Specifications

USAGE	Range of Possible Values	Format (See note #2,#4)	Allows Negative Values? (See note #3)	Used w/ PICTURE?
<b>BINARY</b>	Defined by the quantity of “9”s in the <b>PICTURE</b> and the presence or absence of an “S” in the <b>PICTURE</b>	Compatible Binary Integer	If <b>PICTURE</b> contains “S”	Yes

USAGE	Range of Possible Values	Format (See note #2,#4)	Allows Negative Values? (See note #3)	Used w/ PICTURE?
<u>BINARY-C-LONG [ SIGNED ]</u>	Same as <b>BINARY-DOUBLE SIGNED</b>			
<u>BINARY-C-LONG UNSIGNED</u>	Typically 0 to 4,294,967,295	Native Binary Integer	No – see #3	No
<u>BINARY-CHAR [ SIGNED ]</u>	-128 to 127	Native Binary Integer	Yes	No
<u>BINARY-CHAR UNSIGNED</u>	0 to 255	Native Binary Integer	No – see #3	No
<u>BINARY-DOUBLE [ SIGNED ]</u>	-9,223,372,036,854,775,808 to 9,223,372,036,854,775,807	Native Binary Integer	Yes	No
<u>BINARY-DOUBLE UNSIGNED</u>	0 to 18,446,744,073,709,551,615	Native Binary Integer	No – see #3	No
<u>BINARY-INT</u>	Same as <b>BINARY-LONG SIGNED</b>			
<u>BINARY-LONG [ SIGNED ]</u>	-2,147,483,648 – 2,147,483,647	Native Binary Integer	Yes	No
<u>BINARY-LONG UNSIGNED</u>	0 to 4,294,967,295	Native Binary Integer	No – see #3	No
<u>BINARY-LONG-LONG</u>	Same as <b>BINARY-DOUBLE SIGNED</b>			
<u>BINARY-SHORT [ SIGNED ]</u>	-32,768 to 32,767	Native Binary Integer	Yes	No
<u>BINARY-SHORT UNSIGNED</u>	0 to 65,535	Native Binary Integer	No – see #3	No
<u>COMPUTATIONAL</u>	Same as <b>BINARY</b>			
<u>COMPUTATIONAL-1</u>	Same as <b>FLOAT-SHORT</b>			
<u>COMPUTATIONAL-2</u>	Same as <b>FLOAT-LONG</b>			
<u>COMPUTATIONAL-3</u>	Same as <b>PACKED-DECIMAL</b>			
<u>COMPUTATIONAL-4</u>	Same as <b>BINARY</b>			
<u>COMPUTATIONAL-5</u>	Depends on number of "9"s in <b>PICTURE</b> and the "binary-size" setting of the configuration file used to compile the program	Native Binary Integer	If <b>PICTURE</b> contains "S"	Yes
<u>COMPUTATIONAL-6</u>	Defined by the quantity of "9"s in the <b>PICTURE</b> and the presence or absence of an "S" in the <b>PICTURE</b> (see #1)	Unsigned Packed Decimal <sup>14</sup>	No	Yes
<u>COMPUTATIONAL-X</u>	If used with " <b>PIC X</b> ", allocates one byte of storage per "X"; range of values is 0 to max storable in that many bytes If used with " <b>PIC 9</b> ", range of values depends on number of "9"s in <b>PICTURE</b>	Native unsigned (X) or signed (9) Binary	If <b>PICTURE 9</b> and contains "S"	Yes
<u>DISPLAY</u>	Depends on <b>PICTURE</b> – One character <sup>15</sup> per X, A, 9, period, \$, Z, 0, *, S (if <b>SEPARATE CHARACTER</b> specified), +, - or B symbol in <b>PICTURE</b> ; Add 2 more bytes if <b>DB</b> or <b>CR</b> symbol used	Characters <sup>16</sup>	If <b>PICTURE</b> contains "S"	Yes

<sup>14</sup> No half-byte is reserved for a sign as is the case with **PACKED-DECIMAL**<sup>15</sup> In this context, one character is the same as one byte, unless you've built yourself a GNU COBOL system that uses Unicode (unlikely), in which case 1 character = two bytes.<sup>16</sup> This is the most reliable format, combined with a **ORGANIZATION IS RECORD BINARY SEQUENTIAL** file format to use for data that is being shared between different computer systems because values encoded in this format may be represented exactly, without the possibility of having special control-characters (which could disrupt FTP transmissions or confuse run-time library software) as part of the data.

2. Binary data (integer or floating-point) can be stored in either a “Big-Endian” or “Little-Endian” form.

Big-endian data allocation calls for the bytes that comprise a binary item to be allocated such that the least-significant byte is the right-most byte. For example, a four-byte binary item having a value of decimal 20 would be big-endian allocated as 00000014 (shown in hexadecimal notation).

Little-endian data allocation calls for the bytes that comprise a binary item to be allocated such that the least-significant byte is the left-most byte. For example, a four-byte binary item having a value of decimal 20 would be little-endian allocated as 14000000 (shown in hexadecimal notation).

All CPUs are capable of “understanding” big-endian format, which makes it the “most-compatible” form of binary storage across computer systems.

<sup>17</sup> The **USAGE** specifications **FLOAT-DECIMAL-16** and **FLOAT-DECIMAL-34** will encode data using IEEE 754 “Decimal64” and “Decimal128” format, respectively. The former allows for up to 16 digits of exact precision while the latter offers 34. The phrase “exact precision” is used because the traditional binary renderings of decimal real numbers in a floating-point format (**FLOAT-LONG** and **FLOAT-SHORT**, for example) only yield an approximation of the actual value because many decimal fractions cannot be precisely rendered in binary. The Decimal64 and Decimal128 renderings, however, render decimal real numbers in encoded decimal form in much the same way that **PACKED-DECIMAL** renders a decimal integer in digit-by-digit decimal form. The exact manner in which this rendering is performed is complex (Wikipedia has an excellent article on the subject – just search for “Decimal64”), and in fact the IEEE 754 standard allows Decimal64 and Decimal128 encodings to be performed in two ways. GNU COBOL stores **FLOAT-DECIMAL-16** and **FLOAT-DECIMAL-34** data items using Native byte ordering techniques (see #2).

<sup>18</sup> The **USAGE** specifications **FLOAT-LONG** and **FLOAT-SHORT** use the IEEE 754 “Binary64” and “Binary32” formats, respectively. These are binary encodings of real decimal numbers, and as such cannot represent every possible value between the minimum and maximum values in the range for those **USAGES**. Wikipedia has an excellent article on the Binary64 and Binary32 encoding schemes – just search on “Binary32” or “Binary64”. GNU COBOL stores **FLOAT-LONG** and **FLOAT-SHORT** data items using Native byte ordering techniques (see #2).

Some CPUs – such as the Intel/AMD i386/x64 architecture processors such as those used in most Windows PCs – prefer to process binary data stored in a little-endian format. Since that format is more efficient on those systems, it is referred to as the “native” binary format.

On a system supporting only one format of binary storage (generally, that would be big-endian), the terms “most-efficient” format and “native format” are synonymous.

3. Data items that have the **UNSIGNED** attribute explicitly coded, or **DISPLAY/PACKED-DECIMAL/COMP-5/COMP-X** items that do not have an “S” symbol in their **PICTURE** clause cannot preserve negative values that may be stored into them. Storing a negative value into such a field will actually result in the sign being stripped, essentially saving the absolute value in the data item.
4. Packed-decimal (i.e. **USAGE PACKED-DECIMAL, COMP-3** or **COMP-6**) data is stored as a series of bytes such that each byte contains two 4-bit fields, referred to as “nibbles” (since they comprise half a “byte”) with each nibble representing a “9” in the **PICTURE** and each holding a single decimal digit encoded as its binary value (0 = 0000, 1 = 0001, ..., 9 = 1001). The last byte of a **PACKED-DECIMAL** or **COMP-3** data item will always have its left nibble corresponding to the last “9” in the **PICTURE** and its right nibble reserved as a sign indicator. This sign indicator is always present regardless of whether or not the **PICTURE** included an “S” symbol. The first byte of the data item will contain an unused left nibble if the **PICTURE** had an even number of “9” symbols in it. The sign indicator will have a value of a hexadecimal A thru F. Traditional packed decimal encoding rules call for hexadecimal values of C, A, F and E in the sign nibble to indicate a positive value and B or D to represent a negative value (hexadecimal digits 0-9 are undefined). Testing with a Windows MinGW/GNU COBOL implementation shows that – in fact – hex digit D represents a negative number and any other hexadecimal digit denoting a positive number. Therefore, a **PIC S9(3) COMP-3** packed-decimal field with a value of -15 would be stored internally as a hexadecimal 015D in GNU COBOL. If you attempt to store a negative number into a packed decimal field that has no “S” in its **PICTURE**, the absolute value of the negative number will actually be stored. A **USAGE of COMP-6** does not allow for negative values, therefore no sign nibble will be allocated. A **USAGE COMP-6** data item containing an odd number of “9” symbols in its **PICTURE** will leave its leftmost nibble unused.
5. A **USAGE** clause specified at the group item level will apply that **USAGE** to all subordinate data items, except those that themselves have a **USAGE** clause.

#### *See Also...*

GNU COBOL “config” Files [8.1.6](#)

### 5.2.1.12. VALUE Clause

1. The **VALUE** clause is ignored on **EXTERNAL** data items or on any data items defined as subordinate to an **EXTERNAL** data item.
2. The **VALUE** clause may not be used anywhere in the description of an 01 item serving as an FD or SD record description.
3. **VALUE** specifies an initial compilation-time value that will be assigned to the storage occupied by the data item in the program object code generated by the compiler. If the optional “**ALL**” clause is used, it may only be used with an alphanumeric literal value; the value will be repeated as needed to completely fill the data item. Here are some examples with and without **ALL**:

**VALUE IS [ ALL ] literal-1**

```
PIC X(5) VALUE "A"      *> will have the value "A",SPACE,SPACE,SPACE,SPACE
PIC X(5) VALUE ALL "A"  *> will have the value "A","A","A","A","A"
PIC 9(3) VALUE 1        *> will have the value 001
PIC 9(3) VALUE ALL "1"  *> will have the value 111
```

4. Giving a table an initial, compile-time value is one of the trickier aspects of COBOL data definition. There are basically three standard techniques and a fourth that people familiar with other COBOL implementations but new to GNU COBOL may find interesting. So, here are the three “standard” approaches:
  - a. Don’t bother worrying about it at compile-time. Use the **INITIALIZE** statement to initialize all data item occurrences in a table (at run-time) to their data-type-specific default values (numerics: 0, alphabetic and alphanumeric: **SPACES**).

- b. Initialize small tables at compile time by including a **VALUE** clause on the group item that serves as a “parent” to the table, as follows:

```
05 SHIRT-SIZES      VALUE "S 14M 15L 16XL17".
  10 SHIRT-SIZE-TBL OCCURS 4 TIMES.
    15 SST-SIZE      PIC X(2).
    15 SST-NECK      PIC 9(2).
```

- c. Initialize tables of almost any size at compilation time by utilizing the **REDEFINES** clause:

```
05 SHIRT-SIZE-VALUES.
  10 PIC X(4)        VALUE "S 14".
  10 PIC X(4)        VALUE "M 15".
  10 PIC X(4)        VALUE "L 16".
  10 PIC X(4)        VALUE "XL17".
05 SHIRT-SIZES      REDEFINES SHIRT-SIZE-VALUES.
  10 SHIRT-SIZE-TBL OCCURS 4 TIMES.
    15 SST-SIZE      PIC X(2).
    15 SST-NECK      PIC 9(2).
```

Admittedly, the table shown in #3c is much more verbose than #3b. What is good about #3c, however, is that you can have as many **FILLER/VALUE** items as you need for a larger table (and those values can be as long as necessary!)

Many COBOL compilers do not allow the use of **VALUE** and **OCCURS** on the same data item; additionally, they don’t allow a **VALUE** clause on a data item subordinate to an **OCCURS**. GNU COBOL, however, has neither of these restrictions!

Observe the following example, which illustrates the fourth manner in which tables may be initialized in GNU COBOL:

```
05 X          OCCURS 6 TIMES.
  10 A          PIC X(1) VALUE '?'.
  10 B          PIC X(1) VALUE '%'.
  10 N          PIC 9(2) VALUE 10.
```

In this example, all six “A” items will be initialized to “?”, all six “B” items will be initialized to “%” and all six “N” items will be initialized to 10. It’s not clear exactly how many times this sort of initialization will be useful, but it’s there if you need it.

#### *See Also...*

The **INITIALIZE** Statement [6.2.22](#)

## 5.2.2. Defining SCREEN SECTION Data Items

Figure 5-11 - SCREEN SECTION Data Item Description Syntax

```

level-number [ identifier-1 | FILLER ]
[ AUTO | AUTO-SKIP | AUTOTERMINATE ]
[ BELL | BEEP ]
[ BACKGROUND-COLOR IS integer-1 | identifier-2 ]
[ BLANK LINE | SCREEN ]
[ BLANK WHEN ZERO ]
[ BLINK ]
[ COLUMN NUMBER IS [ PLUS | + ] integer-2 | identifier-3 ]
[ ERASE EOL | EOS ]
[ FOREGROUND-COLOR IS integer-3 | identifier-4 ]
  [ FROM literal-1 | identifier-5 ]
  [ TO identifier-6 ]
  [ USING identifier-7 ]
[ FULL LENGTH-CHECK ]
[ HIGHLIGHT | LOWLIGHT ]
[ JUSTIFIED RIGHT ]
[ LEFTLINE ]
[ LINE NUMBER IS [ PLUS | + ] integer-4 | identifier-8 ]
[ OCCURS integer-5 TIMES ]
[ OVERLINE ]
[ PICTURE picture-string ]
[ PROMPT [ CHARACTER IS literal-2 | identifier-9 ] ]
[ REQUIRED | EMPTY-CHECK ]
[ REVERSE-VIDEO ]
[ SECURE | NO-ECHO ]
[ SIGN IS LEADING | TRAILING [ SEPARATE CHARACTER ] ]
[ UNDERLINE ]
[ VALUE IS [ ALL ] literal-3 ]
.
.
```

The syntax skeleton shown here describes how data items are defined in the **SCREEN SECTION**.

These data items are used via special forms of the **ACCEPT** and **DISPLAY** verbs to create full-screen TUI (“Textual User Interface”) programs.

1. Data items defined in the **SCREEN SECTION** describe input, output or combination screen layouts to be used with **DISPLAY** or **ACCEPT** statements. These screen layouts may define the entire available screen area or any subset of it.
2. The term “available screen area” is a nebulous one in those environments where command-line shell sessions are invoked within a graphical user-interface environment (as will be the case on Windows, OSX and most Unix/Linux systems) – these environments allow command-line session windows to exist with a variable number of available screen rows and columns. When you are designing GNU COBOL screens, you need to do so with an awareness of the logical row/column geometry the program will be executing within.

3. Data items with level numbers 01 (Constants), 66, 78 and 88 may be used in the **SCREEN SECTION**; they have the same syntax, rules and usage as they do in the other **DATA DIVISION** sections.
4. Without **LINE** or **COLUMN** clauses, **SCREEN SECTION** fields will display on the console window beginning at whatever line/column coordinate is stated or implied by the **ACCEPT** or **DISPLAY** statement that presents the screen item. After a field is presented to the console window, the next field will be presented immediately following that field.
5. A **LINE** clause explicitly stated in the definition of a **SCREEN SECTION** data item will override any **LINE** clause included on the **ACCEPT** or **DISPLAY** statement that presents that data item to the screen. The same is true of **COLUMN** clauses.
6. The Tab and Back-Tab (Shift-Tab) keys will position the cursor from field to field in the line/column sequence in which the fields occur on the screen at execution time, regardless of the sequence in which they were defined in the **SCREEN SECTION**.

**See Also...**

Defining Level-01 Constants <a href="#">5.2.3</a>	Defining Level-88 Condition Names <a href="#">5.2.7</a>
Defining Level-66 <b>RENAMES</b> Data Items <a href="#">5.2.4</a>	The <b>ACCEPT</b> Statement (Screen Data) <a href="#">6.4.1.4</a>
Defining Level 78 Constants <a href="#">5.2.6</a>	The <b>DISPLAY</b> Statement (Screen Data) <a href="#">6.4.12.4</a>

### 5.2.2.1. AUTO | AUTO-SKIP | AUTOTERMINATE Clause

1. The **AUTO** clause (the three forms are all equivalent) will cause the cursor to automatically advance to the next input-enabled field if the field having the **AUTO** clause is completely filled.

[ **AUTO** | **AUTO-SKIP** | **AUTOTERMINATE** ]

### 5.2.2.2. BACKGROUND-COLOR Clause

1. The **BACKGROUND-COLOR** clause is used to specify the screen background color of the screen data item or the default screen background color of subordinate items if **BACKGROUND-COLOR** is used on a group item. You specify colors by number (0-7), or by using the constant names provided in the "screenio.cpy" copybook (which is provided with all GNU COBOL source distributions).
2. **BACKGROUND-COLOR** values are inheritable from previous fields - they are not inherited from the prior field encountered but rather from parent data items (data items with numerically lower level numbers).
3. The following is the GNU COBOL color palette:

[ **BACKGROUND-COLOR** IS { *integer-1* *identifier-2* } ]

Figure 5-12 - The GNU COBOL Color Palette (Windows Console)

Color Integer Value	"screenio.cpy" Constant Name	Normal or LOWLIGHT Appearance	HIGHLIGHT Appearance
0	COB-COLOR-BLACK		
1	COB-COLOR-BLUE		
2	COB-COLOR-GREEN		
3	COB-COLOR-CYAN		
4	COB-COLOR-RED		
5	COB-COLOR-MAGENTA		
6	COB-COLOR-YELLOW		
7	COB-COLOR-WHITE		

### 5.2.2.3. BEEP | BELL Clause

1. Use the **BELL** or **BEEP** clauses (they are synonymous) to cause an audible tone to occur when the screen item is **DISPLAYed** ().

[ **BELL** | **BEEP** ]

#### 5.2.2.4. BLANK LINE and BLANK SCREEN Clauses

1. The **BLANK SCREEN** clause will blank-out the entire screen prior to displaying the new screen contents described by the screen data item whose description this clause is part of.
2. The **BLANK LINE** clause will blank out the entire screen line upon which the screen data item whose description contains this clause prior to displaying this screen data item.
3. Blanked-out areas will have their foreground and background colors set to the attributes of the field containing the **BLANK** clause.
4. This clause is useful when one **SCREEN SECTION** item is being **DISPLAYed** over the top of a previously-**DISPLAYed** one.

[ **BLANK** { **LINE** | **SCREEN** } ]

#### 5.2.2.5. BLANK WHEN ZERO Clause

1. The **BLANK WHEN ZERO** will cause that screen data item's value to be automatically transformed into SPACES if a value of 0 is ever put into the field via a FROM, USING or VALUE clause.

**BLANK WHEN ZERO**

#### 5.2.2.6. BLINK Clause

1. The **BLINK** clause modifies the visual appearance of the displayed field by making the field contents blink. The manner in which the blinking is accomplished will vary, depending upon the "curses" package built into the GNU COBOL implementation you're using, as well as the visual presentation capabilities of the command window shell you're using. The Windows console, for example, does not support blinking, so the visual effect of **BLINK** in a native Windows or MinGW version of GNU COBOL is to elevate the **BACKGROUND-COLOR** intensity (normally low) to high intensity.
2. See [Figure 5-12](#). for the GNU COBOL color palette. The "HIGHLIGHT" column shows the effect the **BLINK** clause will have on **BACKGROUND-COLOR** when running within a Windows console window.

[ **BLINK** ]

#### 5.2.2.7. COLUMN Clause

1. The **COLUMN** clause provides a means of explicitly stating in which column a field should be presented on the console window (it's line location will be determined by the **LINE** clause).
2. You may abbreviate **COLUMN** as **COL**.
3. The value of *integer-2* must be 1 or greater.
4. If *identifier-3* is used to specify either an absolute or relative column position, *identifier-3* must be defined as a **PIC 9** item without editing symbols. The value of *identifier-3* at the time the screen data item is presented must be 1 or greater.
5. Any numeric **USAGE** is allowed for *identifier-3* except for **COMPUTATIONAL-1** or **COMPUTATIONAL-2**. Note that either of these floating-point **USAGE** specifications will be accepted, but will produce unpredictable results.
6. Coordinates may be stated on an absolute basis (i.e. "**COLUMN 5**") or on a relative basis based upon the end of the previously-presented field (i.e. "**COLUMN PLUS 1**").
7. The symbol "+" may be used in lieu of the word **PLUS**, if desired; if "+" is used in combination with *integer-2*, however, there must be at least one space separating it from *integer-2*. Failure to include this space will cause

[ **COLUMN NUMBER IS** [ **PLUS** | + ] { *integer-2* | *identifier-3* } ]

- the “+” sign to be simply treated as part of *integer-2* and will treat the **COLUMN** clause as an absolute column specification rather than a relative one.
8. If a screen data items description includes the **FROM**, **TO**, **USING** or **VALUE** clause but has no **COLUMN** clause, “**COLUMN PLUS 1**” will be assumed.

### 5.2.2.8. ERASE EOL and ERASE EOS Clauses

1. The **ERASE EOS** clause will blank-out screen contents from the location where the screen data item whose description contains this clause will be displayed, forward until the end of the screen prior to displaying this screen data item.
2. The **ERASE EOL** clause will blank-out screen contents from the location where the screen data item whose description contains this clause will be displayed, forward until the end of that screen line prior to displaying this screen data item.
3. Erased- areas will have their foreground and background colors set to the attributes of the field containing the **ERASE** clause.
4. This clause is useful when one **SCREEN SECTION** item is being **DISPLAYed** over the top of a previously-**DISPLAYed** one.

[ **ERASE** [ **EOL** ] [ **EOS** ] ]

### 5.2.2.9. FOREGROUND-COLOR Clause

1. The **FOREGROUND-COLOR** clause is used to specify the text color of the screen data item or the default text color of subordinate items if **FOREGROUND-COLOR** is used on a group item. You specify colors by number (0-7), or by using the constant names provided in the “screenio.cpy” copybook (which is provided with all GNU COBOL source distributions).
2. **FOREGROUND-COLOR** values are inheritable from previous fields - they are not inherited from the prior field encountered but rather from parent data items (data items with numerically lower level numbers).
3. See [Figure 5-12](#).for the GNU COBOL color palette.

[ **FOREGROUND-COLOR** **IS** [ *integer-3* ] [ *identifier-4* ] ]

### 5.2.2.10. FROM, TO and USING Clauses

1. The **FROM** clause is used to define a field whose contents should come from the specified literal or identifier.
2. The **TO** clause is used to define a data-entry field with no initial value; when a value is entered, it will be saved to the specified identifier.
3. The **USING** clause is a combination of “**FROM identifier-6**” and “**TO identifier-6**”.

[ [ [ **FROM** [ *literal-1* ] [ *identifier-5* ] ] [ [ **TO** ] [ **USING** ] *identifier-6* ] ] ]

### 5.2.2.11. FULL | LENGTH-CHECK Clause

1. The **FULL** or **LENGTH-CHECK** clause forces the user to enter data into the field it is specified on (or into all subordinate input-capable fields if specified on a group item) sufficient to fill every character position of the field. In order to take effect, the user must move the cursor into the field having the **FULL/LENGTH-CHECK** clause in its definition. The **ACCEPT** statement will ignore the Enter key and any other cursor-moving keystrokes that would cause the cursor to move to another screen item unless the proper amount of data has been entered into the field. Function keys will still be allowed to terminate the **ACCEPT**, however. In order to be functional, this attribute must be supported by the underlying “curses” package your GNU COBOL package was built with. As of this time, the PDCurses package (used for native Windows or MinGW builds) does not support **FULL/LENGTH-CHECK**.

[ **FULL** | **LENGTH-CHECK** ]

*See Also...*

The ACCEPT Statement (Screen Data) [6.4.1.4](#)

### 5.2.2.12. HIGHLIGHT and LOWLIGHT Clauses

1. The **HIGHLIGHT** and **LOWLIGHT** clauses control the intensity of text (**FOREGROUND-COLOR**). This is intended to provide a three-level intensity scheme (**LOWLIGHT** ... nothing (Normal) ... **HIGHLIGHT**). In environments such as a Windows console where only two levels of intensity are supported, **LOWLIGHT** is the same as leaving this clause off altogether.
2. See [Figure 5-12](#) for the GNU COBOL color palette and the effect the HIGHLIGHT clause has on it in 2-level intensity environments such as Windows.

[ [ **HIGHLIGHT** ] ]  
[ **LOWLIGHT** ]

### 5.2.2.13. JUSTIFIED Clause

1. The **JUSTIFIED RIGHT** clause, valid only on an alphabetic (**PIC A**) or alphanumeric (**PIC X**) data item, will cause values shorter than the length of the data item to be right-justified and space-filled when they are transferred into the screen data item via the **FROM** or **USING** clause (the default behavior is to left-justify and space fill).
2. The word **JUSTIFIED** may be abbreviated as **JUST**.

**JUSTIFIED RIGHT**

### 5.2.2.14. LEFTLINE, OVERLINE and UNDERLINE Clauses

1. The **LEFTLINE**, **OVERLINE** and **UNDERLINE** clauses will introduce a horizontal line at the left, top or bottom edge of a screen field, respectively.
2. These clauses may be used in any combination in a single field's description.
3. These clauses are essentially non-functional when used within Windows command shell (cmd.exe) environments; those video attributes are not currently supported by the Windows console window API.
4. Whether or not these clauses operate on Cygwin or UNIX/Linux systems will depend upon the video attribute capabilities of the terminal output drivers being used.

[ **LEFTLINE** ]  
[ **OVERLINE** ]  
[ **UNDERLINE** ]

### 5.2.2.15. LINE Clause

1. The **LINE** clause provides a means of explicitly stating on which line a field should be presented on the console window (it's column location will be determined by the **COLUMN** clause).
2. The value of *integer-4* must be 1 or greater.
3. If *identifier-7* is used to specify either an absolute or relative column position, *identifier-7* must be defined as a **PIC 9** item without editing symbols. The value of *identifier-7* at the time the screen data item is presented must be 1 or greater.
4. Any numeric **USAGE** is allowed for *identifier-7* except for **COMPUTATIONAL-1** or **COMPUTATIONAL-2**. Note that either of these floating-point **USAGE** specifications will be accepted, but will produce unpredictable results.
5. Coordinates may be stated on an absolute basis (i.e. "COLUMN 5") or on a relative basis based upon the end of the previously-presented field (i.e. "COLUMN PLUS 1").
6. The symbol "+" may be used in lieu of the word **PLUS**, if desired; if "+" is used in combination with *integer-4*, however, there must be at least one space separating it from *integer-4*. Failure to include this space will cause the "+" sign to be simply treated as part of *integer-4* and will treat the **LINE** clause as an absolute line specification rather than a relative one.

[ **LINE NUMBER IS** [ **PLUS** | + ] [ *integer-4* ]  
[ *identifier-7* ] ]

7. If a screen data items description includes the **FROM**, **TO**, **USING** or **VALUE** clause but has no **LINE** clause, the "current screen line" will be assumed.

### 5.2.2.16. OCCURS Clause

1. An **OCCURS** clause can be used to repeat screen field definitions. It may be used on either elementary or group data items.
2. If an *identifier-1* was included in the description of the data item containing the **OCCURS** clause, references to *identifier-1* will need to be subscripted.

[ **OCCURS** *integer-1 TIMES* ]

### 5.2.2.17. PICTURE Clause

1. The **PICTURE** clause specifies the type (A=Alphabetic, 9=Numeric, X=Alphanumeric) and size of a screen field.
2. If the screen data item whose description contains the **PICTURE** clause is an input field (meaning its definition includes either the **TO** or **USING** clause), the type specified by the **PICTURE** (A or 9) will be enforced on the user. For example, if the **PICTURE** is 9, only numeric characters (digits, decimal point, sign) will be accepted. If the **PICTURE** is A, only letters and spaces will be accepted.
3. If a screen data item does not have a **PICTURE** clause, its size will be inferred from the literal or identifier associated with the field via a **FROM**, **TO** or **USING** clause. If there is no such clause, then length will be inferred from the **VALUE** clause. If there is no **VALUE** clause, the screen data item will be treated as a group item (if data items that follow have a higher level number) or an elementary item of length 0 (if data items that follow have a smaller or equal level number).

[ **PICTURE** *picture-string* ]

### 5.2.2.18. PROMPT Clause

1. This clause defines the character that will be used as the fill-character for any input fields on the screen.
2. The default character, should no **CHARACTER** specification be coded, or should the **PROMPT** clause be absent altogether, is an underscore ("\_").
3. PROMPT characters will be automatically transformed into SPACES upon input.

[ **PROMPT** [ **CHARACTER** IS { *literal-2* } ] *identifier-8* ] ]

### 5.2.2.19. REQUIRED | EMPTY-CHECK Clause

1. The **REQUIRED** or **EMPTY-CHECK** clauses force the user to enter data into the field it is specified on (or into all subordinate input-capable fields if **REQUIRED/EMPTY-CHECK** is specified on a group item). In order to take effect, the user must move the cursor into the field having the **REQUIRED/EMPTY-CHECK** clause in its definition. The **ACCEPT** statement will ignore the Enter key and any other cursor-moving keystrokes that would cause the cursor to move to another screen item unless data has been entered into the field. Function keys will still be allowed to terminate the **ACCEPT**, however. In order to be functional, this attribute must be supported by the underlying "curses" package your GNU COBOL package was built with. As of this time, the PDCurses package (used for native Windows or MinGW builds) does not support **REQUIRED/EMPTY-CHECK**.

[ **REQUIRED** | **EMPTY-CHECK** ]

*See Also...*

The ACCEPT Statement (Screen Data) [6.4.1.4](#)

### 5.2.2.20. REVERSE-VIDEO Clause

1. The **REVERSE-VIDEO** attribute reverses the meaning of the specified or implied **FOREGROUND-COLOR** and **BACKGROUND-COLOR** attributes for the field (or all subordinate fields if used on a group item).

[ **REVERSE-VIDEO** ]

### 5.2.2.21. SECURE | NO-ECHO Clause

- The **SECURE** or **NO-ECHO** clause (they are synonymous with each other) may only be used on a field allowing data entry (**USING** or **TO**). This attribute will cause all data entered into the field to appear as asterisks.

[ **SECURE** | **NO-ECHO** ]

### 5.2.2.22. SIGN Clause

- The **SIGN** clause specifies how an “S” symbol (see section) within a **PICTURE** clause will be interpreted. Without the **SEPARATE CHARACTER** option, the sign of the screen data item’s value will be encoded by transforming the last (**TRAILING**) or first (**LEADING**) digit. If the **SEPARATE CHARACTER** clause is used, then an actual “+” or “-“ sign will be inserted into the field’s value as the first (**LEADING**) or last (**TRAILING**) character.
- When **SEPARATE CHARACTER** is specified, the “S” symbol in the data item’s **PICTURE** must be counted when determining the data item’s size.

[ **SIGN IS** { **LEADING** } | { **TRAILING** } ] [ **SEPARATE CHARACTER** ] ]

*See Also...*

Defining Signed Data Items (**SIGN**) [5.2.1.9](#)

### 5.2.2.23. VALUE Clause

- The **VALUE** clause specifies an alphanumeric literal that will appear on the screen at the explicit or implicit line/column position of the screen data item.
- A figurative constant may NOT be supplied as *literal-2*.
- The inclusion of a **VALUE** clause into a screen data item’s description overrides any **FROM**, **TO** or **USING** clause that may be present.
- If there is no **PICTURE** clause supplied, the size of the screen data item will be the length of the *literal-2* value. If there is no **PICTURE** clause and the **ALL** option is specified, the **ALL** option will be ignored.
- If there is a **PICTURE** clause specified along with the **VALUE** clause, then the **ALL** option, if any, will fill the field (up to the size specified by the **PICTURE**) with repeated instances of *literal-2* (including a possible trailing partial instance).

[ **VALUE IS** [ **ALL** ] *literal-2* ]

## 5.2.3. 01-Level Constant Descriptions

Figure 5-13 - 01-Level Constant Description Syntax

```
01 constant-name-1 CONSTANT [ IS GLOBAL ]
    [
        AS [ [ BYTE-LENGTH ] | LENGTH ] OF [ identifier-1
                                                usage-name
                                                literal-1 ] ]
    ] .
    FROM compilation-variable-name-1
```

The 01-level constant is one of four types of compilation-time constants that can be declared within a program. The other three types are CDF >>DEFINE constants, CDF >>SET constants and 78-level constants.

This particular type of constant declaration provides the ability to determine the length of a data item or the storage size associated with a particular numeric **USAGE** type – something not possible with the other types of constants.

- The optional **IS GLOBAL** clause will make the constant’s value available to any nested subprograms.
- Constants defined in this way become undefined once an **END PROGRAM** or **END FUNCTION** directive is encountered in the input source.

3. Data descriptions of this form do not actually allocate any storage – they merely define a name (*constant-name-1*) that may be used anywhere a numeric literal (**BYTE-LENGTH** or **LENGTH** options) or a literal of the same type as *literal-1* may be used.
4. The *constant-name-1* name may not be referenced on a CDF statement.
5. Care must be taken that *constant-name-1* does not duplicate any other data item name that has been defined in the program as references to that data item name will refer to the constant and not the data item. The GNU COBOL compiler will not issue a warning about this condition.
6. The value specified for *usage-name-1* may be any of the **USAGE**s that do not use a PICTURE clause.
7. The **BYTE-LENGTH** clause will produce a numeric value for *constant-name-1* identical to that which would be returned by the **BYTE-LENGTH** intrinsic function executed against *identifier-1* or a data item declared with a **USAGE** of *usage-name*.
8. The **LENGTH** clause will produce a numeric value for *constant-name-1* identical to that which would be returned by the **LENGTH** intrinsic function executed against *identifier-1* or a data item declared with a **USAGE** of *usage-name*.
9. If used, *usage-name* may be any of **BINARY-C-LONG**, **BINARY-CHAR**, **BINARY-DOUBLE**, **BINARY-LONG**, **BINARY-SHORT**, **COMP-1** (or **COMPUTATIONAL-1**), **COMP-2** (or **COMPUTATIONAL-2**), **FLOAT-DECIMAL-16**, **FLOAT-DECIMAL-34**, **FLOAT-LONG**, **FLOAT-SHORT**, **POINTER**, or **PROGRAM-POINTER**.

Here is the listing of a GNU COBOL program that uses 01-level constants to DISPLAY the length (in bytes) of the various PICTURE-less USAGE types.

```

IDENTIFICATION DIVISION.
PROGRAM-ID. USAGELengths.
DATA DIVISION.
WORKING-STORAGE SECTION.
01 Len-BINARY-C-LONG      CONSTANT AS LENGTH OF BINARY-C-LONG.
01 Len-BINARY-CHAR        CONSTANT AS LENGTH OF BINARY-CHAR.
01 Len-BINARY-DOUBLE      CONSTANT AS LENGTH OF BINARY-DOUBLE.
01 Len-BINARY-LONG        CONSTANT AS LENGTH OF BINARY-LONG.
01 Len-BINARY-SHORT       CONSTANT AS LENGTH OF BINARY-SHORT.
01 Len-COMP-1              CONSTANT AS LENGTH OF COMP-1.
01 Len-COMP-2              CONSTANT AS LENGTH OF COMP-2.
01 Len-FLOAT-DECIMAL-16   CONSTANT AS LENGTH OF FLOAT-DECIMAL-16.
01 Len-FLOAT-DECIMAL-34   CONSTANT AS LENGTH OF FLOAT-DECIMAL-34.
01 Len-FLOAT-LONG          CONSTANT AS LENGTH OF FLOAT-LONG.
01 Len-FLOAT-SHORT         CONSTANT AS LENGTH OF FLOAT-SHORT.
01 Len-POINTER             CONSTANT AS LENGTH OF POINTER.
01 Len-PROGRAM-POINTER    CONSTANT AS LENGTH OF PROGRAM-POINTER.
PROCEDURE DIVISION.
000-Main.
  DISPLAY "On this system, with this build of GNU COBOL, the"
  DISPLAY "PICTURE-less USAGES have these lengths (in bytes):"
  DISPLAY " "
  DISPLAY "BINARY-C-LONG:      " Len-BINARY-C-LONG
  DISPLAY "BINARY-CHAR:        " Len-BINARY-CHAR
  DISPLAY "BINARY-DOUBLE:      " Len-BINARY-DOUBLE
  DISPLAY "BINARY-LONG:        " Len-BINARY-LONG
  DISPLAY "BINARY-SHORT:       " Len-BINARY-SHORT
  DISPLAY "COMP-1:              " Len-COMP-1
  DISPLAY "COMP-2:              " Len-COMP-2
  DISPLAY "FLOAT-DECIMAL-16:   " Len-FLOAT-DECIMAL-16
  DISPLAY "FLOAT-DECIMAL-34:   " Len-FLOAT-DECIMAL-34
  DISPLAY "FLOAT-LONG:          " Len-FLOAT-LONG
  DISPLAY "FLOAT-SHORT:         " Len-FLOAT-SHORT
  DISPLAY "POINTER:             " Len-POINTER
  DISPLAY "PROGRAM-POINTER:    " Len-PROGRAM-POINTER

```

```
STOP RUN
```

```
.
```

The output of this program, on my Windows 7 system with a 32-bit MinGW build of GNU COBOL is:

```
On this system, with this build of GNU COBOL, the
PICTURE-less USAGES have these lengths (in bytes):
```

```
BINARY-C-LONG:    4
BINARY-CHAR:      1
BINARY-DOUBLE:    8
BINARY-LONG:      4
BINARY-SHORT:     2
COMP-1:           4
COMP-2:           8
FLOAT-DECIMAL-16: 8
FLOAT-DECIMAL-34: 16
FLOAT-LONG:       8
FLOAT-SHORT:      4
POINTER:          4
PROGRAM-POINTER:  4
```

#### *See Also...*

Nested Subprograms <a href="#">7.6</a>	Defining Level 78 Constants <a href="#">5.2.6</a>
The CDF >>DEFINE Statement <a href="#">2.2.1</a>	The <b>BYTE-LENGTH</b> Intrinsic Function <a href="#">6.1.14.6</a>
The CDF >>SET Statement <a href="#">2.2.3</a>	The <b>LENGTH</b> Intrinsic Function <a href="#">6.1.14.31</a>
Storage Format of Data ( <b>USAGE</b> ) <a href="#">5.2.1.11</a>	

## 5.2.4. 66-Level Data Descriptions (RENAMES)

Figure 5-14 - 66-Level Data Description Syntax

```
66 identifier-1 RENAMES identifier-2 [ THRU identifier-3 ].
```

A 66-level data item regroups previously defined items by specifying alternative, possibly overlapping, groupings of elementary data items.

1. You must use the level number 66 for data description entries that contain the **RENAMES** clause.
2. A level-66 data item cannot rename a level-66, level-01, level-77, or level-88 data item.
3. The *identifier-2* and *identifier-3* data items, along with all data items defined between those two data items in the program source, must all be contained within the same 01-level record description.
4. There may be multiple level-66 data items that rename data items contained within the same 01-level record description.
5. All **RENAMES** entries associated with one logical record must immediately follow that record's last data description entry.

## 5.2.5. 77-Level Data Descriptions

1. A 77-level data item is one described using the syntax covered in section where all of the following are true:
  - a. The *level-number* used is 77.
  - b. The data item is described in the **WORKING-STORAGE**, **LOCAL-STORAGE** or **LINKAGE SECTION**.
  - c. The data item is not named **FILLER**.
  - d. The data item is an elementary item.
  - e. The data item is not part of any group item.
  - f. The data item description does not contain the **OCCURS** or **RENAMES** clause.

*See Also...*Defining Data Items [5.2](#)

## 5.2.6. 78-Level Constant Descriptions

Figure 5-15 - 78-Level Constant Description Syntax

```
78 identifier-1 VALUE IS literal-1 .
```

The 78-level constant is one of four types of compilation-time constants that can be declared within a program. The other three types are CDF >>**DEFINE** constants, CDF >>**SET** constants and 01-level constants.

1. Constants defined in this way become undefined once an **END PROGRAM** or **END FUNCTION** directive is encountered in the input source.

*See Also...*The CDF >>**DEFINE** Statement [2.2.1](#)Defining Level-01 Constants [5.2.3](#)The CDF >>**SET** Statement [2.2.3](#)

## 5.2.7. 88-Level Condition Names

Figure 5-16 - 88-Level Condition Name Syntas

```
88 condition-name-1 [ VALUE IS literal-1 ] { literal-1 [ THRU literal-2 ] ... } ...
[ WHEN SET TO FALSE IS literal-3 ]
```

Condition names are Boolean (i.e. "TRUE" / "FALSE") data items that receive their TRUE and FALSE values based upon the values of other data items.

1. Condition names are always defined subordinate to another data item. That data item must be an elementary item.
2. Condition names do not occupy any storage.
3. The VALUE(s) specified for the condition name specify the specific values and/or ranges of values of the parent elementary data item that will cause the condition name to have a value of TRUE.
4. The optional **FALSE** clause defines an explicit value that will be assigned to the parent elementary data item should the **SET** statement ever be used to set the condition-name-1 to FALSE.

*See Also...*Condition Names [6.1.4.2.1](#)The **SET condition-name** Statement [6.4.39.6](#)

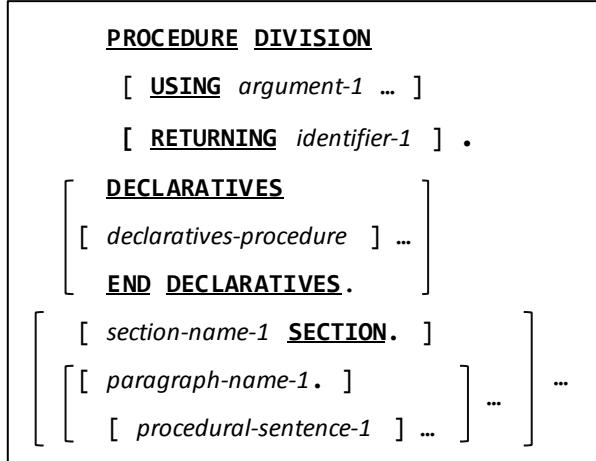
## 6. PROCEDURE DIVISION

The **PROCEDURE DIVISION** of any GNU COBOL program marks the point where all executable code is written.

### 6.1. General PROCEDURE DIVISION Components

#### 6.1.1. General Format of the PROCEDURE DIVISION

Figure 6-1 - General PROCEDURE DIVISION Syntax



It is in the **PROCEDURE DIVISION** that all executable program code will be placed.

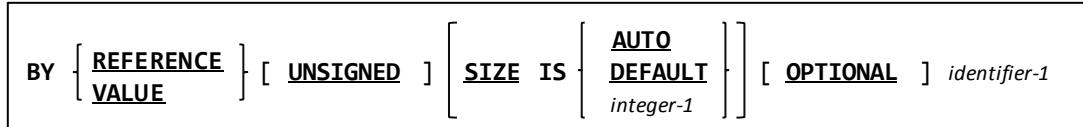
1. The **USING** clause defines arguments that may be passed to a GNU COBOL program serving as a subprogram. All identifiers specified on the **USING** clauses must be defined in the **LINKAGE SECTION**.
2. The **RETURNING** clause can be used as a means of specifying and documenting a value that a subprogram can pass back to the program that invoked it. Main programs that wish to “pass back” a return code value to the operating system when they exit do so simply by **MOVEing** a value to the **RETURN-CODE** special register, and do not need (or use) a **RETURNING** clause on their **PROCEDURE DIVISION** header.
3. The first (optional) segment of any **PROCEDURE DIVISION** is a special area known as “**DECLARATIVES**”. In this area, you may define processing routines that are to be used as special “trap” routines executed only when certain events occur.
4. The various sections and paragraphs in which the procedural logic of your program will be coded will follow any “**DECLARATIVES**”. These sections and paragraphs are discussed in more detail in section 0.

#### See Also...

Special Registers	<a href="#">6.1.13</a>	The MOVE Statement	<a href="#">6.2.26</a>
Subprogram Argument Definitions	<a href="#">6.1.2</a>	Sub-programming	0
Using <b>DECLARATIVES</b>	<a href="#">6.1.4</a>		

#### 6.1.2. General Format for Subprogram Arguments

Figure 6-2 - Syntax of a PROCEDURE DIVISION USING Argument



1. The **BY REFERENCE** clause indicates that the program will be passed the address of the data item corresponding to a program argument; any changes this program makes to a **BY REFERENCE** argument will be passed back to the calling program.

2. **BY REFERENCE** is the assumed default for the first **USING** argument should no **BY** clause be specified for it. Subsequent arguments will assume the “**BY**” specification of the argument prior to them should they lack a **BY** clause of their own.
3. The **BY VALUE** clause indicates the program will be passed a copy of the data item from the calling program that corresponds to the argument. The contents of **BY VALUE** arguments can be changed by the subprograms receiving them, but those changes will not “find their way” back to the calling program.
4. If the calling program passes an argument **BY REFERENCE** or **BY CONTENT**, the subprogram should specify that argument as “**BY REFERENCE**” on its **PROCEDURE DIVISION** header. If the calling program passes an argument **BY VALUE**, the subprogram should specify that argument as “**BY VALUE**” on its **PROCEDURE DIVISION** header.
5. The various **SIZE** clauses specify the size (in bytes) of received **BY VALUE** arguments. The **SIZE IS AUTO** clause (the default) indicates that argument size will be determined automatically based upon the size of the item in the calling program. The remaining **SIZE** options allow you to force a specific size to be assumed.
6. The **UNSIGNED** clause will add “*unsigned*” to the C-language code generated when defining the argument in the function header of the C function corresponding to the GNU COBOL subprogramming. This is of value when a C program will be calling this subprogram.

*See Also...*The **CALL** Statement [6.4.5](#)

Sub-programming 0

### 6.1.3. PROCEDURE DIVISION Sections and Paragraphs

The **PROCEDURE DIVISION** is the only one of the COBOL divisions that allows you to create your own sections and paragraphs. These are collectively referred to as *procedure names*. Procedure names are optional in the **PROCEDURE DIVISION** and – when used – are named entirely according to the needs and whims of the programmer.

When procedure names are defined, the entire collection of GNU COBOL statements that follow the procedure name are collectively referred to as a *procedure*. If there are no procedure names defined whatsoever, then the entire set of all statements defined within the **PROCEDURE DIVISION** constitute a single (unnamed) procedure.

Procedure names may be up to thirty one (31) characters long, and may consist of letters, numbers, dashes and underscores, with just one caveat. A procedure name may neither begin nor end with a dash (-) or underscore (\_) character. This means that “17” is a perfectly valid procedure name.

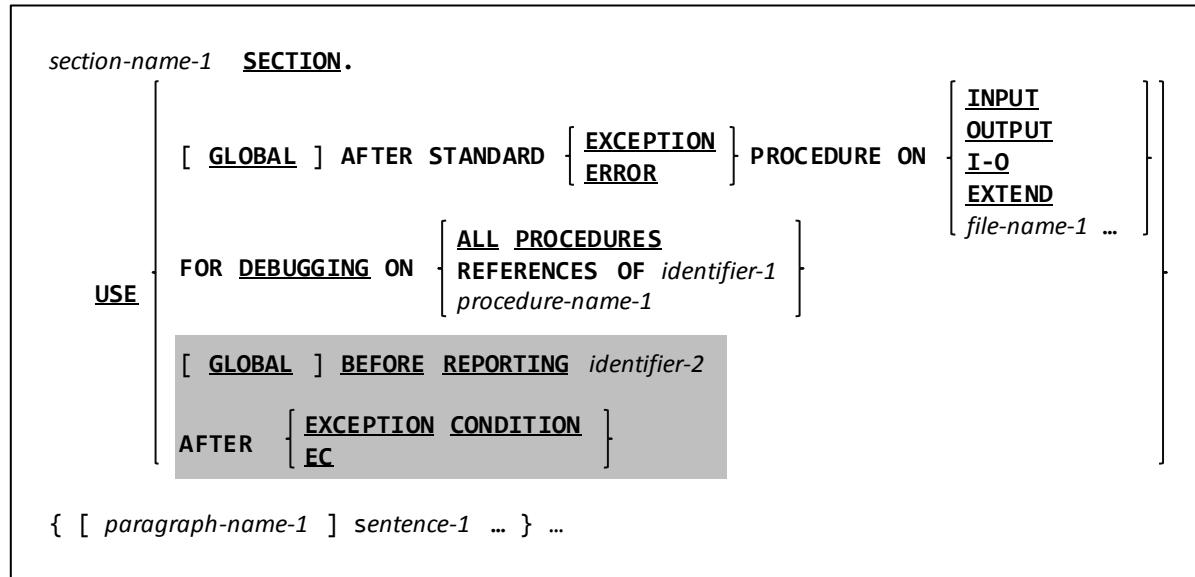
There are two circumstances under which the use of certain GNU COBOL statements or options will require the specification of procedures. These situations are:

1. When **DECLARATIVES** are specified. These are discussed in section [6.1.4](#) (“General Format for DECLARATIVES Procedures”).
2. When any PROCEDURE DIVISION statement that references procedures is used. These statements are:
  - **ALTER**
  - **GO TO**
  - **MERGE** (with an **OUTPUT PROCEDURE**)
  - **PERFORM**
  - **SORT** (with an **INPUT PROCEDURE** and/or an **OUTPUT PROCEDURE**)

*See Also...*User-defined Names [1.10](#)The **PERFORM** Statement (Procedural) [6.2.30.1](#)The **ALTER** Statement [6.2.4](#)The **SORT** Statement (File Sort) [6.4.40.1](#)The **GO TO** Statement [6.2.20](#)USE Statements and **DECLARATIVES** [6.1.4](#)The **MERGE** Statement [6.4.25](#)

### 6.1.4. General Format for DECLARATIVES Procedures

Figure 6-3 - General DECLARATIVES Procedure Syntax



1. The **DECLARATIVES** area of the **PROCEDURE DIVISION** allows the programmer to define a series of "trap" procedures (referred to as *declarative procedures*) capable of intercepting certain events that may occur at program execution time. The syntax diagram above shows the format of a single such procedure.
2. **DECLARATIVES** may contain any number of declarative procedures, but no two declarative procedures should be designed to trap the same event.
3. The **USE BEFORE REPORTING** and **AFTER EXCEPTION CONDITION** clauses are currently syntactically recognized but otherwise unsupported.
4. The **USE FOR DEBUGGING** clause allows you to define a declarative procedure that will be invoked immediately before:
  - a. The specified identifier is referenced (**REFERENCES OF** ...), or ...
  - b. The named procedure is executed (*procedure-name-1*), or ...
  - c. Any procedure is executed (**ALL PROCEDURES**).

Any **USE FOR DEBUGGING** declarative procedures will be ignored at compilation time unless **WITH DEBUGGING MODE** is specified in the **SOURCE-COMPUTER** paragraph.

Any **USE FOR DEBUGGING** declarative procedures will be ignored at execution time unless the "**COB\_SET\_DEBUG**" environment variable has been set to a value of "Y", "y" or "1".

The typical use of a **USE FOR DEBUGGING** declarative procedure is to **DISPLAY** the **DEBUG-ITEM** special register, which will be implicitly and automatically created in your program for you if **WITH DEBUGGING MODE** is active.

5. The structure of **DEBUG-ITEM** will be as follows:

<b>01 DEBUG-ITEM.</b>		
<b>05 DEBUG-LINE</b>	<b>PIC X(6).</b>	The program line number of the statement that triggered the declaratives procedure.
<b>05 FILLER</b>	<b>PIC X(1) VALUE SPACE.</b>	
<b>05 DEBUG-NAME</b>	<b>PIC X(31).</b>	The procedure name or identifier name that triggered the declaratives procedure.
<b>05 FILLER</b>	<b>PIC X(1) VALUE SPACE.</b>	
<b>05 DEBUG-SUB-1</b>	<b>PIC S9(4)</b> <b>SIGN LEADING SEPARATE.</b>	The first subscript value (if any) for the reference of the identifier that triggered the declaratives procedure.
<b>05 FILLER</b>	<b>PIC X(1) VALUE SPACE.</b>	
<b>05 DEBUG-SUB-2</b>	<b>PIC S9(4)</b> <b>SIGN LEADING SEPARATE.</b>	The second subscript value (if any) for the reference of the identifier that triggered the declaratives procedure.
<b>05 FILLER</b>	<b>PIC X(1) VALUE SPACE.</b>	
<b>05 DEBUG-SUB-3</b>	<b>PIC S9(4)</b> <b>SIGN LEADING SEPARATE.</b>	The third subscript value (if any) for the reference of the identifier that triggered the declaratives procedure.
<b>05 FILLER</b>	<b>PIC X(1) VALUE SPACE.</b>	

**05 DEBUG-CONTENTS PIC X(31).**

A (brief) statement of the manner in which the procedure that triggered the declaratives procedure was executed or the first 31 characters of the value of the identifier whose reference triggered the declaratives procedure (the value after the statement was executed).

6. The **USE AFTER STANDARD ERROR PROCEDURE** clause defines a declarative procedure invoked any time a failure is encountered with the specified I/O type (or against the specified file(s)).
7. The **GLOBAL** option, if used, allows a declarative procedure to be used across all programs in the same compilation group.
8. Declarative procedures outines (of any type) may not reference any other procedures defined outside the scope of **DECLARATIVES**.

*See Also...*

The SOURCE-COMPUTER Paragraph	<a href="#">4.1.1</a>
-------------------------------	-----------------------

Using DECLARATIVES	<a href="#">6.1.4</a>
--------------------	-----------------------

Special Registers	<a href="#">6.1.13</a>
-------------------	------------------------

Execution-time Environment Variables	<a href="#">8.2.4</a>
--------------------------------------	-----------------------

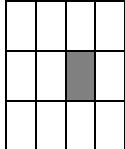
## 6.1.5. Table References

COBOL uses parenthesis to specify the subscripts used to reference table entries (tables in COBOL are what other programming languages refer to as arrays).

For example, observe the following data structure which simulates a 4 column by 3 row grid of characters:

```
01 GRID.
  05 GRID-ROW OCCURS 3 TIMES.
    10 GRID-COLUMN OCCURS 4 TIMES.
      15 GRID-CHARACTER      PIC X(1).
```

A reference to the GRID-CHARACTER shaded in the following diagram:



Would be coded as:

GRID-CHARACTER (2, 3)

Subscripts may be specified as numeric (integer) literals, **PIC 9** (integer) data items, data items created with any of the **PICTURE**-less integer **USAGE** specifications, **USAGE INDEX** data items or arithmetic expressions resulting in an integer value. The ability to use full arithmetic expressions as table (array) subscripts, while common in many languages, is rare in the COBOL universe, only having come into existence with the COBOL2002 standard.

*See Also...*

Arithmetic Expressions	<a href="#">6.1.4.1</a>
------------------------	-------------------------

Table Subscript versus Table Index	<a href="#">9.3</a>
------------------------------------	---------------------

## 6.1.6. Qualification of Data Names

COBOL allows data names to be duplicated within a program, provided references to those data names may be made in such a manner as to make those references unique through a process known as *qualification*.

To see qualification at work, observe the following segments of two data records defined in a COBOL program:

```
01 EMPLOYEE.
  05 MAILING-ADDRESS.
    10 STREET          PIC X(35).
    10 CITY           PIC X(15).
    10 STATE          PIC X(2).
    10 ZIP-CODE.
      15 ZIP-CODE-5   PIC 9(5).
```

```

15 FILLER          PIC X(4).

01 CUSTOMER.

05 MAILING-ADDRESS.

 10 STREET         PIC X(35).

 10 CITY           PIC X(15).

 10 STATE          PIC X(2).

10 ZIP-CODE.

 15 ZIP-CODE-5    PIC 9(5).

 15 FILLER         PIC X(4).

```

Now, let's deal with the problem of setting the CITY portion of an EMPLOYEEs MAILING-ADDRESS to "Philadelphia". Clearly, the following cannot work because the compiler will be unable to determine which of the two CITY fields you are referring to:

## MOVE "Philadelphia" TO CITY.

We could qualify the reference to CITY as follows, in an attempt to correct the problem:

MOVE "Philadelphia" TO CITY OF MAILING-ADDRESS.

Unfortunately that too is insufficient because it is still insufficient to identify specifically which CITY is being referenced. To truly identify which specific CITY you want, you'd have to code the following:

MOVE "Philadelphia" TO CITY OF MAILING-ADDRESS OF EMPLOYEE.

Now there can be no confusion as to which CITY is being changed. Fortunately, you don't need to be quite so specific; COBOL allows intermediate qualification levels to be omitted. This allows you to specify:

MOVE "Philadelphia" TO CITY OF EMPLOYEE.

If you need to qualify a reference to a table, do so as follows:

*identifier-1* OF *identifier-2* ( subscript ... )

The reserved word “IN” may be used in lieu of “OF”.

### 6.1.7. Reference Modifiers

Figure 6-4 - Reference Modifier Syntax

{ *identifier-1* [ **OF** | **IN** *identifier-2* ] [ ( *subscript ...* ) ] } ( *start* : [ *length* ] )  
*intrinsic-function-reference*

The COBOL '85 standard introduced the concept of a *reference modifier* to facilitate references to only a portion of a data item; GNU COBOL fully supports reference modification.

The *start* value indicates the starting character position being referenced (character position values start with 1, not 0 as is the case in some programming languages) and *length* specifies how many characters are wanted. If no *length* is specified, a value equivalent to the remaining character positions from *start* to the end will be assumed. Both *start* and *length* may be specified as integer numeric literals, integer numeric data items or arithmetic expressions with an integer value. The default *length* is 1.

Here are a few examples:

**CUSTOMER-LAST-NAME (1:3)** references the first three characters of CUSTOMER-LAST-NAME

**CUSTOMER-LAST-NAME (4:)** references all character positions of CUSTOMER-LAST-NAME from the fourth onward

**FUNCTION CURRENT-DATE (5:2)** references the current month.

**Hex-Digits (Nibble + 1:1)** Assuming that “Nibble” is a numeric data item with a value in the range 0-15, and Hex-Digits is a PIC X(16) item with a value of “0123456789ABCDEF”, this converts that numeric value to a hexadecimal digit.

**Hex-Digits (Nibble + 1:)** Does the same as the above – if you leave out the length, 1 is assumed; YOU STILL NEED THE “:” CHARACTER THOUGH.

**Array-Element (6) (7:5)**

References 5 characters in the 6<sup>th</sup> occurrence of Array-Element, starting at character position 7.

Reference modification may be used anywhere an identifier is legal, including serving as the receiving field of statements like **MOVE**, **STRING** and **ACCEPT**, to name a few.

*See Also...*

The CURRENT-DATE Intrinsic Function [6.1.14.12](#)

## 6.1.8. Expressions

GNU COBOL supports two basic types of Expressions

- ▶ *Arithmetic expressions*, which calculate a numeric result
- ▶ *Conditional Expressions*, which calculate a TRUE or FALSE value

Unlike other programming languages, which allow arithmetic values such as 0 and -1 to represent FALSE and TRUE, respectively, GNU COBOL treats logical TRUE/FALSE values as something different from 0/-1.

### 6.1.8.1. Arithmetic Expressions

Arithmetic expressions are formed using following operators. In complex expressions composed of multiple operators, a precedence of operation applies whereby those operations having a higher precedence are computed first before operations with a lower precedence.

Precedence	Operation	Discussion
1 <sup>st</sup> (Highest)	<p>Figure 6-5 – Unary “Minus” (-) Operator Syntax</p> <div style="border: 1px solid black; padding: 10px; width: fit-content; margin: auto;"> <math display="block">- \left[ \begin{array}{l} \text{numeric-literal-1} \\ \text{identifier-1} \\ ( \text{arithmetic-expression-1} ) \end{array} \right]</math> </div>	<p>The unary “minus” (-) operator returns the arithmetic negation of its single argument, effectively returning as its value the product of its argument and -1.</p>
	<p>Figure 6-6 – Unary “Plus” (+) Operator Syntax</p> <div style="border: 1px solid black; padding: 10px; width: fit-content; margin: auto;"> <math display="block">+ \left[ \begin{array}{l} \text{numeric-literal-1} \\ \text{identifier-1} \\ ( \text{arithmetic-expression-1} ) \end{array} \right]</math> </div>	<p>The unary “plus” (+) operator returns the value of its single argument, effectively returning as its value the product of its argument and +1.</p>
2 <sup>nd</sup>	<p>Figure 6-7 - Exponentiation Operator (** or ^) Syntax</p> <div style="border: 1px solid black; padding: 10px; width: fit-content; margin: auto;"> <math display="block">\left[ \begin{array}{l} \text{numeric-literal-1} \\ \text{identifier-1} \\ ( \text{arithmetic-expression-1} ) \end{array} \right] ** \left[ \begin{array}{l} \text{numeric-literal-2} \\ \text{identifier-2} \\ ( \text{arithmetic-expression-2} ) \end{array} \right]</math> </div>	<p>The value of the left-hand argument raised to the power indicated by the right-hand argument is computed.</p> <p>Non-integer powers are allowed.</p> <p>GNU COBOL allows the “^” symbol to be used in lieu of the “**” symbol.</p>
3 <sup>rd</sup>	<p>Figure 6-8 - Multiplication Operator (*) Syntax</p> <div style="border: 1px solid black; padding: 10px; width: fit-content; margin: auto;"> <math display="block">\left[ \begin{array}{l} \text{numeric-literal-1} \\ \text{identifier-1} \\ ( \text{arithmetic-expression-1} ) \end{array} \right] * \left[ \begin{array}{l} \text{numeric-literal-2} \\ \text{identifier-2} \\ ( \text{arithmetic-expression-2} ) \end{array} \right]</math> </div>	<p>The product of the left-hand argument and the right-hand argument is computed.</p>

Precedence	Operation	Discussion
	<p>Figure 6-9 - Division Operator (/) Syntax</p> $\left[ \begin{array}{l} \text{numeric-literal-1} \\ \text{identifier-1} \\ ( \text{arithmetic-expression-1} ) \end{array} \right] / \left[ \begin{array}{l} \text{numeric-literal-2} \\ \text{identifier-2} \\ ( \text{arithmetic-expression-2} ) \end{array} \right]$	<p>The value of the left-hand argument divided by the right-hand argument is computed.</p> <p>If the right-hand argument has a value of zero, expression evaluation will be prematurely terminated before a value is generated. This may cause program failure at run-time.</p>
4 <sup>th</sup> (Lowest)	<p>Figure 6-10 - Addition Operator (+) Syntax</p> $\left[ \begin{array}{l} \text{numeric-literal-1} \\ \text{identifier-1} \\ ( \text{arithmetic-expression-1} ) \end{array} \right] + \left[ \begin{array}{l} \text{numeric-literal-2} \\ \text{identifier-2} \\ ( \text{arithmetic-expression-2} ) \end{array} \right]$	<p>The sum of the left-hand argument and the right-hand argument is computed.</p>
	<p>Figure 6-11 - Subtraction Operator (-) Syntax</p> $\left[ \begin{array}{l} \text{numeric-literal-1} \\ \text{identifier-1} \\ ( \text{arithmetic-expression-1} ) \end{array} \right] - \left[ \begin{array}{l} \text{numeric-literal-2} \\ \text{identifier-2} \\ ( \text{arithmetic-expression-2} ) \end{array} \right]$	<p>The value of the right-hand argument subtracted from the left-hand argument is computed.</p>

The syntaxical rules of GNU COBOL, allowing a dash (-) character in data item names, can lead to some ambiguity. Observe this sample GNU COBOL code:

```

01 C      PIC 9 VALUE 5.
01 D      PIC 9 VALUE 2.
01 C-D    PIC 9 VALUE 7.
01 I      PIC 9 VALUE 0.

...
COMPUTE I=C-D+1
DISPLAY I

```

What should be displayed by the **DISPLAY** statement? The number “4”, which is the result of subtracting the value of **D** (the value 2) from the value of **C** (the value 5) and then adding 1 or the number “8”, which is the value of adding 1 to the value of data item **C-D**?

The right answer is “8” – the value of data item **C-D** plus 1!

The GNU COBOL compiler actually went through the following decision-making logic when generating code for the **COMPUTE** Statement

1. Is there a data item named “**C-D**” defined? If so, use its value for “**C-D**”
2. If there is no “**C-D**” data item, then check if there are “**C**” and “**D**” data items. If not, the **COMPUTE** statement is in error. If there are, however, then code will be generated to subtract the value of “**D**” from “**C**” and add 1 to the result.

Had there been at least one space to the left and/or the right of the “-”, there would have been no ambiguity – the compiler would have been forced to use the individual “**C**” and “**D**” data items.

It's considered good COBOL programming practice to always code at least one space to both the left and right of every arithmetic operator as well as the “=” sign on a **COMPUTE**.

Here are some examples of how the precedence of operations affects the results of arithmetic expressions (all examples use numeric literals, to simplify the discussion).

Expression	Result	Notes
$3 * 4 + 1$	13	* has precedence over +
$4 * 2 ^ 3 - 10$	22	$2^3$ is 8 (^ has precedence over *), times 4 is 32, minus 10 is 22.
$(4 * 2) ^ 3 - 10$	502	Parenthesis provide for a recursive application of the arithmetic expression rules, effectively allowing you to alter the precedence of operations. 4 times 2 is 8 (the use of parenthesis “trumps” the exponentiation operator, so the multiplication happens first); $8^3$ is 512, minus 10 is 502.
$5 / 2.5 + 7 * 2 - 1.15$	15.35	Integer and non-integer operands may be freely intermixed

Of course, arithmetic expression operands may be numeric data items (any **USAGE** except **DISPLAY**,  **POINTER** or **PROGRAM POINTER**) as well as numeric literals.

### 6.1.8.2. Conditional Expressions

Conditional expressions are expressions which identify the conditions under which a program may make a decision about processing to be performed. As such, conditional expressions produce a value of TRUE or FALSE.

There are seven types of conditional expressions, as follows, in increasing order of complexity.

#### 6.1.8.2.1. Condition Names (Level-88 Items)

These are the simplest of all conditions. Observe the following code:

```

05 SHIRT-SIZE          PIC 99V9.
  88 LILLIPUTIAN      VALUE 0 THRU 12.5
  88 XS               VALUE 13 THRU 13.5.
  88 S                VALUE 14, 14.5.
  88 M                VALUE 15, 15.5.
  88 L                VALUE 16, 16.5.
  88 XL               VALUE 17, 17.5.
  88 XXL              VALUE 18, 18.5.
  88 BROBDINGNAGIAN  VALUE 19 THRU 99.9.

```

The condition names “LILLIPUTIAN”, “XS”, “S”, “M”, “L”, “XL”, “XXL” and “BROBDINGNAGIAN” will have TRUE or FALSE values based upon the values within their parent data item (SHIRT-SIZE). So, a program wanting to test whether or not the current SHIRT-SIZE value can be classified as “XL” could have that decision coded as a combined condition (the most complex type of conditional expression), as either:

```

IF SHIRT-SIZE = 17 OR SHIRT-SIZE = 17.5
- or -
IF SHIRT-SIZE = 17 OR 17.5

```

Or it could utilize the condition name XL as follows:

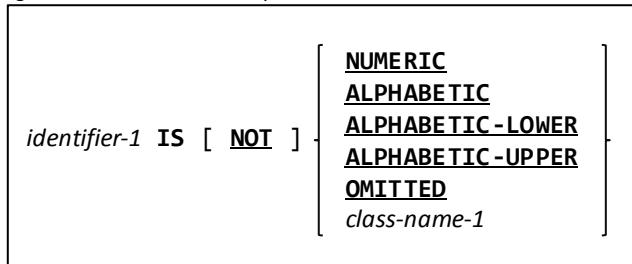
```
IF XL
```

*See Also...*

Defining Level-88 Condition Names	<a href="#">5.2.7</a>
-----------------------------------	-----------------------

### 6.1.8.2.2. Class Conditions

Figure 6-12 - Class Condition Syntax



Class conditions evaluate the type of data that is currently stored in a data item.

1. The **NUMERIC** class test considers only the characters "0", "1", ..., "9" to be numeric; only a data item containing nothing but digits will pass a **NUMERIC** class test. Spaces, decimal points, commas, currency signs, plus signs, minus signs and any other characters except the digit characters will all fail "**NUMERIC**" class tests.
2. The **ALPHABETIC** class test considers only upper-case letters, lower-case letters and **SPACES** to be alphabetic in nature.
3. The **ALPHABETIC-LOWER** and **ALPHABETIC-UPPER** class conditions consider only spaces and the respective type of letters to be acceptable in order to pass such a class test.
4. Note that what constitutes a "letter" (or upper/lower case too, for that manner) may be influenced through the use of **CHARACTER CLASSIFICATION** specifications in the **OBJECT-COMPUTER** paragraph.
5. Only data items whose **USAGE** is either explicitly or implicitly defined as **DISPLAY** may be used in **NUMERIC** or any of the **ALPHABETIC** class conditions.
6. Some COBOL implementations disallow the use of group items or **PIC A** items with **NUMERIC** class conditions and the use of **PIC 9** items with **ALPHABETIC** class conditions. GNU COBOL has no such restrictions.
7. The **OMITTED** class condition is used when it is necessary for a subprogram to determine whether or not a particular argument was passed to it. In such class conditions, *identifier-1* must be a **LINKAGE SECTION** item defined on the **USING** clause of the subprograms **PROCEDURE DIVISION** header.
8. The *class-name-1* option allows you to test for a user-defined class. Here's an example. First, assume the following **SPECIAL-NAMES** definition of the user-defined class "Hexadecimal":

```

SPECIAL-NAMES.
  CLASS Hexadecimal IS '0' THRU '9', 'A' THRU 'F', 'a' THRU 'f'.

```

Now observe the following code, which will execute the **150-Process-Hex-Value** procedure if **Entered-Value** contains nothing but valid hexadecimal digits:

```

IF Entered-Value IS Hexadecimal
  PERFORM 150-Process-Hex-Value
END-IF

```

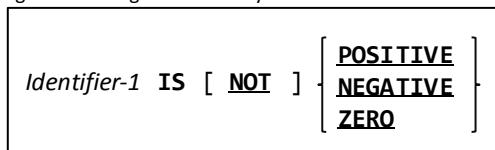
*See Also...*

The **OBJECT-COMPUTER** Paragraph [4.1.2](#)

The **CALL** Statement [6.4.5](#)

### 6.1.8.2.3. Sign Conditions

Figure 6-13 - Sign Condition Syntax

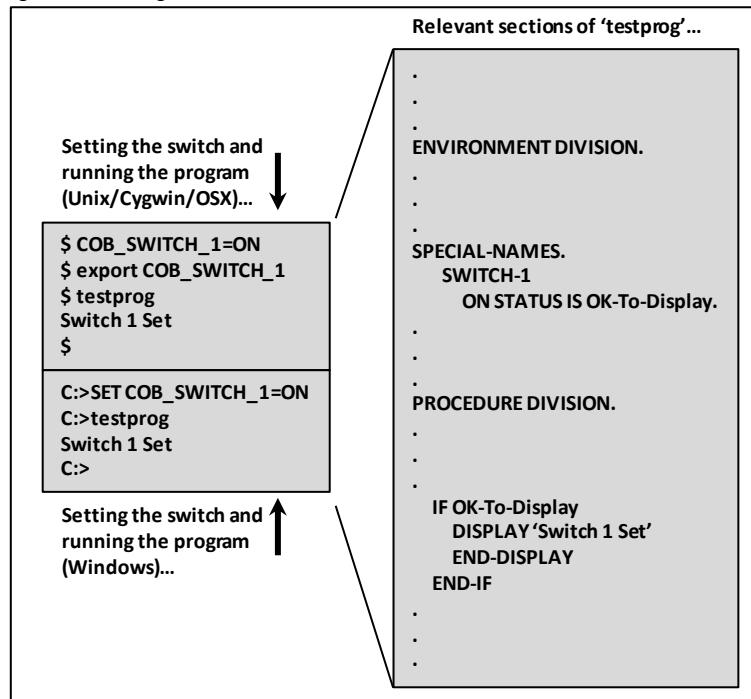


Sign conditions evaluate the numeric state of a **PIC 9** data item.

1. Only data items defined with some sort of numeric **USAGE/PICTURE** can be used for this type of class condition.
2. A **POSITIVE** or **NEGATIVE** class condition will be TRUE only if the value of *identifier-1* is strictly greater than or less than zero, respectively. A **ZERO** class condition can be passed only if the value of *identifier-1* is exactly zero.

### 6.1.8.2.4. Switch-Status Conditions

Figure 6-14 - Using Switch Conditions



In the **SPECIAL-NAMES** paragraph, an external switch name can be associated with one or more condition names. These condition names may then be used to test the ON/OFF status of the external switch.

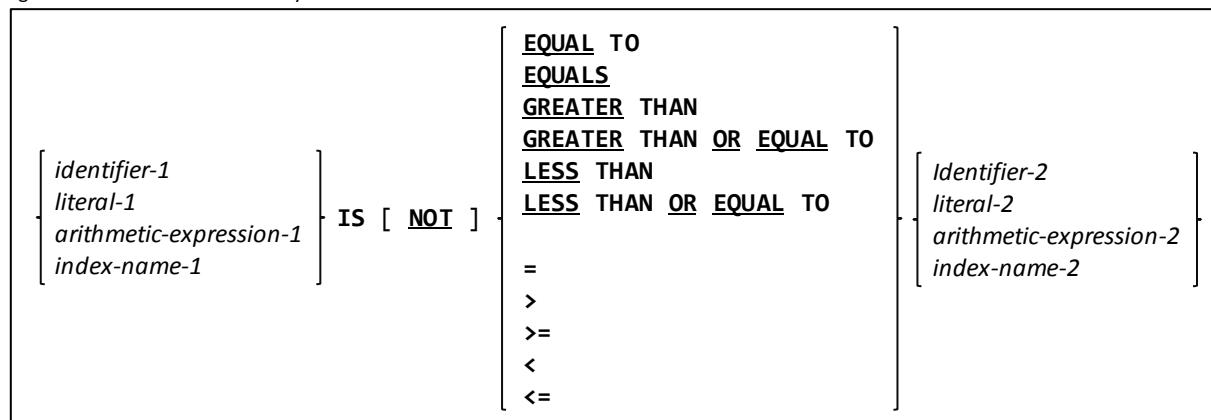
An example is shown to the left.

*See Also...*

The **SPECIAL-NAMES** Paragraph [4.1.4](#)

### 6.1.8.2.5. Relation Conditions

Figure 6-15 - Relation Condition Syntax



These conditions evaluate how two different values “relate” to each other.

1. When comparing one numeric value to another, the **USAGE** and number of significant digits in either value are irrelevant as the comparison is performed using the actual algebraic values.
2. When comparing strings, the comparison is made based upon the program’s collating sequence (see section). When the two string arguments are of unequal length, the shorter is assumed to be padded (on the right) with a sufficient number of **SPACES** as to make the two strings of equal length. String comparisons take place on a corresponding character-by-character basis until a pair of characters is found that violates the condition being tested for based upon the relative position of where each character in the pair falls in the program’s **COLLATING SEQUENCE** (as defined in **SPECIAL-NAMES**).

3. There is no functional difference between using the wordy version ("IS EQUAL TO", "IS LESS THAN", ...) versus the symbolic version ("=", "<", ...) of the actual relation operators.

*See Also...*

The SPECIAL-NAMES Paragraph [4.1.4](#)

### 6.1.8.2.6. Combined Conditions

Figure 6-16 - Combined Condition Syntax

condition-1 [ **AND** ] [ **OR** ] condition-2

A combined condition is one that computes a TRUE/FALSE value from the TRUE/FALSE values of two other conditions (which could – themselves – be combined conditions).

1. If either condition has a value of TRUE, the result of **ORing** the two together will result in a value of TRUE. Only when **ORing** two FALSE conditions will a result of FALSE occur.
2. In order for **AND** to yield a value of TRUE, both conditions must have a value of TRUE. In all other circumstances, **AND** produces a FALSE value.
3. When chaining multiple, similar conditions together with the same operator (**OR/AND**), and left or right arguments having common operators and subjects, it is possible to abbreviate the program code. For example:

**IF ACCOUNT-STATUS = 1 OR ACCOUNT-STATUS = 2 OR ACCOUNT-STATUS = 7**

Could be abbreviated as:

**IF ACCOUNT-STATUS = 1 OR 2 OR 7**

4. Just as multiplication takes precedence over addition in arithmetic expressions, so does **AND** take precedence over **OR** in combined conditions. Use parenthesis to change this precedence, if necessary. For example:

**FALSE OR FALSE AND TRUE** evaluates to TRUE

**FALSE OR (FALSE AND TRUE)** evaluates to TRUE (since AND has precedence over OR, this is identical to the previous example)

**(FALSE OR FALSE) AND TRUE** evaluates to FALSE

### 6.1.8.2.7. Negated Conditions

Figure 6-17 - Negated Condition Syntax

**NOT** condition-1

A condition may be negated by prefixing it with the **NOT** operator.

1. The **NOT** operator has the highest precedence of all logical operators, just as a unary minus sign (which "negates" a numeric value) is the highest precedence arithmetic operator.
2. Parenthesis must be used to explicitly signify the sequence in which conditions are evaluated and processed if the default precedence isn't desired. For example:

**NOT TRUE AND FALSE AND NOT FALSE** evaluates to **FALSE AND FALSE AND TRUE** which evaluates to **FALSE**

**NOT (TRUE AND FALSE AND NOT FALSE)** evaluates to **NOT (FALSE)** which evaluates to **TRUE**

**NOT TRUE AND (FALSE AND NOT FALSE)** evaluates to **FALSE AND (FALSE AND TRUE)** which evaluates to **FALSE**

### 6.1.9. Use of Periods (.)

All COBOL implementations distinguish between sentences and statements in the **PROCEDURE DIVISION**. A *statement* is a single executable COBOL instruction. For example, these are all statements:

```
MOVE SPACES TO Employee-Address
ADD 1 TO Record-Counter
DISPLAY "Record-Counter=" Record-Counter
```

Some COBOL statements have a “scope of applicability” associated with them where one or more other statements can be considered to be part of or related to the statement in question. An example of such a situation might be the following, where the interest on a loan is being calculated and displayed - 4% interest if the loan balance is under \$10000 and 4.5% otherwise:

```
IF Loan-Balance < 10000
    MULTIPLY Loan-Balance BY 0.04 GIVING Interest
ELSE
    MULTIPLY Loan-Balance BY 0.045 GIVING Interest
DISPLAY "Interest Amount = " Interest
```

In this example, the **IF** statement actually has a scope that can include two sets of associated statements – one set to be executed when the **IF** condition is TRUE and another if it is FALSE.

Unfortunately, there’s a problem with the above. A human being looking at that code will probably understand that the **DISPLAY** statement, because of its lack of indentation, is to be executed regardless of the TRUE/FALSE value of the **IF** condition. Unfortunately, the GNU COBOL compiler (or any other COBOL compiler for that matter) won’t see it that way because it really couldn’t care less what sort of indentation, if any, is used. In fact, any COBOL compiler would be just as happy to see the code written like this:

```
IF Loan-Balance < 10000 MULTIPLY Loan-Balance BY 0.04 GIVING Interest ELSE MULTIPLY Loan-
Balance BY 0.045 GIVING Interest DISPLAY "Interest Amount = " Interest
```

So how then do we inform the compiler that the **DISPLAY** statement is outside the scope of the **IF**?

That’s where *sentences* come in.

A COBOL *sentence* is defined as any arbitrarily long sequence of statements, followed by a period (.) character. The period character is what terminates the scope of a set of statements. Therefore, our example needs to be coded like this:

```
IF Loan-Balance < 10000
    MULTIPLY Loan-Balance BY 0.04 GIVING Interest
ELSE
    MULTIPLY Loan-Balance BY 0.045 GIVING Interest.
DISPLAY "Interest Amount = " Interest
```

See the period at the end of the second **MULTIPLY** (I **highlighted** it)? That is what terminates the scope of the “**IF**”, thus making the **DISPLAY** something that will be executed regardless of how the “**Loan-Balance < 10000**” test evaluated.

### 6.1.10. Use of “VERB” / “END-VERB” Constructs

Prior to the 1985 COBOL standard, using a period character was the only way to signal the end of a statement’s scope. Unfortunately, this caused some problems. Take a look at this code:

```
IF A = 1
    IF B = 1
        DISPLAY "A & B = 1"
ELSE
    IF B = 1
        DISPLAY "A NOT = 1 BUT B = 1"
ELSE
    DISPLAY "NEITHER A NOR B = 1".
```

This sort of problem led to the “band-aid” solution<sup>19</sup> shown to the right being added to the COBOL language.

The problem with this code is that indentation – so critical for improving the human-readability of a program – provides an erroneous view of the logical flow. An **ELSE** is always associated with the most-recently encountered **IF**; this means the **highlighted ELSE** will be associated with the “**IF B = 1**” statement, not the “**IF A = 1**” statement.

```
IF A = 1
    IF B = 1
        DISPLAY "A & B = 1"
    ELSE
        NEXT SENTENCE
ELSE
    IF B = 1
        DISPLAY "A NOT = 1 BUT B = 1"
```

<sup>19</sup> Yes, I realize you could have easily fixed the problem by changing the code to “**IF A = 1 AND B = 1**”, but that wouldn’t have allowed me to make my case here

```
ELSE
    DISPLAY "NEITHER A NOR B = 1".
```

The **NEXT SENTENCE** statement informs the GNU COBOL compiler that if the “B = 1” condition is false, control should fall into the first statement that follows the next period.

With the 1985 standard for COBOL, a much more elegant solution was introduced. Those COBOL verbs (statements) that needed such a thing were allowed to use an “END-verb” construct to end their scope without disrupting the scope of any statements whose scope they might have been in. Any COBOL 85 compiler would have allowed the following solution to our problem:

```
IF A = 1
    IF B = 1
        DISPLAY "A & B = 1"
    END-IF
ELSE
    IF B = 1
        DISPLAY "A NOT = 1 BUT B = 1"
    ELSE
        DISPLAY "NEITHER A NOR B = 1".
```

This new facility made the period almost obsolete, as our program segment would probably be coded like this today:

```
IF A = 1
    IF B = 1
        DISPLAY "A & B = 1"
    END-IF
ELSE
    IF B = 1
        DISPLAY "A NOT = 1 BUT B = 1"
    ELSE
        DISPLAY "NEITHER A NOR B = 1"
    END-IF
END-IF
```

COBOL (GNU COBOL included) still requires that each PROCEDURE DIVISION paragraph contain at least one *sentence* if there is any executable code in that paragraph, but a popular coding standard is now to simply code a single period right before the end of each paragraph. Check out the “GCic” sample program in section [10.4](#) and you’ll see how that would be done.

The standard for the COBOL language shows the various “END-verb” specifications to be optional because using a period as a scope-terminator remains legal. Some statements have an “END-verb” scope-terminator defined for them that they don’t appear to need.<sup>20</sup>

If you will be porting existing code over to GNU COBOL, you’ll find it an accommodating facility capable of conforming to language and coding standards that code is likely to use. If you are creating new GNU COBOL programs, however, I would strongly counsel you to use the “END-verb” structures religiously in those programs.

#### See Also...

The **NEXT SENTENCE** Statement [6.4.28](#)

### 6.1.11. Controlling Concurrent Access to Files

The manipulation of data files is one of the COBOL language’s great strengths. There are features built-in to the COBOL language to deal with the possibility that multiple programs may be attempting to access the same file concurrently. Multiple program concurrent access is dealt with in two ways – *file sharing* and *record locking*.

---

<sup>20</sup> **STRING** (section [6.2.43](#)) and **UNSTRING** (section [6.2.49](#)), for example – could it be there are plans in the works for a future standard to introduce an option to such statements that would need a scope-terminator?

Not all GNU COBOL implementations support file sharing and record-locking options. Whether they do or not depends upon the operating system they were built for and the build options that were used when the specific GNU COBOL implementation was generated.

### 6.1.11.1. File Sharing

GNU COBOL controls concurrent-file access at the highest level through the concept of file sharing, enforced when a program attempts to **OPEN** a file. This is accomplished via a UNIX operating-system routine called “**fcntl()**”. That module is not currently supported by Windows<sup>21</sup> and is not present in the MinGW Unix-emulation package. GNU COBOL builds created using a MinGW environment will be incapable of supporting file-sharing controls – files will always be shared in such environments. A GNU COBOL build created using the Cygwin environment on Windows would have access to “**fcntl()**” and therefore will support file sharing. Of course, actual Unix builds of GNU COBOL, as well as OSX builds<sup>22</sup>, should have no issues because “**fcntl()**” should be available.

Any limitations you impose on a successful **OPEN** will remain in place until your program either issues a **CLOSE** against the file or terminates.

There are three ways in which concurrent access to a file may be controlled at the file level:

Sharing Option on “OPEN”	Effect
<b>ALL OTHER</b>	When your program opens a file in this manner, no restrictions will be placed on other programs attempting to <b>OPEN</b> the file after your program did. This is the default sharing mode.
<b>NO OTHER</b>	When your program opens a file in this manner, your program announces that it is unwilling to allow <u>any</u> other program to have <u>any</u> access to the file as long as you are using that file; <b>OPEN</b> attempts made in other programs will fail with a file status of 37 (“PERMISSION DENIED”) until such time as you <b>CLOSE</b> the file.
<b>READ ONLY</b>	Opening a file in this manner indicates you are willing to allow other programs to <b>OPEN</b> the file for <b>INPUT</b> while you have it <b>OPEN</b> . If they attempt any other <b>OPEN</b> , their <b>OPEN</b> will fail with a file status of 37.

Of course, your program may fail if someone else got to the file first and **OPENED** it with a sharing option that imposed file-sharing limitations.

#### See Also...

FILE-STATUS Values [Figure 4-15](#)

The **CLOSE** Statement [6.4.7](#)

The **OPEN** Statement [6.4.29](#)

### 6.1.11.2. Record Locking

Record-locking is supported by advanced file-management software that provides a single point-of-control for access to files (usually **ORGANIZATION INDEXED** files). One such runtime package capable of doing this is the Berkely Database (BDB) package – a package frequently used in GNU COBOL builds to support **ORGANIZATION INDEXED** files. The various I/O statements are capable of imposing limitations on the access – by other concurrently-executing programs – to the file record they just accessed. These limitations are syntactically imposed by placing a lock on the record. Other records in the file remain available, assuming that file-sharing limitations imposed at **OPEN**-time didn’t prevent access to the entire file.

<sup>21</sup> Windows has other means of providing equivalent functionality to “**fcntl()**”, but the BDB package was not coded to utilize them. The use of other advanced file I/O packages that support both the UNIX and Windows concurrent-access routines (such as VBISAM) are currently under review by the author.

<sup>22</sup> Apple Computer’s OSX operating system is based on an open-source version of UNIX (Darwin) and therefore includes support for “**fcntl()**”.

Locks remain in-effect until a program holding the lock terminates or issues a **CLOSE** or **UNLOCK** against the file or executes a **COMMIT** or **ROLLBACK** statement.

The record locking options (not all options are available to all statements) are as shown in the following table.

Record Locking Option	Effect
<b>WITH LOCK</b>	Access to the record by other programs will be denied.
<b>WITH KEPT LOCK</b>	Normally, as a new record is accessed locks held for previous records are released. By using this option, not only is the newly-accessed record locked (as <b>WITH LOCK</b> would do), but prior record locks will be retained as well. A subsequent <b>READ</b> <u>without</u> the <b>KEPT LOCK</b> option will release all "kept" locks, as will the <b>FREE</b> statement.
<b>WITH NO LOCK</b>	The record will not be locked. This is the default locking option in effect for all statements.
<b>IGNORING LOCK</b> <b>WITH IGNORE LOCK</b>	This option is possible only when reading records – it informs GNU COBOL that any locks held by other programs should be ignored. The two options shown are synonymous.
<b>WITH WAIT</b>	This option is possible only when reading records – it informs GNU COBOL that the program is willing to wait for a lock held on the record being read to be released. Without this option, an attempt to read a locked record will be immediately aborted and a file status of 47 will be returned. With this option, the program will wait for a pre-configured time for the lock to be released. If the lock is released within the preconfigured wait time, the read will be successful. If the pre-configured wait time expires before the lock is released, the read attempt will be aborted and a 47 file status will be issued.

If the GNU COBOL build you are using was configured to use the Berkely Database (BDB) package for **INDEXED** file I/O, record locking will be available by using the execution-time environment variable **DB\_HOME**.

#### See Also...

FILE-STATUS Values <a href="#">Figure 4-15</a>	The FREE Statement <a href="#">6.4.17</a>
The CLOSE Statement <a href="#">6.4.7</a>	The ROLLBACK Statement <a href="#">6.4.37</a>
The COMMIT Statement <a href="#">6.4.8</a>	The UNLOCK Statement <a href="#">6.4.48</a>
	Execution-time Environment Variables <a href="#">8.2.4</a>

## 6.1.12. Common Clauses On Executable Statements

### 6.1.12.1. AT END / NOT AT END

AT END clauses may be specified on **READ** and **RETURN** statements.

[ AT END <a href="#"><i>imperative-statement-1</i></a> ]
[ NOT AT END <a href="#"><i>imperative-statement-2</i></a> ]

1. The optional **AT END** clause will – if present on a **READ** or **RETURN** statement – cause *imperative-statement-1* to be executed if the **READ** or **RETURN** attempt fails due to a File-Status of 10 (end-of-file).
2. An **AT END** clause **WILL NOT DETECT OTHER NON-ZERO FILE-STATUS VALUES**. See [Figure 4-15](#) for a list of possible File-Status values.
3. Use a **DECLARATIVES** routine (section) or an explicitly-declared file status field tested after the **READ** or **RETURN** to detect error conditions other than end-of-file.
4. An optional **NOT AT END** clause will cause *imperative-statement-2* to be executed if the **READ** or **RETURN** attempt is successful.

## 5. See Also...

Using DECLARATIVES [6.1.4](#)The RETURN Statement [6.2.35](#)The READ Statement [6.4.31](#)

### 6.1.12.2. CORRESPONDING Option

Three GNU COBOL verbs – **ADD** (section [6.4.2.3](#)), **MOVE** (section [6.4.26.2](#)) and **SUBTRACT** (section [6.4.44.3](#)) support the use of a “**CORRESPONDING**” option that allows multiple data items within one group item (*group-item-1* – the first named on the statement) to be paired with multiple corresponding data items (hence the name) in a second group item (*group-item-2* – the second named on the statement). The contents of *group-item-1* will remain unaffected by the statement while one or more data items within *group-item-2* will be changed.

In order for *data-item-1*, defined subordinate to group item *group-item-1* to be a “**CORRESPONDING**” match to *data-item-2* which is subordinate to *group-item-2*, each of the following must be true:

1. Both *data-item-1* and *data-item-2* must have the same name, and that name may not explicitly or implicitly be **FILLER**.
2. Both *data-item-1* and *data-item-2*...
  - a. ...must exist at the same relative structural “depth” of definition within *group-item-1* and *group-item-2*, respectively
  - b. ...and all “parent” data items defined within each group item must have identical (but non-“**FILLER**”) names.
3. When used with a **MOVE** verb...
  - a. ...one of *data-item-1* or *data-item-2* (but not both) is allowed to be a group item
  - b. ...and it must be valid to **MOVE** *data-item-1* TO *data-item-2*.
4. When used with **ADD** or **SUBTRACT** verbs, both *data-item-1* and *data-item-2* must be numeric, elementary, unedited items. Stated in different terms, neither *data-item-1* nor *data-item-2* may be group, alphabetic, alphanumeric or numeric-edited items.
5. Neither *data item-1* nor *data-item-2* may be a **REDEFINES** or **RENAMES** of another data item.
6. Neither *data item-1* nor *data-item-2* may have an **OCCURS** clause. Either may contain subordinate data items that have an **OCCURS** clause, however (assuming rule 3a applies)

Observe the following two group item structures...

<pre> 03 X.   05 A      PIC 9(1).   05 G1.     10 G2.       15 B  PIC X(1).   05 C.     10 FILLER PIC X(1).   05 G3.     10 G4.       15 D  PIC X(1).   05 E      PIC X(1).   05 F      REDEFINES V1 PIC X(1).   05 G.     10 G6    OCCURS 4 TIMES PIC X(1).   05 H      PIC X(4).   05 I      PIC 9(1).   05 J.     10 K.       15 M  PIC X(1). </pre>	<pre> 01 Y.   02 A      PIC X(1).   02 G1.     03 G2.       04 B  PIC X(1).   02 C      PIC X(1).   02 G3.     03 G5.       04 D  PIC X(1).       03 G6  PIC X(1).   02 E      PIC 9(1).   02 F      PIC X(1).   02 G      PIC X(4).   02 H      OCCURS 4 TIMES PIC X(1).     66 I    RENAMES E.   02 J.     03 K.       04 L.       05 M. </pre>
---	---

The following are the valid **CORRESPONDING** matches, assuming the statement **MOVE CORRESPONDING X TO Y** is being used (there are no valid **CORRESPONDING** matches for **ADD CORRESPONDING** or **SUBTRACT CORRESPONDING** because every potential matchup violates rule #4): **A, B, C, G**

The following are the “**CORRESPONDING**” matchups that failed, and the reasons why they failed.

D Fails due to rule #2b  
 E Fails due to rule #3b  
 F Fails due to rule #5  
**G1** Fails due to rule #3a  
**G2** Fails due to rule #3a

**G3** Fails due to rule #3a  
**G4** Fails due to rule #1  
**G5** Fails due to rule #1  
**G6** Fails due to rule #6  
 H Fails due to rule #6

I Fails due to rule #5  
 J Fails due to rule #3a  
 K Fails due to rule #3a  
 L Fails due to rule #1  
 M Fails due to rule #2a

**See Also...**

The ADD CORRESPONDING Statement 4

The MOVE CORRESPONDING Statement [6.2.26.2](#)

The SUBTRACT CORRESPONDING Statement [6.2.44.3](#)

**6.1.12.3. INVALID KEY / NOT INVALID KEY**

**INVALID KEY** clauses may be specified on **DELETE**, **READ** (Random), **REWRITE**, **START** and **WRITE** statements.

[ ON INVALID KEY *imperative statement-1* ]  
 [ NOT ON INVALID KEY *imperative statement-2* ]

Specification of an **INVALID KEY** clause will allow your program to trap an I/O failure condition (with an I/O error code in the file's **FILE-STATUS** field) that has occurred due to a record-not-found condition and handle it gracefully.

**See Also...**

Defining File Characteristics (**SELECT**) [4.2.1](#)

**FILE-STATUS** Values [Figure 4-15](#)

The **DELETE** Statement [6.4.11](#)

The Random **READ** Statement [6.2.31.2](#)

The **REWRITE** Statement [6.4.36](#)

The **START** Statement [6.2.41](#)

The **WRITE** Statement [6.4.50](#)

**6.1.12.4. ON EXCEPTION / NOT ON EXCEPTION**

**EXCEPTION** clauses may be specified on **ACCEPT**, **CALL** and **DISPLAY** statements.

[ ON EXCEPTION ERROR *imperative statement-1* ]  
 [ NOT ON EXCEPTION ERROR *imperative statement-2* ]

Specification of an **ON EXCEPTION** clause will allow your program to trap the failure condition that has occurred and handle it gracefully. If such a condition occurs at runtime without having one of these clauses specified, an error message will be generated (by the GNU COBOL runtime library) to the **SYSERR** device (pipe 2). The program may also be terminated, depending upon the type and severity of the error.

**See Also...**

The **ACCEPT** Statement (Command Line) [6.2.1.2](#)

The **ACCEPT** Statement (Screen Data) [6.4.1.4](#)

The **CALL** Statement [6.4.5](#)

The **DISPLAY** Statement (Console/Stdout) [6.2.12.1](#)

The **DISPLAY** Statement (Command Line) [6.2.12.2](#)

The **DISPLAY** Statement (Environment) [6.2.12.3](#)

The **DISPLAY** Statement (Screen Data) [6.4.12.4](#)

**6.1.12.5. ON OVERFLOW / NOT ON OVERFLOW**

**OVERFLOW** clauses may be specified on **CALL**, **STRING** and **UNSTRING** statements.

[ ON OVERFLOW ERROR *imperative statement-1* ]  
 [ NOT ON OVERFLOW ERROR *imperative statement-2* ]

Specification of an **ON OVERFLOW** clause will allow your program to trap the failure condition that has occurred and handle it gracefully. If such a condition occurs at runtime without having one of these clauses specified, an error message will be generated (by the GNU COBOL runtime library) to the **SYSERR** device (pipe 2). The program may also be terminated, depending upon the type and severity of the error.

*See Also...*The CALL Statement [6.4.5](#)The UNSTRING Statement [6.2.49](#)The STRING Statement [6.2.43](#)

### 6.1.12.6. ON SIZE ERROR / NOT ON SIZE ERROR

**SIZE ERROR** clauses may be included on **ADD**, **COMPUTE**, **DIVIDE**, **MULTIPLY** and **SUBTRACT** statements.

[ ON SIZE ERROR *imperative statement-1* ]

[ NOT ON SIZE ERROR *imperative statement-2* ]

Specification of an **ON SIZE ERROR** clause will allow your program to trap the failure condition that has occurred and handle it gracefully. Field size overflow conditions occur silently, usually without any runtime messages being generated, even though such events rarely lend themselves to generating correct results. Division by zero errors, when no **ON SIZE ERROR** clause exists, will produce an error message (by the GNU COBOL runtime library) to the SYSERR device (pipe 2) and will also abort the program.

*See Also...*The ADD Statement [6.4.2](#)The MULTIPLY Statement [6.4.27](#)The COMPUTE Statement [6.4.9](#)The SUBTRACT Statement [6.4.44](#)The DIVIDE Statement [6.4.13](#)

### 6.1.12.7. Rounding Options

GNU COBOL provides for control over the final rounding process applied to the receiving fields on all arithmetic verbs. Each of the arithmetic statements (**ADD**, **COMPUTE**, **DIVIDE**, **MULTIPLY** and **SUBTRACT**) statements provide an optional **ROUNDED** clause to each receiving data item. The syntax of this clause is shown to the right.

The following rules apply to the rounding behavior induced by this clause.

<u>ROUNDED</u>	<u>MODE IS</u>	<u>AWAY-FROM-ZERO</u> <u>NEAREST-AWAY-FROM-ZERO</u> <u>NEAREST-EVEN</u> <u>NEAREST-TOWARD-ZERO</u> <u>PROHIBITED</u> <u>TOWARD-GREATER</u> <u>TOWARD-LESSER</u> <u>TRUNCATION</u>
----------------	----------------	--

1. Rounding only applies when the result being saved to the receiving field having a **ROUNDED** clause is a non-integer value
2. Absence of a **ROUNDED** clause is the same as specifying **ROUNDED MODE IS TRUNCATION**.
3. Use of a **ROUNDED** clause without a **MODE** specification is the same as specifying **ROUNDED MODE IS NEAREST-AWAY-FROM-ZERO**.
4. The behavior of the eight different rounding modes is defined in the following table.

Figure 6-18 - ROUNDED MODE Behavior

MODE		Behavior - Examples assume an <u>integer</u> receiving field – An ellipsis (...) indicates the last result value digit repeats			
		Result	Becomes	Result	Becomes
AWAY-FROM-ZERO	Rounding is to the nearest value of larger magnitude.	+2.499...	+3	-3.499...	-4
		-2.499...	-3	+3.500	+4
		+2.500	+3	-3.500	-4
		-2.500	-3	3.510	+4
		+3.499...	+4	-3.510	-4
NEAREST-AWAY-FROM-ZERO	Rounding is to the nearest value (larger or smaller). If two values are equally near, the value with the larger absolute value is selected.	Result	Becomes	Result	Becomes
		+2.499...	+2	-3.499...	-3
		-2.499...	-2	+3.500	+4
		+2.500	+3	-3.500	-4
		-2.500	-3	3.510	+4
		+3.499...	+3	-3.510	-4
NEAREST-EVEN	Rounding is to the nearest value (larger or smaller). If two values are equally near, the value whose rightmost digit is even is selected. This mode is sometimes called "Banker's rounding".	Result	Becomes	Result	Becomes
		+2.499...	+2	-3.499...	-3
		-2.499...	-2	+3.500	+4
		+2.500	+2	-3.500	-4
		-2.500	-2	3.510	+4
		+3.499...	+3	-3.510	-4
NEAREST-TOWARD-ZERO	Rounding is to the nearest value (larger or smaller). If two values are equally near, the value with the smaller absolute value is selected.	Result	Becomes	Result	Becomes
		+2.499...	+2	-3.499...	-3
		-2.499...	-2	+3.500	+3
		+2.500	+2	-3.500	-3
		-2.500	-2	3.510	+4
		+3.499...	+3	-3.510	-4
PROHIBITED	No rounding is performed. If the value cannot be represented exactly in the desired format, the EC-SIZE-TRUNCATION condition (exception code 1005) is set to exist (and may be retrieved via the <b>ACCEPT</b> statement) and the results of the operation are undefined.	Result	Becomes	Result	Becomes
		+2.499...	Undefined	-3.499...	Undefined
		-2.499...		+3.500	
		+2.500		-3.500	
		-2.500		+3.510	
		+3.499...		-3.510	
TOWARD-GREATER	Rounding is toward the nearest value whose algebraic value is larger.	Result	Becomes	Result	Becomes
		+2.499...	+3	-3.499...	-3
		-2.499...	-2	+3.500	+4
		+2.500	+3	-3.500	-3
		-2.500	-2	3.510	+4
		+3.499...	+4	-3.510	-3
TOWARD-LESSER	Rounding is toward the nearest value whose algebraic value is smaller.	Result	Becomes	Result	Becomes
		+2.499...	+2	-3.499...	-4
		-2.499...	-3	+3.500	+3
		+2.500	+2	-3.500	-4
		-2.500	-3	3.510	+3
		+3.499...	+3	-3.510	-4
TRUNCATION	Rounding is to the nearest value whose magnitude is smaller.	Result	Becomes	Result	Becomes
		+2.499...	+2	-3.499...	-3
		-2.499...	-2	+3.500	+3
		+2.500	+2	-3.500	-3
		-2.500	-2	3.510	+3
		+3.499...	+3	-3.510	-3

**See Also...**

The <b>ACCEPT</b> Statement (Run-time Info) <a href="#">6.2.1.7</a>	The <b>DIVIDE</b> Statement <a href="#">6.4.13</a>
The <b>ADD</b> Statement <a href="#">6.4.2</a>	The <b>MULTIPLY</b> Statement <a href="#">6.4.27</a>
The <b>COMPUTE</b> Statement <a href="#">6.4.9</a>	The <b>SUBTRACT</b> Statement <a href="#">6.4.44</a>

## 6.1.13. Special Registers

GNU COBOL, like other COBOL dialects, includes a number of data items that are automatically available to a programmer without the need to actually define them in the **DATA DIVISION**. COBOL refers to such items as registers or special registers. The special registers available to a GNU COBOL program are as follows:

Figure 6-19 - Special Registers

Register Name	Implied COBOL PIC/USAGE <sup>23</sup>	Usage
COB-CRT-STATUS	PIC 9(4)	This is the default data item allocated for use by format 4 of the <b>ACCEPT</b> statement.
DEBUG-ITEM Subordinate items: <b>DEBUG-LINE</b> <b>DEBUG-NAME</b> <b>DEBUG-SUB-1</b> <b>DEBUG-SUB-2</b> <b>DEBUG-SUB-3</b> <b>DEBUG-CONTENTS</b>	PIC X(88) (group item)	A group item in which debugging information generated by a <b>USE FOR DEBUGGING</b> section in the <b>DECLARATIVES</b> area will place information documenting why the <b>USE FOR DEBUGGING</b> procedure was invoked.
LINAGE-COUNTER	BINARY-LONG SIGNED	An occurrence of this register exists for each <b>SELECTED</b> file having a <b>LINAGE</b> clause. If there are multiple files whose <b>FDs</b> have a <b>LINAGE</b> clause, any explicit references to this register will require qualification (using " <b>OF file-name</b> ").  The value of this register will be the current logical line number within the page body.  <b>DO NOT MODIFY THE CONTENTS OF THIS REGISTER.</b>
NUMBER-OF-CALL-PARAMETERS	BINARY-LONG SIGNED	This register contains the number of arguments passed to a subroutine – the same value that would be returned by the <b>C\$NARG</b> built-in subroutine. Its value will be zero when referenced in a main program. This register, when referenced from within a user-defined function, returns a value of one (1) if the function has any number of arguments and a zero if it has no arguments.
RETURN-CODE	BINARY-LONG SIGNED	This register provides a numeric data item into which a subroutine may <b>MOVE</b> a value prior to transferring control back to the program that <b>CALLed</b> it, or into which a main program may <b>MOVE</b> a value before returning control to the operating system.  Many built-in subroutines will return a value using this register.  These values are – by convention – used to signify success (usually with a value of 0) or failure (usually with a non-zero value) of the process the program setting the <b>RETURN-CODE</b> value was attempting to perform.  Chapter 0 discusses the role this special register plays with subprograms.
SORT-RETURN	BINARY-LONG SIGNED	This register is used to report the success/fail status of a <b>RELEASE</b> or <b>RETURN</b> statement. A value of 0 is reported on success. A value of 16 denotes failure. An " <b>AT END</b> " condition on a <b>RETURN</b> is <u>not</u> considered a failure.
WHEN-COMPILED	PIC X(16)	This register contains the date and time the program was compiled in the format "mm/dd/yyhh.mm.ss". Note that only a two-digit year is provided.

<sup>23</sup> See sections 5.2.1.6 and 5.2.1.11 for a description of the PICTURE and USAGE specifications, respectively

*See Also...*

Describing the Structure of a File (FD/SD) <a href="#">5.1</a>	The RELEASE Statement <a href="#">6.2.33</a>
Using DECLARATIVES <a href="#">6.1.4</a>	The RETURN Statement <a href="#">6.2.35</a>
The ACCEPT Statement (Screen Data) <a href="#">6.4.1.4</a>	The C\$NARG Subroutine <a href="#">8.3.1.9</a>

## 6.1.14. Intrinsic Functions

GNU COBOL supports a variety of “intrinsic functions” that may be used anywhere in the PROCEDURE DIVISION where a literal is allowed. For example:

```
MOVE FUNCTION LENGTH(Employee-Last-Name) TO Employee-LN-Len.
```

Note how the word “FUNCTION” is part of the syntax when you use an intrinsic function. You can use intrinsic functions without having to include the reserved word **FUNCTION** via settings in the **REPOSITORY** paragraph of the **CONFIGURATION SECTION**. You may accomplish the same thing by specifying the “-fintrinsics” option to the GNU COBOL compiler when you compile your programs.

The following intrinsic functions, known to other “dialects” of COBOL, are defined to GNU COBOL as reserved words but are not otherwise implemented currently. Any attempts to use these functions will result in a compile-time error message.

BOOLEAN-OF-INTEGER	FORMATTED-CURRENT-DATE	INTEGER-OF-FORMATTED-DATE
CHAR-NATIONAL	FORMATTED-DATE	NATIONAL-OF
DISPLAY-OF	FORMATTED-DATETIME	STANDARD-COMPARE
EXCEPTION-FILE-N	FORMATTED-TIME	TEST-FORMATTED-DATETIME
EXCEPTION-LOCATION-N	INTEGER-OF-BOOLEAN	

The supported intrinsic functions are listed in the following sections, along with their syntax and usage notes.

*See Also...*

The REPOSITORY Paragraph <a href="#">4.1.3</a>	Compiler Switches Reference <a href="#">8.1.2</a>
--	---

### 6.1.14.1. ABS(*number*)

Determines and returns the absolute value of the *number* (a numeric literal or data item) supplied as an argument.

### 6.1.14.2. ACOS(*cosine*)

The ACOS function determines and returns the trigonometric arc-cosine, or inverse cosine, of the *cosine* value (a numeric literal or data item) supplied as an argument.

### 6.1.14.3. ANNUITY(*interest-rate*, *number-of-periods*)

This function returns a numeric value approximating the ratio of an annuity paid at the specified *interest-rate* (numeric data items or literals) for each of the specified *number-of-periods* (numeric data items or literals).

The *interest-rate* is the rate of interest paid at each payment. If you only have an annual interest rate and you wish to compute annuity payments for monthly payments, divide the annual interest rate by 12 and use that value for *interest-rate* on this function.

Multiply this result times the desired principal amount to determine the amount of each period’s payment.

A note for the financially challenged: an annuity is basically a reverse loan; an accountant would take the result of this function multiplied by -1 to compute a loan payment you are making.

### 6.1.14.4. ASIN(*sine*)

The **ASIN** function determines and returns the trigonometric arc-sine, or inverse sine, of the *sine* value (a numeric literal or data item) supplied as an argument.

### 6.1.14.5. ATAN(*tangent*)

Use this function to determine and return the trigonometric arc-tangent, or inverse tangent, of the *tangent* value (a numeric literal or data item) supplied as an argument.

### 6.1.14.6. BYTE-LENGTH(*string*)

**BYTE-LENGTH** returns the length – in bytes – of the specified string (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal). This intrinsic function is identical to the **LENGTH-AN** function. Note that the value returned by this function is not necessarily the number of characters making up the *string*, but rather the number of actual bytes required to store *string*.

For example, if *string* is encoded using a double-byte character set such as UNICODE (where each character is represented by 16 bits of storage, not the 8-bits inherent to character sets like ASCII or EBCDIC), then calling this function with a *string* argument whose **PICTURE** is **X(4)** would return a value of 8 rather than the value 4.

### 6.1.14.7. CHAR(*integer*)

This function returns the character in the ordinal position specified by the *integer* argument (a numeric integer literal or data item) from the collating sequence being used by the program.

For example, if the program is using the (default) ASCII character set, CHAR(34) returns the 34<sup>th</sup> character in the ASCII character set – an exclamation-point (“!”). If you are using this function to convert a numeric value to its corresponding ASCII character, you must use an argument value one greater than the numeric value.

If an argument whose value is less than 1 or greater than 256 is specified, the character in the program collating sequence corresponding to a value of all zero bits is returned.

The following code is an alternative approach when you just wish to convert a number to its ASCII equivalent:

```
01 Char-Value.
  05 Numeric-Value      USAGE BINARY-CHAR.
.
.
.
MOVE numeric-character-value TO Numeric-Value
The Char-Value item now has the corresponding ASCII character value
```

### 6.1.14.8. COMBINED-DATETIME(*days, seconds*)

This function returns a 12-digit result, the first seven digits of which are the integer value of the *days* argument (a numeric data item or literal) and the last five of which are the integer value of the *seconds* argument (also a numeric data item or literal).

If a *days* value less than 1 or greater than 3067671 is specified, or if a *seconds* value less than 1 or greater than 86400 is specified, a value of 0 is returned and a runtime error will result.

### 6.1.14.9. CONCATENATE(*string-1 [, string-2 ] ...*)

This function concatenates the *string-1*, *string-2*, ... (group items, **USAGE DISPLAY** elementary items and/or alphanumeric literals) together into a single string result.

If a numeric literal or **PIC 9** identifier is specified as an argument, decimal points, if any, will be removed and negative signs in **PIC S9** fields or numeric literals will be inserted as defined by the **SIGN** clause (or absence thereof) of the field. Numeric literals are processed as if **SIGN IS TRAILING SEPARATE** were in effect.

*See Also...*

Defining Signed Data Items (**SIGN**) [5.2.1.9](#)

### 6.1.14.10. COS(*angle*)

The **COS** function determines and returns the trigonometric cosine of the *angle* (a numeric literal or data item) supplied as an argument. The *angle* is assumed to be a value expressed in radians.

### 6.1.14.11. CURRENCY-SYMBOL

The **CURRENCY-SYMBOL** function returns the currency symbol character currently in effect for the locale under which your program is running. On UNIX systems, your locale is established via the LANG environment variable. On Windows, the Control Panel's Regional and Language Options define the locale.

Changing the currency symbol via the **SPECIAL-NAMES** paragraph's **CURRENCY SYMBOL** setting will not affect the value returned by this function.

*See Also...*

The **SPECIAL-NAMES** Paragraph [4.1.4](#)

### 6.1.14.12. CURRENT-DATE

Returns the current date and time as the following 21-character structure:

```
01 CURRENT-DATE-AND-TIME.
  05 CDT-Year          PIC 9(4).
  05 CDT-Month         PIC 9(2). *> 01-12
  05 CDT-Day           PIC 9(2). *> 01-31
  05 CDT-Hour          PIC 9(2). *> 00-23
  05 CDT-Minutes        PIC 9(2). *> 00-59
  05 CDT-Seconds        PIC 9(2). *> 00-59
  05 CDT-Hundredths-Of-Secs PIC 9(2). *> 00-99
  05 CDT-GMT-Diff-Hours  PIC S9(2)
                           SIGN LEADING SEPARATE.
  05 CDT-GMT-Diff-Minutes PIC 9(2). *> 00 or 30
```

Since the **CURRENT-DATE** function has no arguments, no parenthesis should be specified.

### 6.1.14.13. DATE-OF-INTEGER(*integer*)

This function returns a calendar date in *yyyymmdd* format. The date is determined by adding the number of days specified as *integer* (a numeric integer data item or literal) to December 31, 1600. For example, **DATE-OF-INTEGER(1)** returns 16010101.

A value less than 1 or greater than 3067671 (9999/12/31) will return a result of 0.

### 6.1.14.14. DATE-TO-YYYYMMDD(*yyyymmdd* [*yy-cutoff*])

You can use this function to convert the six-digit date specified as *yyyymmdd* (a numeric integer data item or literal) to an eight-digit format (*yyyymmdd*). The optional *yy-cutoff* (a numeric integer data item or literal) argument is the year cutoff used to delineate centuries; if the year component of the date meets or exceeds this cutoff value, the result will be 19*yyyymmdd*; if the year component of the date is less than the cutoff value, the result will be 20*yyyymmdd*. The default cutoff value if no second argument is given will be 50.

### 6.1.14.15. DAY-OF-INTEGER(*integer*)

This function returns a calendar date in yyyyddd (i.e. Julian) format. The date is determined by adding the number of days specified as *integer* (a numeric integer data item or literal) to December 31, 1600. For example, DATE-OF-INTEGER(1) returns 1601001.

A value less than 1 or greater than 3067671 (9999/12/31) will return a result of 0.

### 6.1.14.16. DAY-TO-YYYYDDD(*yyddd* [, *yy-cutoff*])

You can use this function to convert the five-digit Julian date specified as *yyddd* (a numeric integer data item or literal) to a seven-digit Julian format (yyyyddd). The optional *yy-cutoff* argument (a numeric integer data item or literal) is the year cutoff used to delineate centuries; if the year component of the date meets or exceeds this cutoff value, the result will be 19*yyddd*; if the year component of the date is less than the cutoff, the result will be 20*yyddd*. The default cutoff value if no second argument is given will be 50.

### 6.1.14.17. E

This function returns the mathematical constant “E” (the base of natural logarithms). The maximum precision with which this value may be returned is 2.7182818284590452353602874713526625.

Since the **E** function has no arguments, no parenthesis should be specified.

### 6.1.14.18. EXCEPTION-FILE

This function returns I/O exception information from the most-recently executed input or output statement. The information is returned to a structure resembling the following:

```
01 INPUT-OUTPUT-EXCEPTION.
  05 IOE-FILE-STATUS      PIC 9(2).
  05 IOE-FILE-SELECT-NAME PIC X(32).
```

See [Figure 4-15](#) for information about possible file-status values.

The name returned after the file status information will be the “**SELECT**” name of the file, and it will be returned only if the returned file status value is not 00.

Since the **EXCEPTION-FILE** function has no arguments, no parenthesis should be specified.

The documentation of the CBL\_ERROR\_PROC built-in subroutine illustrates the use of this function.

*See Also...*

The CBL_ERROR_PROC Subroutine	<a href="#">8.3.1.24</a>
-------------------------------	--------------------------

### 6.1.14.19. EXCEPTION-LOCATION

This function returns exception information from the most-recently failing statement. The information is returned to a 1023 character string in one of the following formats, depending on the nature of the failure:

- ▶ *primary-entry-point-name; paragraph OF section; statement-number*
- ▶ *primary-entry-point-name; section; statement-number*
- ▶ *primary-entry-point-name; paragraph; statement-number*
- ▶ *primary-entry-point-name; statement-number*

Since the **EXCEPTION-LOCATION** function has no arguments, no parenthesis should be specified.

The program must be compiled with the “**-debug**”, “**-ftraceall**” or “**-g**” option for this function to return any meaningful information.

The documentation of the CBL\_ERROR\_PROC built-in subroutine illustrates the use of this function.

*See Also...*The CBL\_ERROR\_PROC Subroutine [8.3.1.24](#)

### 6.1.14.20. EXCEPTION-STATEMENT

This function returns the most-recent COBOL statement that generated an exception condition.

Since the **EXCEPTION-STATEMENT** function has no arguments, no parenthesis should be specified.

The program must be compiled with the “**-debug**”, “**-ftraceall**” or “**-g**” option for this function to return any meaningful information.

The documentation of the CBL\_ERROR\_PROC built-in subroutine illustrates the use of this function.

*See Also...*The CBL\_ERROR\_PROC Subroutine [8.3.1.24](#)

### 6.1.14.21. EXCEPTION-STATUS

This function returns the error type (as a text string) from the most-recent COBOL statement that generated an exception condition. [Figure 6-28](#) shows a list of possible error types.

Since the **EXCEPTION-STATUS** function has no arguments, no parenthesis should be specified.

The documentation of the CBL\_ERROR\_PROC built-in subroutine illustrates the use of this function.

*See Also...*The CBL\_ERROR\_PROC Subroutine [8.3.1.24](#)

### 6.1.14.22. EXP(*number*)

Computes and returns the value of the mathematical constant “e” raised to the power specified by *number* (a numeric literal or data item).

### 6.1.14.23. EXP10(*number*)

Computes and returns the value of 10 raised to the power specified by *number* (a numeric literal or data item).

### 6.1.14.24. FACTORIAL(*number*)

This function computes and returns the factorial value of *number* (a numeric literal or data item).

### 6.1.14.25. FRACTION-PART(*number*)

This function returns that portion of *number* that occurs to the right of the decimal point. *Number* must be a numeric data item or a numeric literal. **FRACTION-PART(3.1415)**, for example, returns a value of 0.1415. This function is equivalent to the expression:

$$\textit{number} - \text{FUNCTION INTEGER-PART}(\textit{number})$$

### 6.1.14.26. HIGHEST-ALGEBRAIC(*numeric-identifier*)

This function returns the highest (i.e. largest or farthest away from 0 in a positive direction if *numeric-identifier* is signed) value that could possibly be stored in the specified *numeric-identifier*.

### 6.1.14.27. INTEGER(*number*)

The **INTEGER** function returns the greatest integer value that is less than or equal to *number* (a numeric literal or data item).

### 6.1.14.28. INTEGER-OF-DATE(*date*)

This function converts *date* (a numeric integer data item or literal) – presumed to be a Gregorian calendar form standard date (YYYYMMDD) - to integer date form – that is, the number of days that have transpired since 1600/12/31.

### 6.1.14.29. INTEGER-OF-DAY(*date*)

This function converts *date* (a numeric integer data item or literal) – presumed to be a Julian calendar form standard date (YYYYDDD) to integer date form – that is, the number of days that have transpired since 1600/12/31.

### 6.1.14.30. INTEGER-PART(*number*)

Returns the integer portion of the value of *number* (a numeric literal or data item).

### 6.1.14.31. LENGTH(*string*)

Returns the length – in characters – of *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal). Note that the value returned by this function is not the number of bytes of storage occupied by *string*, but rather the number of actual characters making up the *string*. For example, if *string* is encoded using a double-byte character set such as UNICODE (where each character is represented by 16 bits of storage, not the 8-bits inherent to character sets like ASCII or EBCDIC), then calling this function with a *string* argument whose **PICTURE** is X(4) would return a value of 4 rather than the value 8 (the actual number of bytes of storage occupied by that item).

### 6.1.14.32. LENGTH-AN(*string*)

Returns the length – in bytes of storage – of *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal). This intrinsic function is identical to the **BYTE-LENGTH** function. Note that the value returned by this function is not the number of actual characters making up the *string*, bytes of storage occupied by *string*, but rather the number of actual bytes required to store *string*. For example, if *string* is encoded using a double-byte character set such as UNICODE (where each character is represented by 16 bits of storage, not the 8-bits inherent to character sets like ASCII or EBCDIC), then calling this function with a *string* argument whose **PICTURE** is X(4) would return a value of 8 rather than the value 4.

### 6.1.14.33. LOCALE-COMPARE(*argument-1*, *argument-2* [ , *locale* ])

The **LOCALE-COMPARE** function returns a character indicating the result of comparing *argument-1* and *argument-2* using a culturally-preferred ordering defined by a *locale*.

Either argument may be an alphanumeric literal, a group item or an elementary item appropriate to storing alphabetic or alphanumeric data. If the lengths of the two arguments are unequal, the shorter will be assumed to be padded to the right with **SPACES**.

The two arguments will be compared, character by character, against each other until their relationship to each other can be determined. The comparison is made according to the cultural rules in effect for the specified locale name or for the current locale if no locale argument is specified<sup>24</sup>. Once that relationship is determined, a one-character alphanumeric value will be returned as follows:

- “<”      If *argument-1* is determined to be less than *argument-2*
- “=”      If the two arguments are equal to each other
- “>”      If *argument-1* is determined to be greater than *argument-2*

---

<sup>24</sup> Locale-based ordering is not necessarily a character-by-character comparison.

### 6.1.14.34. LOCALE-DATE(*date [, locale ]*)

Converts the eight-digit Gregorian date (a numeric integer data item or literal) from YYYYMMDD format to the format appropriate to the current locale. On a Windows system, this will be the “short date” format as set using Control Panel.

You may include an optional second argument to specify the *locale* name (group item or **PIC X** identifier) you’d like to use for date formatting. If used, this second argument MUST be an identifier. Locale names are specified using UNIX-standard names. The complete list of supported locale names is shown in [Figure 4-7](#).

### 6.1.14.35. LOCALE-TIME(*time [, locale ]*)

Converts the four- (HHMM) or six-digit (HHMMSS) *time* (a numeric integer data item or literal) to a format appropriate to the current locale. On a Windows system, this will be the “time” format as set using Control Panel.

You may include an optional *locale* name (a group item or **PIC X** identifier) you’d like to use for time formatting. If used, this second argument MUST be an identifier. Locale names are specified using UNIX-standard names. The complete list of supported locale names is shown in [Figure 4-7](#).

### 6.1.14.36. LOCALE-TIME-FROM-SECS(*seconds [, locale ]*)

Converts the number of *seconds* since midnight (a numeric integer data item or literal) to a format appropriate to the current locale. On a Windows system, this will be the “time” format as set using Control Panel.

You may include an optional *locale* name (a group item or **PIC X** identifier) you’d like to use for time formatting. If used, this second argument MUST be an identifier. Locale names are specified using UNIX-standard names. The complete list of supported locale names is shown in [Figure 4-7](#).

### 6.1.14.37. LOG(*number*)

Computes and returns the natural logarithm (base “e”) of *number* (a numeric literal or data item).

### 6.1.14.38. LOG10(*number*)

Computes and returns the base 10 logarithm of *number* (a numeric literal or data item).

### 6.1.14.39. LOWER-CASE(*string*)

This function returns the value of *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal), converted entirely to lower case. Note that what constitutes a “letter” (or upper/lower case too, for that manner) may be influenced through the use of a **CHARACTER CLASSIFICATION** specification in the **OBJECT-COMPUTER** paragraph..

*See Also...*

The **OBJECT-COMPUTER** Paragraph [4.1.2](#)

### 6.1.14.40. LOWEST-ALGEBRAIC(*numeric-identifier*)

This function returns the lowest (i.e. smallest or farthest away from 0 in a negative direction if *numeric-identifier* is signed) value that could possibly be stored in the specified *numeric-identifier*.

### 6.1.14.41. MAX(*number-1 [, number-2 ] ...*)

This function returns the maximum value from the specified list *numbers* (these may be numeric data items or literals).

### 6.1.14.42. MEAN(*number-1 [, number-2 ] ...*)

This function returns the statistical mean value of the specified list *numbers* (these may be numeric data items or literals).

#### 6.1.14.43. MEDIAN(*number-1 [, number-2 ] ...*)

This function returns the statistical median value of the specified list *numbers* (these may be numeric data items or literals).

#### 6.1.14.44. MIDRANGE(*number-1 [, number-2 ] ...*)

The **MIDRANGE** (middle range) function returns a numeric value that is the arithmetic mean (average) of the values of the minimum and maximum *numbers* (these may be numeric data items or literals).

#### 6.1.14.45. MIN(*number-1 [, number-2 ] ...*)

This function returns the minimum value from the specified list *numbers* (these may be numeric data items or literals).

#### 6.1.14.46. MOD(*value, modulus*)

Returns *value* modulo *modulus*. Both arguments may be PIC 9 data items or numeric literals. Either (or both) may have a non-integer value.

The result is determined according to the following formula:

$$\text{value} - (\text{modulus} * \text{FUNCTION INTEGER}(\text{value} / \text{modulus}))$$

#### 6.1.14.47. MODULE-CALLER-ID

Returns the primary entry-point name (section 3) of the GNU COBOL program that **CALLED** this one, or the null string if the program is a main program.

The discussion of the **MODULE-TIME** function includes a sample program that also uses this function.

*See Also...*

The **MODULE-TIME** Intrinsic Function [6.1.14.53](#)

#### 6.1.14.48. MODULE-DATE

Returns the date the GNU COBOL program was compiled, in the form YYYYMMDD.

The discussion of the **MODULE-TIME** function includes a sample program that also uses this function.

*See Also...*

The **MODULE-TIME** Intrinsic Function [6.1.14.53](#)

#### 6.1.14.49. MODULE-FORMATTED-DATE

Returns the fully-formatted date and time when the program was compiled. The exact format of this returned string value may vary depending on the operating system, GNU COBOL build type and/or LOCALE settings.

The discussion of the **MODULE-TIME** function includes a sample program that also uses this function.

*See Also...*

The **MODULE-TIME** Intrinsic Function [6.1.14.53](#)

#### 6.1.14.50. MODULE-ID

Returns the primary entry-point name (section 3) of this GNU COBOL program.

The discussion of the **MODULE-TIME** function includes a sample program that also uses this function.

*See Also...*

The **MODULE-TIME** Intrinsic Function [6.1.14.53](#)

## 6.1.14.51. MODULE-PATH

This function returns the full path to the executable version of this GNU COBOL program. The filename component of this value will be exactly as typed on the command line, down to the use of upper- and lowercase letters and presence (or absence) of any extension.

The discussion of the **MODULE-TIME** function includes a sample program that also uses this function.

*See Also...*

The **MODULE-TIME** Intrinsic Function [6.1.14.53](#)

## 6.1.14.52. MODULE-SOURCE

The filename of the source code of the program (as specified on the “cdbc” command when the program was compiled) is returned by this function.

The discussion of the **MODULE-TIME** function includes a sample program that also uses this function.

*See Also...*

The **MODULE-TIME** Intrinsic Function [6.1.14.53](#)

## 6.1.14.53. MODULE-TIME

This function returns the time the GNU COBOL program was compiled, in the form HHMMSS.

The following sample main program uses all the MODULE- Functions

```

IDENTIFICATION DIVISION.
PROGRAM-ID. DEMOMODULE.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
REPOSITORY.
    FUNCTION ALL INTRINSIC.
PROCEDURE DIVISION.
000-Main.
    DISPLAY "MODULE-CALLER-ID"      = [" MODULE-CALLER-ID "]"
    DISPLAY "MODULE-DATE"           = [" MODULE-DATE "]"
    DISPLAY "MODULE-FORMATTED-DATE" = [" MODULE-FORMATTED-DATE "]"
    DISPLAY "MODULE-ID"             = [" MODULE-ID "]"
    DISPLAY "MODULE-PATH"           = [" MODULE-PATH "]"
    DISPLAY "MODULE-SOURCE"         = [" MODULE-SOURCE "]"
    DISPLAY "MODULE-TIME"           = [" MODULE-TIME "]"
    STOP RUN
.

```

The program produces this output when executed:

```

MODULE-CALLER-ID      = []
MODULE-DATE           = [20120614]
MODULE-FORMATTED-DATE = [Jun 14 2012 15:07:45]
MODULE-ID              = [DEMOMODULE]
MODULE-PATH             = [E:\Programs\Demos\DEMOMODULE.exe]
MODULE-SOURCE           = [DEMOMODULE.cb1]
MODULE-TIME              = [150745]

```

### 6.1.14.54. MONETARY-DECIMAL-POINT

This function returns the character used to separate the integer portion from the fractional part of a monetary currency value according to the rules currently in effect for the locale under which your program is running. On UNIX systems, your locale is established via the LANG environment variable. On Windows, the Control Panel's Regional and Language Options define the locale.

Note that using the **SPECIAL-NAMES** paragraph's **DECIMAL-POINT IS COMMA** setting will not affect the value returned by this function.

*See Also...*

The **SPECIAL-NAMES** Paragraph [4.1.4](#)

### 6.1.14.55. MONETARY-THOUSANDS-SEPARATOR

This function returns the character used to separate the thousands digit groupings of monetary currency values according to the rules currently in effect for the locale under which your program is running. On UNIX systems, your locale is established via the LANG environment variable. On Windows, the Control Panel's Regional and Language Options define the locale.

Note that using the **SPECIAL-NAMES** paragraph's **DECIMAL-POINT IS COMMA** setting will not affect the value returned by this function.

*See Also...*

The **SPECIAL-NAMES** Paragraph [4.1.4](#)

### 6.1.14.56. NUMERIC-DECIMAL-POINT

This function returns the character used to separate the integer portion of a non-integer numeric item from the fractional part according to the rules currently in effect for the locale under which your program is running. On UNIX systems, your locale is established via the LANG environment variable. On Windows, the Control Panel's Regional and Language Options define the locale.

Note that using the **SPECIAL-NAMES** paragraph's **DECIMAL-POINT IS COMMA** setting will not affect the value returned by this function.

*See Also...*

The **SPECIAL-NAMES** Paragraph [4.1.4](#)

### 6.1.14.57. NUMERIC-THOUSANDS-SEPARATOR

This function returns the character used to separate the thousands digit groupings of numeric values according to the rules currently in effect for the locale under which your program is running. On UNIX systems, your locale is established via the LANG environment variable. On Windows, the Control Panel's Regional and Language Options define the locale.

Note that using the **SPECIAL-NAMES** paragraph's **DECIMAL-POINT IS COMMA** setting will not affect the value returned by this function.

*See Also...*

The **SPECIAL-NAMES** Paragraph [4.1.4](#)

### 6.1.14.58. NUMVAL(*string*)

**Format 1:**

$$[ \text{space...} ] \left[ \begin{array}{c} + \\ - \end{array} \right] [ \text{space...} ] [ \text{digit...} ] [ . [ \text{digit...} ] ] [ \text{space...} ]$$
**Format 2:**

$$[ \text{space...} ] [ \text{digit...} ] [ . [ \text{digit...} ] ] [ \text{space...} ] \left[ \begin{array}{c} + \\ - \\ \text{DB} \\ \text{CR} \end{array} \right] [ \text{space...} ]$$

The **NUMVAL** function converts a *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal) to its corresponding numeric value.

The *string* must have either of the formats shown here, where *space* represents a SPACE character and *digit* represents one of the digit characters “0” through “9”. In addition, there must be at least one *digit* characters in the *string*.

If *string* does not conform to either of the formats shown here, a value of zero will be returned.

### 6.1.14.59. NUMVAL-C(*string [, symbol ]*)

**Format 1:**

$$[ \text{space...} ] \left[ \begin{array}{c} + \\ - \end{array} \right] [ \text{space...} ] [ \text{currency} ] [ \text{space...} ] [ \text{digit...} ] [ . [ \text{digit...} ] ] [ \text{space...} ]$$
**Format 2:**

$$[ \text{space...} ] [ \text{currency} ] [ \text{space...} ] [ \text{digit...} ] [ . [ \text{digit...} ] ] [ \text{space...} ] \left[ \begin{array}{c} + \\ - \\ \text{DB} \\ \text{CR} \end{array} \right] [ \text{space...} ]$$

This function converts a *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal) representing a currency value to its corresponding numeric value.

The *string* must have either of the formats shown here, where *space* represents a SPACE character, *digit* represents one of the digit characters “0” through “9” and *currency* represents a currency symbol (a “\$”, for example). In addition, there must be at least one *digit* characters in the *string*.

The optional *symbol* character represents the currency symbol (a single-character group item, **USAGE DISPLAY** elementary item or alphanumeric literal) that may be used as the *currency* character in *string*. If no symbol is specified, the value that would be returned by the **CURRENCY-SYMBOL** intrinsic function will be used.

*See Also...*

The **CURRENCY-SYMBOL** Intrinsic Function [6.1.7.11](#)

### 6.1.14.60. NUMVAL-F(*string*)

$$[ \text{space...} ] \left[ \begin{array}{c} + \\ - \end{array} \right] [ \text{space...} ] [ \text{digit...} ] [ . [ \text{digit...} ] ] \text{ E } [ \text{space...} ] \left[ \begin{array}{c} + \\ - \end{array} \right] \text{digit...} [ \text{space...} ]$$

This function converts a *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal) representing a floating-point value to its corresponding numeric value.

The *string* must have the format shown here, where *space* represents a SPACE character and *digit* represents one of the digit characters “0” through “9”. In addition, there must be at least one *digit* character in the *string* to the left of the “E” character.

### 6.1.14.61. ORD(*char*)

This function returns the ordinal position in the program character set (usually ASCII) corresponding to the 1<sup>st</sup> character of the *char* argument (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal). For example, assuming the program is using the standard ASCII collating sequence, **ORD("!"**) returns 34 because "!" is the 34<sup>th</sup> ASCII character. If you are using this function to convert an ASCII character to its numeric value, you must subtract one from the result.

The following code is an alternative approach when you just wish to convert an ASCII character to its numeric equivalent:

```
01 Char-Value.
  05 Numeric-Value      USAGE BINARY-CHAR.
.
.
.
 MOVE "character" TO Char-Value
The Numeric-Value item now has the corresponding numeric value
```

### 6.1.14.62. ORD-MAX( *char-1* [, *char-2*] ... )

This function returns the ordinal position in the argument list corresponding to the argument whose 1<sup>st</sup> character has the highest position in the program collating sequence (usually ASCII). For example, assuming the program is using the standard ASCII collating sequence, **ORD-MAX("Z", "z", "!"**) returns 2 because the ASCII character "z" occurs after "Z" and "!" in the program collating sequence. Each *char* argument is a group item, **USAGE DISPLAY** elementary item or alphanumeric literal

### 6.1.14.63. ORD-MIN( *char-1* [, *char-2*] ... )

This function returns the ordinal position in the argument list corresponding to the argument whose 1<sup>st</sup> character has the lowest position in the program collating sequence (usually ASCII). For example, assuming the program is using the standard ASCII collating sequence, **ORD-MIN("Z", "z", "!"**) returns 3 because the ASCII character "!" occurs before "Z" and "z" in the program's collating sequence. Each *char* argument is a group item, **USAGE DISPLAY** elementary item or alphanumeric literal

### 6.1.14.64. PI

This function returns the mathematical constant "PI". The maximum precision with which this value may be returned is 3.1415926535897932384626433832795029.

Since the **PI** function has no arguments, no parenthesis should be specified.

### 6.1.14.65. PRESENT-VALUE(*rate*, *value-1* [, *value-2*] )

The **PRESENT-VALUE** function returns a value that approximates the present value of a series of future period-end amounts specified by the various *value* arguments at a discount rate specified by the *rate* argument. All arguments are **PIC 9** items and/or numeric literals.

The following formula summarizes the functions operation:  $\text{result} = \sum_{n=1}^{\# \text{ of } \text{values}} \frac{\text{value}_n}{(1+\text{rate})^n}$

### 6.1.14.66. RANDOM [ ( *seed* ) ]

The **RANDOM** function returns a non-integer value in the range 0 to 1 (for example, 0.123456789).

If *seed* is specified, it must be zero or a positive integer (specified as a PIC 9 item and/or numeric literal). It is used as the seed value to generate a sequence of pseudo-random numbers.

If a subsequent reference specifies *seed*, a new sequence of pseudo-random numbers is started.

If the first executed reference to this function does not specify a *seed*, the seed will be supplied by the compiler.

In each case, subsequent references without specifying a *seed* return the next number in the current sequence.

### 6.1.14.67. RANGE(number-1 [, number-2 ] ...)

The **RANGE** function returns a value that is equal to the value of the maximum *number* in the argument list minus the value of the minimum *number* argument. All arguments are numeric data items and/or numeric literals.

### 6.1.14.68. REM(number, divisor)

This function returns a numeric value that is the remainder of *number* divided by *divisor*. Both arguments must be numeric data items or numeric literals.

The result is determined according to the following formula:

$$\text{number} - (\text{divisor} * \text{FUNCTION INTEGER-PART } (\text{number} / \text{divisor}))$$

### 6.1.14.69. REVERSE(string)

This function returns the byte-by-byte reversed value of the specified *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal).

### 6.1.14.70. SECONDS-FROM-FORMATTED-TIME(format, time)

This function decodes a string whose value represents a formatted time and returns the total number of seconds that string represents. The time string must contain hours, minutes and seconds. The time argument may be specified as a group item, **USAGE DISPLAY** elementary item or an alphanumeric literal.

The *format* argument is a string (a group item, **USAGE DISPLAY** elementary item or an alphanumeric literal) documenting the format of *time* using “hh”, “mm” and “ss” to denote where the respective time information can be found. Any other characters found in *format* represent character positions that will be ignored. For example, a *format* of “hhmmss” indicates that *time* will be treated as a six-digit value where the first two characters are the number of hours, the next two represent minutes and the last two represent seconds. Similarly, a *format* of “hh:mm:ss” states that *time* will be an eight-character string where characters 3 and 6 will be ignored.

### 6.1.14.71. SECONDS-PAST-MIDNIGHT

This function returns the current time of day expressed as the total number of elapsed seconds since midnight.

### 6.1.14.72. SIGN(number)

The **SIGN** function returns a -1 if the value of *number* (a numeric literal or data item) is negative, a zero if the value of *number* is exactly zero and a 1 if the value of *number* is greater than 0.

### 6.1.14.73. SIN(angle)

Determines and returns the trigonometric sine of the specified *angle* (a numeric literal or data item). The *angle* is assumed to be a value expressed in radians.

### 6.1.14.74. SQRT(number)

The **SQRT** function returns a numeric value that approximates the square root of *number* (a numeric data item or literal with a non-negative value).

### 6.1.14.75. STANDARD-DEVIATION(number-1 [, number-2 ] ...)

This function returns the statistical standard deviation of the specified list *numbers* (these may be numeric data items or literals).

### 6.1.14.76. STORED-CHAR-LENGTH(*string*)

Returns the length – in bytes – of the specified *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal) minus the total number of trailing spaces, if any.

### 6.1.14.77. SUBSTITUTE(*string, from-1, to-1 [, from-n, to-n ]*)

This function parses the specified *string*, replacing all occurrences of the *from-n* strings with the corresponding *to-n* strings. The *from* strings must match exactly with regard to value and case. The *from* strings do not have to be the same length as the *to* strings. All arguments are group items, **USAGE DISPLAY** elementary items or alphanumeric literals.

A null *to* string will be treated as a single **SPACE**.

### 6.1.14.78. SUBSTITUTE-CASE(*string, from-1, to-1 [, from-n, to-n ]*)

The **SUBSTITUTE-CASE** function operates the same as the **SUBSTITUTE** function, except that *from* string matching is performed without regard for case. All arguments are group items, **USAGE DISPLAY** elementary items or alphanumeric literals.

### 6.1.14.79. SUM(*number-1 [, number-2 ] ...*)

The **SUM** function returns a value that is the sum of the *number* arguments (these may be numeric data items or literals).

### 6.1.14.80. TAN(*angle*)

Determines and returns the trigonometric tangent of the specified angle (a numeric literal or data item). The *angle* is assumed to be a value expressed in radians.

### 6.1.14.81. TEST-DATE-YYYYMMDD(*date*)

Determines if the supplied *date* (a numeric integer data item or literal) is a valid date of the form yyymmdd and that the date is in the range 1601/01/01 to 9999/12/31. If it is, a 0 value is returned. If it isn't, a value of 1, 2 or 3 is returned signaling the problem lies with the year, month or day, respectively.

### 6.1.14.82. TEST-DAY-YYYYDDD(*date*)

Determines if the supplied date (a numeric integer data item or literal) is a valid date of the form yyyyddd and that the date is in the range 1601001 to 9999365. If it is, a 0 value is returned. If it isn't, a value of 1 or 2 is returned signaling the problem lies with the year or day, respectively.

### 6.1.14.83. TEST-NUMVAL(*string*)

The **TEST-NUMVAL** function evaluates the specified *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal) for being appropriate for use as the string argument to a **NUMVAL** function, returning a TRUE value if it is appropriate and FALSE otherwise.

*See Also...*

The **NUMVAL** Intrinsic Function [6.1.14.58](#)

### 6.1.14.84. TEST-NUMVAL-C(*string [, symbol ]*)

The **TEST-NUMVAL-C** function evaluates the specified *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal) and symbol combination for being appropriate for use as the arguments to a **NUMVAL-C** function, returning a TRUE value if they are appropriate and FALSE otherwise.

*See Also...*

The NUMVAL-C Intrinsic Function	<a href="#">6.1.14.59</a>
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### 6.1.14.85. TEST-NUMVAL-F(*string*)

This function evaluates the specified *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal) for being appropriate for use as the string argument to a **NUMVAL-F** function, returning a TRUE value if it is appropriate and FALSE otherwise.

*See Also...*

The NUMVAL-F Intrinsic Function	<a href="#">6.1.7.60</a>
---------------------------------	--------------------------

### 6.1.14.86. TRIM(*string*[ , LEADING|TRAILING ] )

This function removes leading or trailing spaces from the specified *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal). The second argument is specified as a keyword, not a quoted string or identifier. If no second argument is specified, both leading and trailing spaces will be removed.

### 6.1.14.87. UPPER-CASE(*string*)

This function returns the value of *string* (a group item, **USAGE DISPLAY** elementary item or alphanumeric literal), converted entirely to upper case. Note that what constitutes a “letter” (or upper/lower case too, for that manner) may be influenced through the use of **CHARACTER CLASSIFICATION** specifications in the **OBJECT-COMPUTER** paragraph.

*See Also...*

The OBJECT-COMPUTER Paragraph	<a href="#">4.1.2</a>
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### 6.1.14.88. VARIANCE(*number-1* [ , *number-2* ] ...)

This function returns the statistical variance of the specified list *numbers* (these may be numeric data items or literals).

### 6.1.14.89. YEAR-TO-YYYY (*yy* [ ,*yy-cutoff* ])

YEAR-TO-YYYY converts *yy* (a) - a two-digit year - to a four-digit format (yyyy). The optional *yy-cutoff* argument is the year cutoff used to delineate centuries; if *yy* meets or exceeds this cutoff value, the result will be 19*yy*; if *yy* is less than the cutoff, the result will be 20*yy*. The default cutoff value if no second argument is given will be 50. Both arguments must be numeric data items or literals.

## 6.2. GNU COBOL Statements

The remaining sections in this chapter present (in alphabetical order) the various verbs (statements) that make up the GNU COBOL procedural language.

### 6.2.1. ACCEPT

#### 6.2.1.1. ACCEPT Format 1 – Read from Console

Figure 6-20 - ACCEPT (Read from Console) Syntax

```
ACCEPT identifier-1
  [FROM mnemonic-name-1 ]
  [END-ACCEPT ]
```

This format of the **ACCEPT** verb is used to read a value from the console window or the standard input device and store it into a data item (*identifier-1*).

1. *Mnemonic-name-1* must either be the built-in device name **CONSOLE**, **STDIN**, **SYSIN** or **SYSIPT** or a user-defined (**SPECIAL-NAMES**) mnemonic name attached to one of those four device names.
2. If no **FROM** clause is specified, **FROM CONSOLE** is assumed.
3. Input will be read either from the console window (**CONSOLE**) or from the system-standard input (pipe 0 = **STDIN**, **SYSIN** or **SYSIPT**) and will be saved in *identifier-1*.
4. If *identifier-1* is a numeric data item, the character value read from the console or standard-input device will be parsed according to the rules for “Format 1” input to the **NUMVAL** intrinsic function.

*See Also...*

The **SPECIAL-NAMES** Paragraph [4.1.4](#)

The **NUMVAL** Intrinsic Function [6.1.14.58](#)

### 6.2.1.2. ACCEPT Format 2 – Retrieve Command-Line Arguments

Figure 6-21 - ACCEPT (Command Line Arguments) Syntax

```
ACCEPT identifier-1
  [FROM {
    COMMAND-LINE
    ARGUMENT-NUMBER
    ARGUMENT-VALUE [ exception-handler ]
  }]
  [END-ACCEPT ]
```

This format of the **ACCEPT** verb is used to retrieve information from the programs command-line.

1. When you accept from the **COMMAND-LINE** option, you will retrieve the entire set of arguments entered on the command line that executed the program, exactly as they were specified. Parsing that returned data into its meaningful information will be your responsibility.
2. By accepting from **ARGUMENT-NUMBER**, you will be asking the GNU COBOL run-time system to parse the arguments from the command-line and return the number of arguments found. Parsing will be conducted according to the operating system’s rules, as follows:
  - ▶ Arguments will be separated by treating SPACES between characters as the delineators between arguments. The number of spaces separating two non-blank values is irrelevant.
  - ▶ Strings enclosed in double-quote characters (“”) will be treated as a single argument, regardless of how many spaces (if any) might be imbedded within those quotation characters.
  - ▶ On Windows systems, single-quote, or apostrophe characters (‘) will be treated just like any other data character and will NOT delineate strings.
3. By accepting from **ARGUMENT-VALUE**, you will be asking the GNU COBOL run-time system to parse the arguments from the command-line and return the “current” argument. You specify which argument number is “current” via the **DISPLAY ... UPON ARGUMENT-NUMBER** statement (section 0). Parsing of arguments will be conducted according to the rules set forth in #2 above.
4. Attempts to retrieve non-existent arguments can be handled via an optional *exception-handler*.

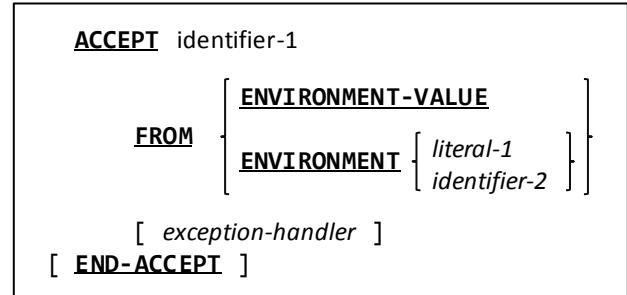
*See Also...*

Handling Exceptions (**ON EXCEPTION**) [6.1.12.4](#)

The **DISPLAY** Statement (Command Line) [6.2.12.2](#)

### 6.2.1.3. ACCEPT Format 3 – Retrieve Environment Variable Values

Figure 6-22 - ACCEPT (Environment Variable Values) Syntax



This format of the **ACCEPT** verb is used to retrieve environment variable values.

1. By accepting from **ENVIRONMENT-VALUE**, you will be asking the GNU COBOL run-time system to retrieve the value of the environment variable whose name is currently in the **ENVIRONMENT-NAME** register. A value may be placed into the **ENVIRONMENT-NAME** register using the **DISPLAY** statement.
2. A simpler approach to retrieving an environment variables value is to use “**ACCEPT ... FROM ENVIRONMENT**”. Using that form, you specify the environment variable to be retrieved right on the **ACCEPT** command itself.
3. The optional *exception-handler* may be used to detect requests to retrieve the values of non-existent environment variables..

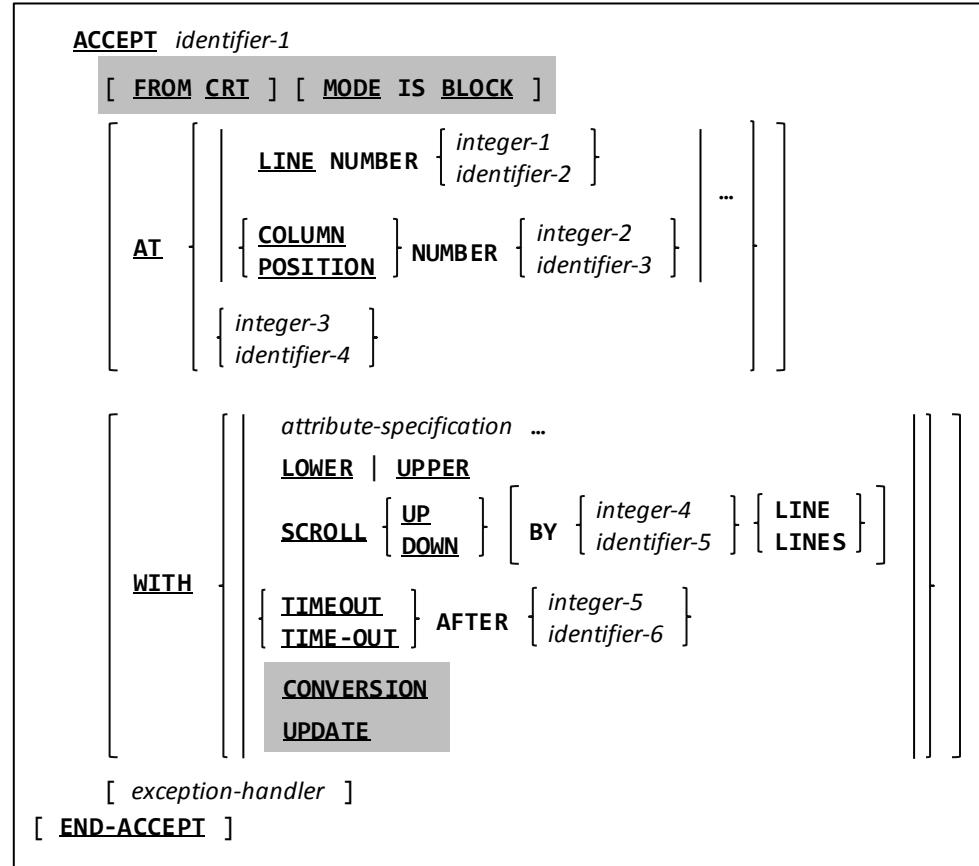
*See Also...*

Handling Exceptions (**ON EXCEPTION**) [6.1.12.4](#)

The **DISPLAY** Statement (Environment) [6.2.12.3](#)

#### 6.2.1.4. ACCEPT Format 4 – Retrieve Full-Screen Data

Figure 6-23 - ACCEPT (Retrieve Screen Data) Syntax



This format of the **ACCEPT** verb is used to retrieve data from a formatted console window screen.

1. The following *attribute-specification* clauses are allowed on the **ACCEPT** statement – these are the same as those allowed for **SCREEN SECTION** data items.

AUTO   AUTO-SKIP   AUTOTERMINATE	FULL   LENGTH-CHECK	REQUIRED   EMPTY-CHECK
BACKGROUND-COLOR	HIGHLIGHT   LOWLIGHT	REVERSE-VIDEO
BEEP   BELL	LEFTLINE	SECURE   NO-ECHO
BLINK	OVERLINE	UNDERLINE
FOREGROUND-COLOR	PROMPT CHARACTER	

2. If *identifier-1* is defined in the **SCREEN SECTION**, any **AT**, *attribute-specification* **LOWER**, **UPPER** or **SCROLL** clauses specified on the **ACCEPT** will be ignored.
3. The various **AT** clauses provide a means of positioning the cursor to a specific spot on the screen before the screen is read. The *literal-3 / identifier-4* value must be a four- or six-digit value with the 1<sup>st</sup> half of the number indicating the line where the cursor should be positioned and the second half indicating the column. There is no distinction between using the word **COLUMN** or **POSITION**.
4. **WITH** options (including the various individual *attribute-specifications*) should be coded only once.
5. The **SCROLL** option will cause the entire contents of the screen to be scrolled **UP** or **DOWN** by the specified number of lines before any value is displayed on the screen. It is possible to specify a **SCROLL UP** clause as well as a **SCROLL DOWN** clause. If no **LINES** specification is made, “**1 LINE**” will be assumed.
6. The **TIMEOUT** option will cause the **ACCEPT** to wait no more than the specified number of seconds for input. The wait count may be specified as a positive integer or a numeric data item with a positive value. Once the timeout limit expires, **ACCEPT** will proceed as if the Enter key had been pressed with no data being entered. The keyword **TIME-OUT** may be used as a synonym for **TIMEOUT**.
7. While supported syntactically, the **CONVERSION** and **UPDATE** options are non-functional.
8. When a Format 4 **ACCEPT** statement with a **SCREEN SECTION** item specified as *identifier-1* is executed, an implied **DISPLAY** of *identifier-1* will occur before input is accepted. Coding an explicit “**DISPLAY identifier-1**” before an “**ACCEPT identifier-1**” is redundant and will incur the performance penalty of painting the screen contents twice.

9. The optional *exception-handler* may be used to handle screen I/O errors.
10. After this format of the **ACCEPT** statement is executed, the programs **CRT STATUS** code identifier (section [4.1.4](#)) will be populated with one of the following:

Figure 6-24 - Screen ACCEPT CRT STATUS Codes

Code	Meaning
0000	ENTER key pressed
1001 - 1064	F1 – F64
2001,2002	PgUp,PgDn <sup>25</sup>
2003,2004,2006	Up Arrow,Down-Arrow,PrtSc (Print Screen) <sup>26</sup>

Code	Meaning
2005	Esc <sup>27</sup>
8000	No data is available on screen ACCEPT
9000	Fatal screen I/O error

This value will indicate what special key was pressed to terminate the **ACCEPT**.

The actual key pressed to generate a function key (Fn) will depend on the type of terminal device you're using (PC, Macintosh, VT100, etc.) and what type of enhanced display driver was configured with the version of GNU COBOL you're using. For example, on a GNU COBOL built for a Windows PC using MinGW and PDCurses, F1-F12 are the actual F-keys on the PC keyboard, F13-F24 are entered by shifting the F-keys, F25-F36 are entered by holding Ctrl while pressing an F-key and F37-F48 are entered by holding Alt while pressing an F-key. On the other hand, a GNU COBOL implementation built for Windows using Cygwin and NCurses treats the PCs F1-F12 keys as the actual F1-F12, while shifted F-keys will enter F11-F20. With Cygwin/NCurses, Ctrl- and Alt-modified F-keys aren't recognized. Neither are Shift-F11 or Shift-F12.

Numeric keypad keys are not recognizable on Windows MinGW/PDCurses builds of GNU COBOL, regardless of NumLock settings. Windows Cygwin/NCurses builds recognize numeric keypad inputs properly. Although not tested during the preparation of this documentation, I would expect native Windows builds using PDCurses to behave as MinGW builds do and native Unix builds using NCurses to behave as do Cygwin builds.

The **CRT STATUS** field the status code is saved into will be either **COB-CRT-STATUS**, if the **CRT STATUS** clause was not specified in the **SPECIAL-NAMES** paragraph, or the programmer-specified identifier if that clause was specified in **SPECIAL-NAMES**.

#### See Also...

Defining Screens [5.2.2](#)

Handling Exceptions (ON EXCEPTION) [6.1.12.4](#)

### 6.2.1.5. ACCEPT Format 5 – Retrieve Date/Time

Figure 6-25 - ACCEPT (Retrieve Date/Time) Syntax

<b>ACCEPT</b> <i>identifier-1</i>
<b>FROM</b> [ <b>DATE</b> [ <u>YYYYMMDD</u> ] ]
[ <b>DAY</b> [ <u>YYYYDDD</u> ] ]
[ <b>DAY-OF-WEEK</b> ]
[ <b>TIME</b> ]
[ <b>END-ACCEPT</b> ]

This format of the **ACCEPT** verb is used to retrieve the current system date, time or current day of the week and store it into a data item.

1. The data retrieved from the system, and the format in which it is structured, will vary according to the following chart:

Figure 6-26 - ACCEPT Options for DATE/TIME Retrieval

ACCEPT Option	Data Returned	<i>identifier-1</i> Format
<b>DATE</b>	Current date in Gregorian form (two-digit year)	01 CURRENT-DATE. 05 CD-YEAR                                  PIC 9(2). 05 CD-MONTH                                PIC 9(2). 05 CD-DAY-OF-MONTH                      PIC 9(2).

<sup>25</sup> These keys are available only if the environment variable COB\_SCREEN\_EXCEPTIONS is set to any non-blank value at runtime.

<sup>26</sup> These keys are not detectable on Windows systems

<sup>27</sup> This key is available only if the environment variable COB\_SCREEN\_ESC is set to any non-blank value at runtime (this is in addition to setting COB\_SCREEN\_EXCEPTIONS)

ACCEPT Option	Data Returned	<i>identifier-1</i> Format
<b>DATE YYYYMMDD</b>	Current date in Gregorian form (four-digit year)	01 CURRENT-DATE. 05 CD-YEAR PIC 9(4). 05 CD-MONTH PIC 9(2). 05 CD-DAY-OF-MONTH PIC 9(2).
<b>DAY</b>	Current date in Julian form (two-digit year)	01 CURRENT-DATE. 05 CD-YEAR PIC 9(2). 05 CD-DAY-OF-YEAR PIC 9(3).
<b>DAY YYYYDDD</b>	Current date in Julian form (four-digit year)	01 CURRENT-DATE. 05 CD-YEAR PIC 9(4). 05 CD-DAY-OF-YEAR PIC 9(3).
<b>DAY-OF-WEEK</b>	Current day of the week	01 CURRENT-DATE. 05 CD-DAY-OF-WEEK PIC 9(1). 88 MONDAY VALUE 1. 88 TUESDAY VALUE 2. 88 WEDNESDAY VALUE 3. 88 THURSDAY VALUE 4. 88 FRIDAY VALUE 5. 88 SATURDAY VALUE 6. 88 SUNDAY VALUE 7.
<b>TIME</b>	Current time	01 CURRENT-TIME. 05 CT-HOURS PIC 9(2). 05 CT-MINUTES PIC 9(2). 05 CT-SECONDS PIC 9(2). 06 CT-HUNDREDS-OF-SECS PIC 9(2).

### 6.2.1.6. ACCEPT Format 6 - Retrieve Screen Information

Figure 6-27 - ACCEPT (Retrieve Screen Information) Syntax

```

ACCEPT identifier-1
  FROM [ LINES | LINE-NUMBER ]
    [ COLUMNS | COLS ]
    [ ESCAPE KEY ]
  [ END-ACCEPT ]

```

This format of the **ACCEPT** verb is used to retrieve information about the console window or about the user's interactions with it.

1. The **LINES** and **COLUMNS** options will retrieve the respective components of the size of the console display. When the console is running in a windowed environment, this will be the sizing of the window in which the program is executing, in terms of horizontal (**COLUMNS**) or vertical (**LINES**) character counts – not pixels. When the system is not running a windowing environment, the physical console screen attributes will be returned. In environments such as a Windows console window, where the logical size of the window may far exceed that of the physical console window, the size returned will be that of the physical console window. If necessary, the screen will be initialized so that the screen window size may be determined. Values of 0 will be returned if GNU COBOL was not generated to include screen I/O.. Compare this result with that of the **CBL\_GET\_SCR\_SIZE** built-in subroutine.
2. The **LINE NUMBER** option is a synonym for **LINES** and the word **COLUMNS** may be specified as **COLS**.
3. The **ESCAPE KEY** option may be used after a format 4 **ACCEPT** has been used to retrieve data off a formatted screen. The result returned will be the four-digit key id of the special key that was pressed to terminate the format 4 **ACCEPT** (a 0000 is returned for the Enter key). This value will be the same as that returned into the **CRT STATUS** field defined in the **SPECIAL-NAMES** paragraph or into the **COB-CRT-STATUS** identifier if no **CRT STATUS** was specified. Consult [Figure 6-23](#) for a list of possible values.

*See Also...*

The **SPECIAL-NAMES** Paragraph [4.1.4](#)

The **CBL\_GET\_SCR\_SIZE** Subroutine [8.3.1.30](#)

### 6.2.1.7. ACCEPT Format 7 - Retrieve Run-Time Information

Figure 6-28 - ACCEPT (Retrieve Run-Time Information) Syntax

```
ACCEPT identifier-1
  FROM [EXCEPTION STATUS]
    [USER NAME]
  [END-ACCEPT]
```

This format of the **ACCEPT** verb is used to retrieve run-time information such as the most-recent error exception code and the current user's user name.

1. The specified identifier must be defined as a **PIC X(4)** item to receive **EXCEPTION STATUS**. When receiving **USER NAME**, the identifier should be large enough to receive the longest user name on your system. If insufficient space is allocated, the returned value will be truncated. If excess space is allocated, the returned value will be padded with **SPACES** (to the right).
2. The most-recently encountered runtime error status will be returned in the identifier ('0000' if no error has occurred) when issuing an **ACCEPT ... FROM EXCEPTION STATUS**.
3. The following table summarizes the current run-time error exception codes.

Figure 6-29 - Run-Time Exception Code Values

Exception Code Returned to ACCEPT	Error Type String Returned by the EXCEPTION-STATUS Function	Description
0101	EC-ARGUMENT-FUNCTION	Function argument error
0202	EC-BOUND-ODO	OCCURS ... DEPENDING ON data item out of bounds
0204	EC-BOUND-PTR	Data-pointer contains an address that is out of bounds
0205	EC-BOUND-REF-MOD	Reference modifier out of bounds
0207	EC-BOUND-SUBSCRIPT	Subscript out of bounds
0303	EC-DATA-INCOMPATIBLE	Incompatible data exception
0500	EC-I-O	input-output exception
0501	EC-I-O-AT-END	I-O status "1x"
0502	EC-I-O-EOP	An end of page condition occurred
0504	EC-I-O-FILE-SHARING	I-O status "6x"
0505	EC-I-O-IMP	I-O status "9x"
0506	EC-I-O-INVALID-KEY	I-O status "2x"
0508	EC-I-O-LOGIC-ERROR	I-O status "4x"
0509	EC-I-O-PERMANENT-ERROR	I-O status "3x"
050A	EC-I-O-RECORD-OPERATION	I-O status "5x"
0601	EC-IMP-ACCEPT	Implementation-defined accept condition
0602	EC-IMP-DISPLAY	Implementation-defined display condition
0A00	EC-OVERFLOW	Overflow condition
0A02	EC-OVERFLOW-STRING	STRING overflow condition
0A03	EC-OVERFLOW-UNSTRING	UNSTRING overflow condition
0B05	EC-PROGRAM-NOT-FOUND	Called program not found
0D03	EC-RANGE-INSPECT-SIZE	Size of replace item in inspect differs
1000	EC-SIZE	Size error exception
1004	EC-SIZE-OVERFLOW	Arithmetic overflow in calculation
1005	EC-SIZE-TRUNCATION	Significant digits truncated in store
1007	EC-SIZE-ZERO-DIVIDE	Division by zero
1202	EC-STORAGE-NOT-ALLOC	The data-pointer specified in a FREE statement does not identify currently allocated storage
1203	EC-STORAGE-NOT-AVAIL	The amount of storage requested by an ALLOCATE statement is not available

4. When using **ACCEPT ... FROM USER NAME**, the returned result is the userid that was used to login to the system with, and not any actual first and/or last name of the user in question (unless, of course, that is the information used as a logon id).

## 6.2.2. ADD

### 6.2.2.1. ADD Format 1 – ADD TO

Figure 6-30 - ADD (TO) Syntax

```
ADD { [ literal-1 ] } ...  

      TO { identifier-2 [ rounding-option ] } ...  

      [ size-error-clause ]  

[ END-ADD ]
```

This format of the **ADD** statement generates the arithmetic sum of all arguments that appear before the **TO** (*identifier-1* or *literal-1*) and then adds that sum to each of the identifiers listed after the **TO** (*identifier-2*).

1. *Identifier-1* and *identifier-2* must be numeric unedited data items while *literal-1* must be a numeric literal.
2. The value(s) specified before the “**TO**” keyword will be added together, and that sum will be added onto each of the identifiers specified after the “**TO**” keyword (*identifier-2*), in turn.
3. The optional “*rounding-option*” clause available to each *identifier-2* will control how non-integer results will be saved.
4. The optional *size-error-clause* may be used to detect arithmetic overflow situations where *identifier-2* is insufficiently sized to hold the generated results.

*See Also...*

Handling Size Errors (ON SIZE ERROR) [6.1.12.6](#)

Rounding Options [6.1.12.7](#)

### 6.2.2.2. ADD Format 2 – ADD GIVING

Figure 6-31 - ADD (GIVING) Syntax

```
ADD { [ literal-1 ] } ...  

      [ TO identifier-2 ]  

      GIVING { identifier-3 [ rounding-option ] } ...  

      [ size-error-clause ]  

[ END-ADD ]
```

This format of the **ADD** statement generates the arithmetic sum of all arguments that appear before the **TO** (*identifier-1* or *literal-1*), adds that sum to the contents of *identifier-2* (if any) and then replaces the contents of the identifiers listed after the **GIVING** (*identifier-3*) with that sum.

1. *Identifier-1* and *identifier-2* must be numeric unedited data items, *identifier-3* must be a numeric (edited or unedited) data item and *literal-1* must be a numeric literal.
2. The value(s) specified before the “**TO**” keyword will be added together, and that sum will be added to the value of *identifier-2* (if any). The contents of *identifier-2* are not altered. The resulting sum is then saved to each of the identifiers specified after the “**GIVING**” keyword (*identifier-3*), in turn. Unless also specified as one of the *identifier-1* items or as the *identifier-2* item, none of the *identifier-3* items will be involved in the calculation other than simply serving as the receiving field(s) of the operation.
3. The optional “*rounding-option*” clause available to each *identifier-3* will control how non-integer results will be saved.
4. The optional *size-error-clause* may be used to detect arithmetic overflow situations where *identifier-2* is insufficiently sized to hold the generated results.

*See Also...*Handling Size Errors (ON SIZE ERROR) [6.1.12.6](#)Rounding Options [6.1.12.7](#)

### 6.2.2.3. ADD Format 3 – ADD CORRESPONDING

Figure 6-32 - ADD (CORRESPONDING) Syntax

```
ADD CORRESPONDING identifier-1
    TO identifier-2 [ rounding-option ]
    [ size-error-clause ]
[ END-ADD ]
```

This format of the **ADD** statement generates code equivalent to individual **ADD TO** statements for corresponding matches of data items found subordinate to the two identifiers.

1. When corresponding matches are established, the effect of an **ADD CORRESPONDING** on those matches will be as if a series of individual **ADD** Format 1 statements were done – one for each match.
2. The optional “*rounding-option*” clause available to each *identifier-2* will control how non-integer results will be saved.
3. The optional *size-error-clause* may be used to detect arithmetic overflow situations where *identifier-2* is insufficiently sized to hold the generated results.

*See Also...*The CORRESPONDING Clause [6.1.12.2](#)Rounding Options [6.1.12.7](#)Handling Size Errors (ON SIZE ERROR) [6.1.12.6](#)

### 6.2.3. ALLOCATE

Figure 6-33 - ALLOCATE Syntax

```
ALLOCATE [ expression-1 CHARACTERS ]
[ identifier-1 ]
[ INITIALIZED ]
[ RETURNING identifier-2 ]
```

The **ALLOCATE** statement is used to dynamically allocate memory at run-time.

1. If used, *expression-1* must be an arithmetic expression with a non-zero positive integer value.
2. If used, *identifier-1* should be an 01-level item defined with the **BASED** attribute in **WORKING-STORAGE** or **LOCAL-STORAGE**. It can be an 01 item defined in the **LINKAGE SECTION** without the **BASED** option, but using such a data item is not recommended.
3. If used, *identifier-2* should be a **USAGE POINTER** data item.
4. The optional **RETURNING** clause will return the address of the allocated memory block into the specified **USAGE POINTER** item. When this option is used, GNU COBOL will retain knowledge of the originally-requested size of the allocated memory block in case a **FREE** statement is ever issued against that **USAGE POINTER** item.
5. When the “*identifier-1*” option is used in conjunction with **INITIALIZED**, the allocated memory block will be initialized according to the **PICTURE** and (if any) **VALUE** clauses present in the definition of *identifier-1* as if an **INITIALIZE** *identifier-1* **WITH FILLER ALL TO VALUE THEN TO DEFAULT** were executed once *identifier-1* was allocated.
6. When the “*expression-1* **CHARACTERS**” option is used, **INITIALIZED** will initialize the allocated memory block to binary zeros.
7. If the **INITIALIZED** clause is not used, the initial contents of allocated memory will be left to whatever rules of memory allocation are in effect for the operating system the program is running under.
8. There are two basic ways in which this statement is used. The simplest is:

```
ALLOCATE My-01-Item
```

With this form, a block of storage equal in size to the defined size of **My-01-Item** (which must have been defined with the **BASED** attribute) will be allocated. The address of that block of storage will become the base address of **My-01-Item** so that it and its subordinate data items become usable within the program.

A second (and equivalent) approach is:

```
ALLOCATE LENGTH OF My-01-Item CHARACTERS RETURNING The-Pointer.
SET ADDRESS OF My-01-Item TO The-Pointer.
```

9. Referencing a **BASED** data item either before its storage has been **ALLOCATED** or after its storage has been **FREEEd** will lead to unpredictable results<sup>28</sup>.

*See Also...*

<b>The DATA DIVISION</b> 5	The <b>FREE Statement</b> <a href="#">6.4.17</a>
Dynamically Allocated Items ( <b>BASED</b> ) <a href="#">5.2.1.2</a>	The <b>INITIALIZE Statement</b> <a href="#">6.2.22</a>
Storage Format of Data ( <b>USAGE</b> ) <a href="#">5.2.1.11</a>	

<sup>28</sup> The COBOL standards like to use the term “unpredictable results” to indicate any sort of unexpected or undesirable behavior – the results in this case probably are predictable though – the program will probably abort from attempting to access an invalid address.

## 6.2.4. ALTER

Figure 6-34 - ALTER Syntax

```
ALTER procedure-name-1 TO PROCEED TO procedure-name-2
```

The **ALTER** verb was used in the early years of the COBOL language to edit a program, changing a “**GO TO**” statement ***at run time*** to branch to a spot in the program different than where the **GO TO** statement was originally compiled for.

1. Support for the **ALTER** verb has been added to GNU COBOL for the purpose of enabling GNU COBOL to pass those National Institute of Standards and Technology (NIST) tests for the COBOL programming language that require support for the **ALTER** verb.
2. Use of this statement is STRONGLY discouraged because it’s use makes it extremely difficult to know where a potentially ALTER-able **GO TO** statement is actually going to at run time.

## 6.2.5. CALL

Figure 6-35 - CALL Syntax

```

CALL [ [  STDCALL 
       STATIC 
      mnemonic-name-1 ] ] [ literal-1 ]
          identifier-1

[  USING  argument-1 ... ]
[  RETURNING|GIVING  identifier-2 ]
[ overflow-clause | exception-clause ]
[  END-CALL  ]

```

The **CALL** statement is used to transfer control to a subprogram, called a *subroutine*.

Chapter 7 deals with the specifics of using subprograms with GNU COBOL programs.

1. The expectation is that the subroutine will eventually return control back to the **CALLing** program, at which point the **CALLing** program will resume execution starting with the statement immediately following the **CALL**. Subprograms are not required to return to their **CALLers**, however, and are free to halt program execution if they wish.
2. The *mnemonic-name-1* / **STATIC** /  **STDCALL** option, if used, affects the linkage conventions that will be used to the subroutine being called, as follows:
  - a. The **STATIC** option will cause the linkage to the subroutine to be performed in such a way as to require the subroutine to be statically-linked with the calling program. Note that this enables static-linking to be used on a subroutine-by-subroutine selective basis.
  - b. The  **STDCALL** option allows system-standard calling conventions (as opposed to GNU COBOL calling conventions) to be used when calling a subroutine. The definition of what constitutes "system standard" may vary from operating system to operating system. Use of this requires special knowledge about the linkage requirements of subroutines you are intending to **CALL**. Subroutines written in GNU COBOL do not need this option.
  - c. The *mnemonic-name* option allows a custom-defined calling convention to be used. Such mnemonic names are defined using the **CALL-CONVENTION** clause of the **SPECIAL-NAMES** paragraph. That clause associates a decimal integer value with *mnemonic-name-1* such that the individual bits set on or off in the binary number corresponding to the integer affect linkage to the subroutine as described in the following chart. Those rows of the chart that are greyed-out represent bit positions (switch settings) in the integer value that are currently accepted if (to provide compatibility to other COBOL implementations) coded, but are otherwise unsupported.

Bit Position	Decimal Value If 1	Meaning if 0	Meaning if 1
0 (right-most)	1	Subroutine arguments will be processed in right-to-left sequence	Subroutine arguments will be passed in left-to-right sequence
1	2	The calling program will flush processed arguments from the argument stack	The called program (subroutine) will flush processed arguments from the argument stack
2	4	The <b>RETURN-CODE</b> register will be updated in addition to any <b>RETURNING/GIVING</b> data item	The <b>RETURN-CODE</b> register will not be updated (but any <b>RETURNING/GIVING</b> data item still will)

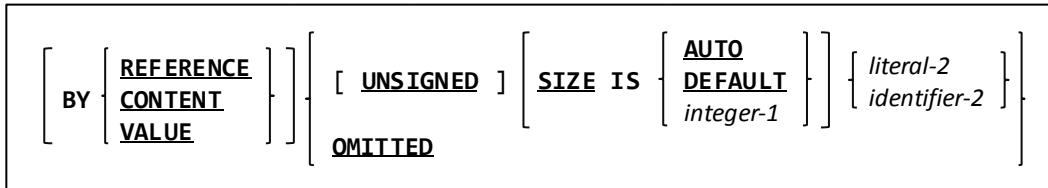
Bit Position	Decimal Value If 1	Meaning if 0	Meaning if 1
3	8	If <b>CALL</b> "literal" is used, the subroutine will be located and linked in with the calling program at compile time or may be dynamically located and loaded at execution time, depending on compiler switch settings and operating system capabilities.	If <b>CALL</b> "literal" is used, the subroutine can only be located and linked with the calling program at compilation time.
4	16	OS/2 "OPTLINK" conventions will <u>not</u> be used to <b>CALL</b> the subprogram.	OS/2 "OPTLINK" conventions will be used to <b>CALL</b> the subprogram.
5	32	Windows 16-bit "thunking" will not be in effect.	Windows 16-bit "thunking" will be used to <b>CALL</b> the subroutine as a DLL.
6	64	The <b>STDCALL</b> convention will not be used.	The <b>STDCALL</b> convention will be used. <sup>29</sup>

Using the " **STDCALL**" option on a **CALL** statement is equivalent to using a **CALL-CONVENTION "8"** (only bit 3 set)

Using the " **STATIC**" option on a **CALL** statement is equivalent to using a **CALL CONVENTION 64** (only bit 6 set)

3. The **RETURNING** and **GIVING** keywords may be used interchangeably.
4. The value of *literal-1* or *identifier-1* is the entry-point of the subprogram you wish to **CALL**.
5. When you **CALL** a subroutine using *identifier-1*, you are forcing the runtime system to call a dynamically-loadable module. The contents of *identifier-1* will be the entry-point name within that module. If this is the first **CALL** to any entry-point within the module, the contents of *identifier-1* must be the name of the module itself (making it the primary entry-point name within the module).
6. If the subprogram being called is a GNU COBOL program, and if that program had the **INITIAL** attribute specified on its **PROGRAM-ID** clause, all of the subprogram's **DATA DIVISION** data will be restored to its initial state each time the subprogram is executed<sup>30</sup>. This [re]-initialization behavior will always apply to any data defined in the subprogram's **LOCAL-STORAGE SECTION** (if any), regardless of the use (or not) of **INITIAL**.
7. The **USING** clause defines a list of arguments that may be passed from the calling program to the subprogram. The syntax used to specify an argument is as follows:

Figure 6-36 - Argument Format When CALLing a Subroutine



8. The manner in which an argument is passed to the subroutine depends upon its **BY** clause, if any, specified for the arguments, as follows:
  - a. **BY REFERENCE** passes the address of the argument to the subprogram. If the subprogram changes the contents of that argument, the change will be "visible" to the calling program.
  - b. **BY CONTENT** passes the address of a copy of the argument to the subprogram. If the subprogram changes the value of such an argument, the original version of it back in the calling program remains unchanged.

<sup>29</sup> The  **STDCALL** calling convention is the one required to use the Microsoft Win32 API

<sup>30</sup> This is regardless of which entry-point within the subprogram is **CALLED**

- c. **BY VALUE** passes the value of the argument as the argument. This feature exists to provide compatibility with C, C++ and other languages and would not normally be used when calling GNU COBOL subprograms.
  - d. If an argument lacks a **BY REFERENCE**, **BY CONTENT** or **BY VALUE** clause, the most-recently encountered “**BY**” specification on that **CALL** statement will be assumed (or **BY REFERENCE** if there have been no “**BY**” specifications specified yet).
  - e. No more than 36 arguments may be passed to a subroutine, unless the GNU COBOL compiler was built with a specifically different argument limit specified for it..
9. The **RETURNING** clause allows you to specify a data item into which the subroutine should return a value. If you use this clause on the **CALL**, the subroutine should include a **RETURNING** clause on its **PROCEDURE DIVISION** header. Of course, a subroutine may pass a value back in any argument passed **BY REFERENCE**.
10. The optional *overflow-clause* or *exception-clause* (the two may be used interchangably) may be used to define actions to be taken if the subroutine could not be located and/or loaded.
11. For additional information, see the documentation of the **CANCEL**,**ENTRY**,**EXIT PROGRAM** and **GOBACK** statements.

*See Also...*

The IDENTIFICATION DIVISION 3	The ENTRY Statement <a href="#">6.2.14</a>
The SPECIAL-NAMES Paragraph <a href="#">4.1.4</a>	The EXIT PROGRAM Statement <a href="#">6.2.16</a>
The DATA DIVISION 5	The GOBACK Statement <a href="#">6.2.19</a>
Special Registers <a href="#">6.1.13</a>	Sub-programming 0
Handling Exceptions ( <b>ON EXCEPTION</b> ) <a href="#">6.1.12.4</a>	Compiling & Dynamic-Linking Programs <a href="#">8.1.3.2</a>
Handling Overflow ( <b>ON OVERFLOW</b> ) <a href="#">6.1.12.5</a>	Compiling & Static-Linking Programs <a href="#">8.1.3.3</a>
The CANCEL Statement <a href="#">6.2.6</a>	

## 6.2.6. CANCEL

Figure 6-37 - CANCEL Syntax

```
CANCEL [ literal-1  
         identifier-1 ] ...
```

The **CANCEL** statement unloads the dynamically-loadable module containing the entry-point specified as *literal-1* or *identifier-1* from memory.

1. If the dynamically-loadable module unloaded by the **CANCEL** is subsequently re-executed, all **DATA DIVISION** storage for that dynamically-loadable module will once again be in its initial state.

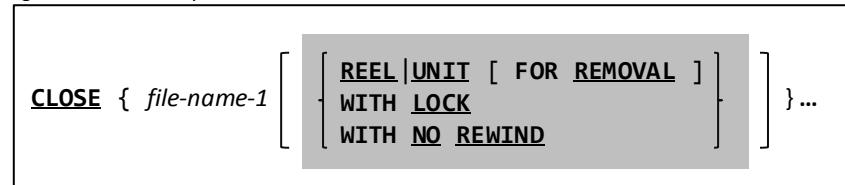
*See Also...*

Sub-programming 0

Compiling & Dynamic-Linking Programs [8.1.3.2](#)

## 6.2.7. CLOSE

Figure 6-38 - CLOSE Syntax



The **CLOSE** statement terminates the program's access to the specified file(s).

1. The **CLOSE** statement may only be executed against files that have been successfully **OPENed**.
2. The **REEL**, **UNIT**, **WITH LOCK** and **NO REWIND** clauses are recognized syntactically but are otherwise non-functional except for the fact that a successful **CLOSE ... NO REWIND** will generate a **FILE-STATUS** value of 07 rather than 00.
3. A successful **CLOSE** will write any remaining unwritten record buffers to the file (similar to an **UNLOCK**) and release any file locks for the file; regardless of **OPEN** mode. A closed file will then be no longer available for subsequent I/O statements until it is once again **OPENed**.
4. When a **LINE SEQUENTIAL** or **LINE ADVANCING** file is **CLOSEd**, a final delimiter sequence will be written to the file to signal the termination point of the final data record in the file. This will only be necessary if the final record written to the file was written with the **AFTER ADVANCING** option.

### See Also...

Types of Files <a href="#">1.3.3.5</a>	The <b>OPEN</b> Statement <a href="#">6.4.29</a>
FILE-STATUS Values <a href="#">Figure 4-15</a>	The <b>UNLOCK</b> Statement <a href="#">6.4.48</a>
	The <b>WRITE</b> Statement <a href="#">6.4.50</a>

## 6.2.8. COMMIT

Figure 6-39 - COMMIT Syntax



COMMIT

The **COMMIT** statement performs an **UNLOCK** against every currently-**OPEN** file, but does NOT **CLOSE** any of the files.

1. See the **UNLOCK** statement for additional details.

*See Also...*

The **CLOSE** Statement [6.4.7](#)

The **UNLOCK** Statement [6.4.48](#)

## 6.2.9. COMPUTE

Figure 6-40 - COMPUTE Syntax

```
COMPUTE { identifier-1 [ rounding-option ] } ... =|EQUAL arithmetic-expression-1
[ size-error-clause ]
[ END-COMPUTE ]
```

The **COMPUTE** statement provides a means of easily performing complex arithmetic operations with a single statement, instead of using cumbersome and possibly confusing sequences of **ADD**, **SUBTRACT**, **MULTIPLY** and **DIVIDE** statements.

1. Each *identifier-1* must be a numeric or numeric-edited data item.
2. The word **EQUAL** and the equals-sign (=) may be used interchangeably.
3. The optional “*rounding-option*” clause available to each *identifier-1* will control how non-integer results will be saved.
4. The optional *size-error-clause* may be used to detect arithmetic overflow situations where *identifier-1* is insufficiently sized to hold the generated results.

### See Also...

Handling Size Errors ( <b>ON SIZE ERROR</b> ) <a href="#">6.1.12.6</a>	The <b>DIVIDE</b> Statement <a href="#">6.4.13</a>
Rounding Options <a href="#">6.1.12.7</a>	The <b>MULTIPLY</b> Statement <a href="#">6.4.27</a>
The <b>ADD</b> Statement <a href="#">6.4.2</a>	The <b>SUBTRACT</b> Statement <a href="#">6.4.44</a>

## 6.2.10. CONTINUE

Figure 6-41 - CONTINUE Syntax

```
CONTINUE
```

The **CONTINUE** statement is a no-operation statement, performing no action whatsoever.

1. The **CONTINUE** statement is often used with **IF** statements as a place-holder for conditionally-executed code that is not yet needed or not yet designed. The following two sentences are equivalent. One uses **CONTINUE** statements to mark places where code may need to be inserted in the future.

"Minimalist" Coding (Specifying only what is necessary)	Coding With CONTINUE (Documenting where code might be needed someday)
<pre>IF A = 1   IF B = 1     DISPLAY 'A=1 &amp; B=1' END-DISPLAY   END-IF ELSE   IF A = 2     IF B = 2       DISPLAY 'A=2 &amp; B=2' END-DISPLAY     END-IF   END-IF END-IF</pre>	<pre>IF A = 1   IF B = 1     DISPLAY 'A=1 &amp; B=1' END-DISPLAY   ELSE     <b>CONTINUE</b>   END-IF ELSE   IF A = 2     IF B = 2       DISPLAY 'A=2 &amp; B=2' END-DISPLAY     ELSE       <b>CONTINUE</b>     END-IF   ELSE     <b>CONTINUE</b>   END-IF END-IF</pre>

Coding such as this is generally a matter of personal preference or site coding standards. There is no difference in the object code generated by the two, so there isn't a run-time efficiency issue (just one of "coding efficiency").

2. Another **IF**-statement usage for **CONTINUE** is to avoid the use of **NOT** in the conditional expression coded on the **IF** statement. This too is a personal and/or site standards issue. Here's an example:

Without CONTINUE	With CONTINUE
<pre>IF Action-Flag NOT = 'I' AND 'U'   DISPLAY 'Invalid Action-Flag'   EXIT PARAGRAPH END-IF</pre>	<pre>IF Action-Flag = 'I' OR 'U'   <b>CONTINUE</b> ELSE   DISPLAY 'Invalid Action-Flag'   EXIT PARAGRAPH END-IF</pre>

Because of the way COBOL (GNU COBOL included) handles the abbreviation of conditional expressions, the conditional expression in the left-hand box is actually a short-hand version of the (not-so-intuitive):

```
IF Action-Flag NOT = 'I' AND Action-Flag NOT = 'U'
```

Inexperienced COBOL programmers would have coded the "IF" (incorrectly) as "IF Action-Flag NOT = 'I' OR 'U'", because it's basically how one might say it if describing the logic; this is sure to cause run-time problems as it actually represents "IF Action-Flag NOT = 'I' OR Action-Flag NOT = 'U'" – not the same thing at all!

This causes many programmers to consider the code in the right-hand box to be more readable, even though it is a little longer.

*See Also...*

The **IF** Statement [6.2.21](#)

## 6.2.11. DELETE

Figure 6-42 - DELETE Syntax

```
DELETE file-name-1 RECORD
      [ invalid-key-clause ]
      [ END-DELETE ]
```

The **DELETE** statement logically deletes a record from an **ORGANIZATION RELATIVE** or **ORGANIZATION INDEXED** file.

1. The **ORGANIZATION** of *file-name-1* must be **RELATIVE** or **INDEXED**.
2. For **RELATIVE** or **INDEXED** files in the **SEQUENTIAL** access mode, the last input-output statement executed for *file-name* prior to the execution of the **DELETE** statement must have been a successfully executed sequential-format **READ** statement. That **READ** will therefore identify the record to be deleted.
3. If *file-name-1* is a **RELATIVE** file whose **ACCESS MODE** is either **RANDOM** or **DYNAMIC**, the record to be deleted is the one whose relative record number is currently the value of the field specified as the file's **RELATIVE KEY** in its **SELECT** statement.
4. If *file-name-1* is an **INDEXED** file whose **ACCESS MODE** is **RANDOM** or **DYNAMIC**, the record to be deleted is the one whose primary key is currently the value of the field specified as the **RECORD KEY** in the file's **SELECT** statement.
5. An "invalid key" condition will exist, and can be dealt with via the *invalid-key-clause*, if the record specified to be deleted by the **RELATIVE KEY** or **RECORD KEY** value does not exist in an access mode **RANDOM** or **DYNAMIC** file. This is a condition that cannot exist for **ACCESS MODE SEQUENTIAL** files because of rule #2. **DELETE** failures on **ACCESS MODE SEQUENTIAL** files can only be "handled" via **DECLARATIVES** (section ).
6. No *invalid-key-clause* may be specified for a file who's **ACCESS MODE IS SEQUENTIAL**.

### See Also...

Types of Files <a href="#">1.3.3.5</a>	Using DECLARATIVES <a href="#">6.1.4</a>
Defining File Characteristics ( <b>SELECT</b> ) <a href="#">4.2.1</a>	The <b>READ</b> Statement <a href="#">6.4.31</a>
Handling Invalid Keys ( <b>INVALID KEY</b> ) <a href="#">6.1.12.3</a>	

## 6.2.12. DISPLAY

### 6.2.12.1. DISPLAY Format 1 – “UPON “device”

Figure 6-43 - DISPLAY (Upon Console) Syntax

```
DISPLAY [ literal-1 ] ...
[ UPON mnemonic-name-1 ]
[ WITH NO ADVANCING ]
[ exception-handler ]
[ END-DISPLAY ]
```

This format of the **DISPLAY** statement displays the specified identifier contents and/or literal values on the specified device.

1. If no **UPON** clause is specified, **UPON CONSOLE** will be assumed. If the **UPON** clause is specified, *mnemonic-name-1* must be one of the built-in device names or a mnemonic name assigned to one of those devices via the **SPECIAL-NAMES** paragraph of the **CONFIGURATION SECTION**.
2. The **NO ADVANCING** clause, if used, will suppress the normal carriage-return / line-feed sequence that normally is added to the end of any console display. You can see an example of this at work in the sample program on page [6-62](#).
3. The optional *exception-handler* may be used to deal with errors attempting to display to the output device.

*See Also...*

The **SPECIAL-NAMES** Paragraph [4.1.4](#)

Handling Exceptions (**ON EXCEPTION**) [6.1.12.4](#)

Built-in Device Names [Figure 4-8](#)

4.

### 6.2.12.2. DISPLAY Format 2 – Access Command-Line Arguments

Figure 6-44 - DISPLAY (Access Command-line Arguments) Syntax

```
DISPLAY [ literal-1 ] ...
[ identifier-1 ] ...
UPON [ ARGUMENT-NUMBER ]
[ COMMAND-LINE ]
[ exception-handler ]
[ END-DISPLAY ]
```

This form of the **DISPLAY** statement may be used to specify the command-line argument number to be retrieved by a subsequent **ACCEPT** or to specify a new value for the command-line arguments themselves.

1. By **DISPLAYing** a numeric integer value **UPON ARGUMENT-NUMBER**, you will specify which argument (by its relative number) will be retrieved by a subsequent **ACCEPT ... FROM ARGUMENT VALUE** statement.
2. Executing a **DISPLAY ... UPON COMMAND-LINE** will influence subsequent **ACCEPT ... FROM COMMAND-LINE** statements (which will then return the **DISPLAYed** value), but will not influence subsequent **ACCEPT ... FROM ARGUMENT-VALUE** statements – these will continue to return the original program execution parameters.
3. The optional *exception-handler* may be used to deal with errors that occur at run-time.

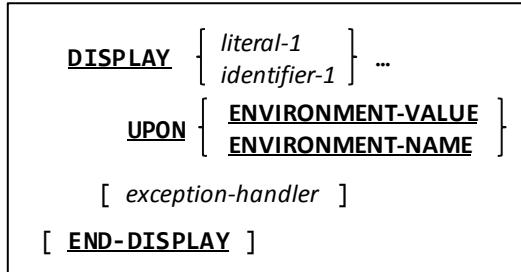
*See Also...*

Handling Exceptions (**ON EXCEPTION**) [6.1.12.4](#)

The **ACCEPT** Statement (Command Line) [6.2.1.2](#)

### 6.2.12.3. DISPLAY Format 3 – Access or Set Environment Variables

Figure 6-45 - DISPLAY (Access / Set Environment Variables) Syntax



This form of the **DISPLAY** statement can be used to create or modify environment variables.

- To create or change an environment variable will require two **DISPLAY** statements. The following example sets the environment variable “MY\_ENV\_VAR” to a value of “Demonstration Value”:

```

DISPLAY "MY_ENV_VAR" UPON ENVIRONMENT-NAME
DISPLAY "Demonstration Value" UPON ENVIRONMENT-VALUE
  
```

- Environment variables created or changed from within GNU COBOL programs will be available to any sub-shell processes spawned by that program (i.e. **CALL** “SYSTEM”) but will not be known to the shell or console window that started the GNU COBOL program.
- Consider using **SET ENVIRONMENT** in lieu of **DISPLAY** to set environment variables as it is much simpler.
- The optional *exception-handler* may be used to deal any errors that occur at run-time.

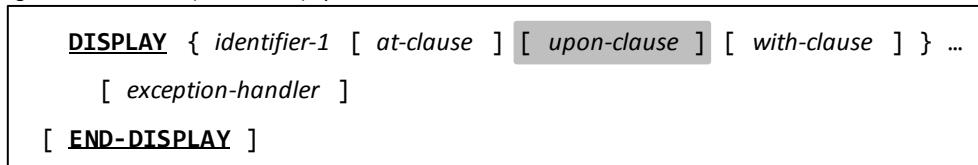
*See Also...*

Handling Invalid Keys (**INVALID KEY**) [6.1.12.3](#)

The **SET ENVIRONMENT** Statement [6.4.39.1](#)

### 6.2.12.4. DISPLAY Format 4 – Screen Data

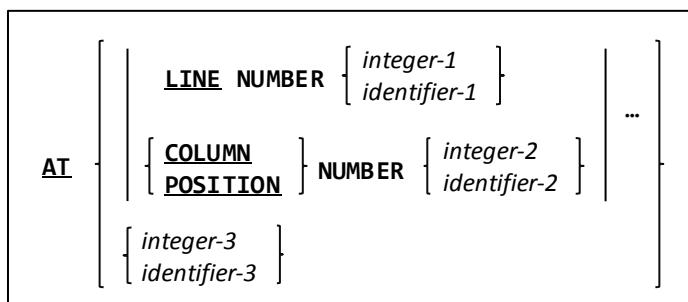
Figure 6-46 - DISPLAY (Screen Data) Syntax



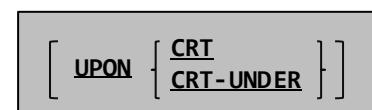
This format of the **DISPLAY** statement presents data onto a formatted screen.

- If *identifier-1* is defined in the **SCREEN SECTION**, any *at-clause*, *upon-clause* and *with-clause* specified for that identifier will be ignored, and all field positioning and screen control will occur as a result of the **SCREEN SECTION** definition of *identifier-1*.

- The purpose of the *at-clause* is to define where on the screen *identifier-1* should be displayed. Consult the documentation for format 4 of the **ACCEPT** statement (Screen Data) for additional information.



- The **UPON** clause, while supported syntactically, is otherwise non-functional at this time.



4. The purpose of the *with-clause* is to define the visual attributes that should be applied to *identifier-1* when it is displayed on the screen. Consult the documentation for format 4 of the **ACCEPT** statement (Screen Data) for additional information.

The following *attribute-specification* clauses are allowed on a **DISPLAY** statement *with-clause* – these are the same as those allowed for **SCREEN SECTION** data items.

**BACKGROUND-COLOR**

**BEEP | BELL**

**BLANK LINE | BLANK SCREEN**

**BLINK**

**FOREGROUND-COLOR**

**HIGHLIGHT | LOWLIGHT**

**OVERLINE**

**REVERSE-VIDEO**

*attribute-specification* ...

**SCROLL** [ UP ] [ DOWN ] [ **BY** [ *integer-4* ] [ *identifier-5* ] [ **LINE** ] [ **LINES** ] ]

[ TIMEOUT ] [ TIME -OUT ] **AFTER** [ *integer-5* ] [ *identifier-6* ]

**CONVERSION**

4. The optional *exception-handler* may be used to deal any screen I/O errorsthat occur at run-time.

*See Also...*

Defining Screens [5.2.2](#)

The ACCEPT Statement (Screen Data) [6.4.1.4](#)

Handling Exceptions (**ON EXCEPTION**) [6.1.12.4](#)

## 6.2.13. DIVIDE

### 6.2.13.1. DIVIDE Format 1 – DIVIDE INTO

Figure 6-47 - DIVIDE INTO Syntax

```
DIVIDE { literal-1 } INTO { identifier-2 [ rounding-option ] } ...
[ size-error-clause ]
[ END-DIVIDE ]
```

This format of **DIVIDE** will divide a specified value into one or more data items, replacing the value in each of those data items with the result of its old value divided by the *identifier-1* or *literal-1* value. Any remainder calculated as a result of the division is discarded.

1. *Identifier-1* and *identifier-2* must be numeric unedited data items and *literal-1* must be a numeric literal.
2. The optional “*rounding-option*” clause available to each *identifier-2* will control how non-integer results will be saved.
3. The optional *size-error-clause* may be used to detect arithmetic overflow situations where *identifier-2* is insufficiently sized to hold the generated results; this clause will also detect attempts to divide by zero.

*See Also...*

Handling Size Errors (**ON SIZE ERROR**) [6.1.12.6](#)

Rounding Options [6.1.12.7](#)

### 6.2.13.2. DIVIDE Format 2 – DIVIDE INTO GIVING

Figure 6-48 - DIVIDE INTO GIVING Syntax

```
DIVIDE { literal-1 } INTO { literal-2 }
[ identifier-1 ] { identifier-2 }

GIVING { identifier-3 [ rounding-option ] } ...
[ REMAINDER identifier-4 ]
[ size-error-clause ]
[ END-DIVIDE ]
```

This format of **DIVIDE** will divide a specified value (*identifier-1* or *literal-1*) into another value (*identifier-2* or *literal-2*) and will then replace the contents of one or more receiving data items (*identifier-3* ...) with the results of that division.

Any remainder calculated as a result of the division is discarded unless a **REMAINDER** clause is present.

1. *Identifier-1* and *identifier-2* must be numeric unedited data items, *identifier-3* and *identifier-4* must be numeric (edited or unedited) data items and *literal-1* and *literal-2* must be numeric literals.
2. The optional “*rounding-option*” clause available to each *identifier-3* will control how non-integer results will be saved.
3. The optional *size-error-clause* may be used to detect arithmetic overflow situations where *identifier-3* is insufficiently sized to hold the generated results; this clause will also detect attempts to divide by zero.

*See Also...*

Handling Size Errors (**ON SIZE ERROR**) [6.1.12.6](#)

Rounding Options [6.1.12.7](#)

### 6.2.13.3. DIVIDE Format 3 – DIVIDE BY GIVING

Figure 6-49 - DIVIDE BY GIVING Syntax

```

DIVIDE [ literal-1 ] BY [ literal-2 ]
    GIVING { identifier-3 [ rounding-option ] } ...
    [ REMAINDER identifier-4 ]
    [ size-error-clause ]
[ END-DIVIDE ]

```

This format of **DIVIDE** will divide a specified value (*identifier-1* or *literal-1*) by another value (*identifier-2* or *literal-2*) and will then replace the contents of one or more receiving data items (*identifier-3* ...) with the results of that division.

Any remainder calculated as a result of the division is discarded unless a **REMAINDER** clause is present.

1. *Identifier-1* and *identifier-2* must be numeric unedited data items, *identifier-3* and *identifier-4* must be numeric (edited or unedited) data items and *literal-1* and *literal-2* must be numeric literals.
2. The optional “*rounding-option*” clause available to each *identifier-3* will control how non-integer results will be saved.
3. The optional *size-error-clause* may be used to detect arithmetic overflow situations where *identifier-3* is insufficiently sized to hold the generated results; this clause will also detect attempts to divide by zero.

*See Also...*

Handling Size Errors (**ON SIZE ERROR**) [6.1.12.6](#)

Rounding Options [6.1.12.7](#)

## 6.2.14. ENTRY

Figure 6-50 - ENTRY Syntax

<b>ENTRY</b> <i>literal-1</i> [ <b>USING</b> <i>argument-1</i> ... ]
--

The **ENTRY** statement is used to define an alternate *entry-point* into a subroutine, along with the arguments that subroutine will be expecting.

1. You may not use an **ENTRY** statement in a nested subprogram.
2. The **USING** clause defines the arguments the subroutine entry-point supports. This list of arguments must match up against the **USING** clause of any **CALL** statements that will be invoking the subroutine using this entry-point.
3. Each *argument-n* specified on the **ENTRY** statement must be defined in the **LINKAGE SECTION** of the subprogram in which the **ENTRY** statement exists.
4. The *literal-1* value will specify the entry-point name of the subroutine. It must be specified exactly on **CALL** statements (with regard to the use of upper- and lower-case letters) as it is specified on the **ENTRY** statement.
5. Each *argument-n* entry must follow the syntax shown to the right. The usage of **REFERENCE**, **CONTENT** and **VALUE** on an argument should match the manner in which that argument is being passed on the **CALL** statement.

Figure 6-51 - ENTRY Statement Argument Syntax

BY	[	<b>REFERENCE</b>	]	[	<b>CONTENT</b>	]	[	<b>VALUE</b>	]	]	<i>identifier-1</i>
----	---	------------------	---	---	----------------	---	---	--------------	---	---	---------------------

### See Also...

The DATA DIVISION 5	Sub-programming 0
The CALL Statement <a href="#">6.4.5</a>	Details of Nested Subprograms <a href="#">7.6</a>

## 6.2.15. EVALUATE

Figure 6-52 - EVALUATE Syntax

```
EVALUATE selection-subject-1 [ ALSO selection-subject-2 ] ...
  { { WHEN selection-object-1 [ ALSO selection-object-2 ] } ... [ imperative-statement-1 ] } ...
    [ WHEN OTHER imperative-statement-2 ]
  [ END-EVALUATE ]
```

The **EVALUATE** statement provides a means of defining processing that should take place under a multitude of conditions.

1. There must be at least one **WHEN** clause specified on any **EVALUATE** statement. There may also be multiple **WHEN** clauses specified.
2. There must be at least one *selection-subject* specified on the **EVALUATE** statement itself. The syntax of a *selection-subject* is shown to the right.
3. Each *selection subject* will have its value matched against the corresponding *selection object* value on every **WHEN** clause.
4. The first **WHEN** clause having each of its *selection-object(s)* successfully matched by the corresponding *selection-subject* on the **EVALUATE** statement will be the one whose *imperative-statement-1* (if any) is executed. If the successfully matched WHEN clause does not have its own *imperative-statement-1* then the next *imperative-statement-1* (on another **WHEN** clause) following the **WHEN** that was matched will be executed.
5. If no **WHEN** clause has its *imperative-statement-1* executed, then the **WHEN OTHER** clause's *imperative-statement-2* will be executed (if **WHEN OTHER** was specified).
6. Once *imperative-statement-1* or *imperative statement-2* is executed (or would have been executed if it existed), control will proceed with the statement following the **END-EVALUATE**.
7. The syntax of a *selection-object* is shown to the right.
8. The reserved words **THRU** and **THROUGH** may be used interchangeably.
9. When using **THRU**, the values on both sides of the **THRU** must be the same class (both numeric, both alphanumeric, etc.).
10. A *partial-expression* is one of the following:
  - a. A *class-condition* without a leading *identifier-1*
  - b. A *sign-condition* without a leading *identifier-1*
  - c. A *relation-condition* with nothing to the left of the relational operator
11. In order for a *selection-subject* to match the corresponding *selection-object* on a **WHEN** clause, one of the following must be true:
  - a. The *selection-object* is **ANY**
  - b. The value of the *selection-subject* is equal to the value of the *selection object*
  - c. The value of the *selection-subject* falls within the range specified by the **THRU** clause of the *selection-object*
  - d. If the *selection-object* is a *partial-expression* (see #10, above), then the true/false result that would be obtained if the *partial-expression* is applied to the *selection-subject* must be true; this will be illustrated in an upcoming example

Syntax of a  
*selection-subject*

<b>TRUE</b>
<b>FALSE</b>
<i>expression-1</i>
<i>identifier-1</i>
<i>literal-1</i>

Syntax of a *selection-object*

<b>ANY</b>
<b>TRUE</b>
<b>FALSE</b>
<i>partial-expression-1</i>
<i>expression-2</i>
<i>identifier-2</i>
<i>literal-2</i>
<b>THRU</b>   <b>THROUGH</b>
<i>expression-3</i>
<i>identifier-3</i>
<i>literal-3</i>

Here is a sample program that illustrates the **EVALUATE** statement.

```

IDENTIFICATION DIVISION.
PROGRAM-ID. DEMOEVULATE.
DATA DIVISION.
WORKING-STORAGE SECTION.
01 Test-Digit          PIC 9(1).
  88 Digit-Is-Odd VALUE 1, 3, 5, 7, 9.
  88 Digit-Is-Prime VALUE 1, 3, 5, 7.
PROCEDURE DIVISION.
P1. PERFORM UNTIL EXIT
    DISPLAY "Enter a digit (0 Quits):"
    WITH NO ADVANCING
    ACCEPT Test-Digit
    IF Test-Digit = 0
        EXIT PERFORM
    END-IF
    EVALUATE Digit-Is-Odd ALSO Digit-Is-Prime
        WHEN TRUE ALSO FALSE
            DISPLAY Test-Digit " is ODD"
            WITH NO ADVANCING
        WHEN TRUE ALSO TRUE
            DISPLAY Test-Digit " is PRIME"
            WITH NO ADVANCING
        WHEN FALSE ALSO ANY
            DISPLAY Test-Digit " is EVEN"
            WITH NO ADVANCING
    END-EVALUATE
    EVALUATE Test-Digit
        WHEN < 5
            DISPLAY " and it's small too"
        WHEN < 8
            DISPLAY " and it's medium too"
        WHEN OTHER
            DISPLAY " and it's large too"
    END-EVALUATE
END-PERFORM
DISPLAY "Bye!"
STOP RUN
.

```

Console output when run (user input is highlighted):

```

Enter a digit (0 Quits): 1
1 is PRIME and it's small too
Enter a digit (0 Quits): 2
2 is EVEN and it's small too
Enter a digit (0 Quits): 3
3 is PRIME and it's small too
Enter a digit (0 Quits): 4
4 is EVEN and it's small too
Enter a digit (0 Quits): 5
5 is PRIME and it's medium too
Enter a digit (0 Quits): 6
6 is EVEN and it's medium too
Enter a digit (0 Quits): 7
7 is PRIME and it's medium too
Enter a digit (0 Quits): 8
8 is EVEN and it's large too
Enter a digit (0 Quits): 9
9 is ODD and it's large too
Enter a digit (0 Quits): 0
Bye!

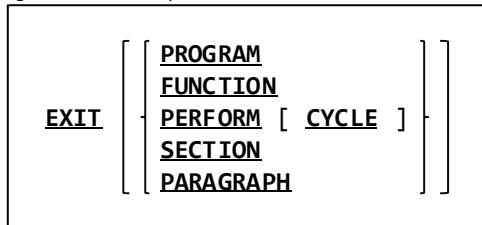
```

#### *See Also...*

Class Tests <a href="#">6.1.4.2.2</a>	Relation Tests <a href="#">6.1.8.2.5</a>
Sign Tests <a href="#">6.1.8.2.3</a>	

## 6.2.16. EXIT

Figure 6-53 - EXIT Syntax



The **EXIT** statement is a multi-purpose statement; it may provide a common end point for a series of procedures, exit an inline **PERFORM**, a paragraph or a section or it may mark the logical end of a subprogram.

- When used without any of the optional clauses, the “**EXIT**” statement simply provides a common “**GO TO**” end point for a series of procedures. [Figure 6-57](#) illustrates this usage of the **EXIT** statement.
- When an **EXIT** statement is used, it must be the only statement in the paragraph in which it occurs.
- The **EXIT** statement takes no other run-time action.

- An **EXIT PARAGRAPH** statement transfers control to a point immediately past the end of the current paragraph, while an **EXIT SECTION** statement causes control to pass to point immediately past the last paragraph in the current section. If the **EXIT PARAGRAPH** or **EXIT SECTION** resides in a paragraph within the scope of a procedural **PERFORM**, control will be returned back to the **PERFORM** for evaluation of any **TIMES**, **VARYING** and/or **UNTIL** clauses. If the **EXIT PARAGRAPH** or **EXIT SECTION** resides outside the scope of a procedural **PERFORM**, control simply transfers to the first executable statement in the next paragraph (**EXIT PARAGRAPH**) or section (**EXIT SECTION**).

[Figure 6-58](#) shows how the example shown in [Figure 6-57](#) could have been coded without a **GO TO** by utilizing an **EXIT PARAGRAPH** statement.

- The **EXIT PERFORM** and **EXIT PERFORM CYCLE** statements are intended to be used in conjunction with an inline **PERFORM** statement.
- An **EXIT PERFORM CYCLE** will terminate the current iteration of the inline **PERFORM**, giving control to any **TIMES**, **VARYING** and/or **UNTIL** clauses for them to determine if another cycle needs to be performed.

Figure 6-54 - Using the EXIT Statement

```

01 Switches.
05 Input-File-Switch PIC X(1).
     88 EOF-On-Input-File VALUE 'Y' FALSE 'N'.
.
.
.

SET EOF-On-Input-File TO FALSE.
PERFORM 100-Process-A-Transaction
       THRU 199-Exit
       UNTIL EOF-On-Input-File.

.
.

100-Process-A-Transaction.
READ Input-File AT END
      SET EOF-On-Input-File TO TRUE
      GO TO 199-Exit.
      IF Input-Rec of Input-File = SPACES
          GO TO 199-Exit. *> IGNORE BLANK RECORDS!
      process the record just read
199-Exit.
      EXIT.
  
```

Figure 6-55 - Using EXIT PARAGRAPH

```

01 Switches.
05 Input-File-Switch PIC X(1).
     88 EOF-On-Input-File VALUE 'Y' FALSE 'N'.
.
.

SET EOF-On-Input-File TO FALSE.
PERFORM 100-Process-A-Transaction
       UNTIL EOF-On-Input-File.

.
.

100-Process-A-Transaction.
READ Input-File AT END
      SET EOF-On-Input-File TO TRUE
      EXIT PARAGRAPH.
      IF Input-Rec of Input-File = SPACES
          EXIT PARAGRAPH. *> IGNORE BLANK RECORDS!
      process the record just read
  
```

7. An **EXIT PERFORM** will terminate the inline **PERFORM** outright, transferring control to the first statement following the **PERFORM**. [Figure 6-59](#) shows the final modification to the [Figure 6-57](#) example; by using Inline **PERFORM** and **EXIT PERFORM** statements we can really streamline processing.

Figure 6-56 - Using the EXIT PERFORM Statement

```

PERFORM UNTIL EXIT
  READ Input-File AT END
    EXIT PERFORM
  END-READ
  IF Input-Rec of Input-File = SPACES
    EXIT PERFORM CYCLE  *-> IGNORE BLANK RECORDS!
  END-IF
  process the record just read
END PERFORM

```

8. The **EXIT PROGRAM** and **EXIT FUNCTION** statements terminate the execution of a subroutine (i.e. a program that has been **CALLED** by another) or user-defined function, respectively. An **EXIT PROGRAM** statement returns control back to the statement following the **CALL** of the subprogram. An **EXIT FUNCTION** returns control back to the processing of the statement in the calling program that invoked the user-defined function.
9. If executed by a main program, neither the **EXIT PROGRAM** nor **EXIT FUNCTION** statements are non-functional. The **EXIT PROGRAM** statement is not legal anywhere within a user-defined function and **EXIT FUNCTION** cannot be used anywhere within a subroutine. Neither may be used within a **USE GLOBAL** routine in **DECLARATIVES**.
10. The COBOL2002 standard has made a common extension to the COBOL language - the **GOBACK** statement – now a standard language element; the **GOBACK** statement should be strongly considered as the preferred alternative to **EXIT PROGRAM** and **EXIT FUNCTION** for new subprograms.

**See Also...**

Using <b>DECLARATIVES</b> <a href="#">6.1.4</a>	The <b>PERFORM</b> Statement (Procedural) <a href="#">6.2.30.1</a>
The <b>CALL</b> Statement <a href="#">6.4.5</a>	The <b>PERFORM</b> Statement (Inline) <a href="#">6.4.30.2</a>
The <b>GOBACK</b> Statement <a href="#">6.2.19</a>	Sub-programming 0
The <b>GO TO</b> Statement <a href="#">6.2.20</a>	Subprograms Subroutines vs Functions <a href="#">7.1</a>

## 6.2.17. FREE

Figure 6-57 - FREE Syntax

```
FREE { [ ADDRESS OF ] identifier-1 } ...
```

The **FREE** statement releases memory previously allocated to the program by the **ALLOCATE** statement.

1. *Identifier-1* must be a **USAGE POINTER** data item or an 01-level data item with the **BASED** attribute.
2. If *identifier-1* is a **USAGE POINTER** data item and it contains a valid address, the **FREE** statement will release the memory block the pointer references. In addition, any **BASED** data items that the pointer was used to provide an address for will become un-based and therefore un-useable. If *identifier-1* did not contain a valid address, no action will be taken.
3. If *identifier-1* is a **BASED** data item and that data item is currently based (meaning it currently has memory allocated for it), its memory is released and *identifier-1* will become un-based and therefore un-useable. If *identifier-1* was not based, no action will be taken.
4. The **ADDRESS OF** clause adds no special function to the **FREE** statement.

*See Also...*

Dynamically Allocated Items (**BASED**) [5.2.1.2](#)

The **ALLOCATE** Statement [6.4.3](#)

Storage Format of Data (**USAGE**) [5.2.1.11](#)

## 6.2.18. GENERATE

Figure 6-58 - GENERATE Syntax

```
GENERATE { identifier-1  
          report-name-1 }
```

Although syntactically recognized by the GNU COBOL compiler, the **GENERATE** statement is non-functional because the RWCS (COBOL Report Writer Control System) is not currently supported by GNU COBOL.

## 6.2.19. GOBACK

Figure 6-59 - GOBACK Syntax

```
GOBACK
```

The **GOBACK** statement is used to logically terminate an executing program.

1. If executed within a subprogram (i.e. a subroutine or user-defined function), **GOBACK** behaves like an **EXIT PROGRAM** or **EXIT FUNCTION** statement, respectively.
2. If executed within a main program, **GOBACK** will act as a **STOP RUN** statement.

*See Also...*

The **EXIT FUNCTION** Statement [6.2.16](#)

The **STOP RUN** Statement [6.4.42](#)

The **EXIT PROGRAM** Statement [6.2.16](#)

Sub-programming 0

3.

## 6.2.20. GO TO

### 6.2.20.1. GO TO Format 1 – Simple GO TO

Figure 6-60 - Simple GO TO Syntax

```
GO TO procedure-name-1
```

This form of the **GO TO** statement unconditionally transfers control in a program to the specified *procedure-name-1*.

1. If *procedure-name-1* is a section, control will transfer to the first paragraph in that section.

### 6.2.20.2. GO TO Format 2 – GO TO DEPENDING ON

Figure 6-61 – GO TO DEPENDING ON Syntax

```
GO TO procedure-name-1 ...
DEPENDING ON identifier-1
```

This form of the **GO TO** statement will transfer control to any one of a number of specified procedure names depending on the numeric value of the identifier specified on the statement.

1. The **PICTURE** and/or **USAGE** of the specified *identifier-1* must be such as to define it as a numeric, unedited, preferably unsigned integer data item.
2. If the value of *identifier-1* has the value 1, control will be transferred to the 1<sup>st</sup> specified procedure name. If the value is 2, control will transfer to the 2<sup>nd</sup> procedure name, and so on.
3. If the value of *identifier-1* is less than 1 or exceeds the total number of procedure names specified on the **GO TO** statement, control will simply fall thru into the next statement following the **GO TO**.
4. The following table shows how **GO TO DEPENDING ON** may be used in a real application situation, and compares it against the two alternatives – **IF** and **EVALUATE**.

Figure 6-62 - GOTO DEPENDING ON vs IF vs EVALUATE

GOTO DEPENDING ON	IF	EVALUATE
<pre>GO TO PROCESS-ACCT-TYPE-1 PROCESS-ACCT-TYPE-2 PROCESS-ACCT-TYPE-3 DEPENDING ON ACCT-TYPE. Code to handle invalid account type GO TO DONE-WITH-ACCT-TYPE. PROCESS-ACCT-TYPE-1. Code to handle account type 1 GO TO DONE-WITH-ACCT-TYPE. PROCESS-ACCT-TYPE-2. Code to handle account type 2 GO TO DONE-WITH-ACCT-TYPE. PROCESS-ACCT-TYPE-3. Code to handle account type 3 DONE-WITH-ACCT-TYPE.</pre>	<pre>IF ACCT-TYPE = 1   Code to handle account type 1 ELSE   IF ACCT-TYPE = 2     Code to handle account type 2   ELSE     IF ACCT-TYPE = 3       Code to handle account type 3     ELSE       Code to handle invalid       account type     END-IF   END-IF END-IF</pre>	<pre>EVALUATE ACCT-TYPE WHEN 1   Code to handle account type 1 WHEN 2   Code to handle account type 2 WHEN 3   Code to handle account type 3 WHEN OTHER   Code to handle invalid account type END-EVALUATE.</pre>

There is no question that “modern programming philosophy” would prefer the **EVALUATE** approach. An interesting note is that the code generated by the **IF** and **EVALUATE** techniques is virtually identical.

*See Also...*

The **EVALUATE** Statement [6.2.15](#)

The **IF** Statement [6.2.21](#)

## 6.2.21. IF

Figure 6-63 - IF Syntax

```
IF conditional-expression THEN imperative-statement-1  
[ ELSE imperative-statement-2 ]  
[ END-IF ]
```

The **IF** statement is used to conditionally execute an imperative statement or to select one of two different imperative statements based upon the TRUE/FALSE value of a conditional expression.

1. If *conditional-expression* evaluates to true, *imperative-statement-1* will be executed regardless of whether or not an **ELSE** clause is present. Once *imperative-statement-1* has been executed, control falls into the first statement following the **END-IF** or to the first statement of the next sentence if there is no **END-IF** clause.
2. If the optional **ELSE** clause is present and *conditional-expression-1* evaluates to false, then (and only then) *imperative-statement-2* will be executed. Once *imperative-statement-2* has been executed, control falls into the first statement following the **END-IF** or to the first statement of the next sentence if there is no **END-IF** clause.
3. The **END-IF** statement isn't the only way the scope of an IF (or ELSE) can be terminated – the period character (.) can be used also to terminate the IF/ELSE by ending the sentence in which it is coded.

*See Also...*

Conditional Expressions [6.1.8.2](#)

Use of Periods (.) [6.1.5](#)

## 6.2.22. INITIALIZE

Figure 6-64 - INITIALIZE Syntax

```
INITIALIZE identifier-1 ... [ WITH FILLER ]
[ [ ALL
    category-name ] TO VALUE ]
[ THEN REPLACING { category-name DATA BY [ LENGTH OF ] [ literal-1
                                                                identifier-2 ] } ... ]
[ THEN TO DEFAULT ]
```

The **INITIALIZE** statement initializes each *identifier-1* with certain specific values, depending upon the options specified.

1. From the sequence of *identifier-1* data items specified on the **INITIALIZE** statement, a list of initializable fields, referred to as the *field list* in the remainder of this section, will include:
  - a. Every *identifier-1* that is an elementary item.
  - b. Every *identifier-1* that is a group item will have each elementary item defined anywhere within its full hierarchical structure included, excluding **FILLER** items.
  - c. If the optional **WITH FILLER** clause is included on the **INITIALIZE** statement, then rule #1.b above will include **FILLER** items.

Any *identifier-1* containing a **REDEFINES** in its definition will be included in the field list, but items defined subordinate to any *identifier-1* that contain **REDEFINES** in their descriptions (and any items subordinate to them as well) will be excluded.

2. A *category-name* may be any of the following:

<b>ALPHABETIC</b>	The <b>PICTURE</b> of any <b>ALPHABETIC</b> data item only contains A symbols
<b>ALPHANUMERIC</b>	The <b>PICTURE</b> of any <b>ALPHANUMERIC</b> data item contains only A, X and 9 symbols (but all A symbols is considered <b>ALPHABETIC</b> and all 9 symbols is considered <b>NUMERIC</b> )
<b>ALPHANUMERIC-EDITED</b>	The <b>PICTURE</b> of any <b>ALPHANUMERIC-EDITED</b> data item is that it is an <b>ALPHANUMERIC</b> data item that <u>also</u> contains B, 0 (zero) and/or slash (/) symbols
<b>NUMERIC</b>	A <b>NUMERIC</b> data item is one that is described with one of the pictureless <b>USAGES</b> (see <a href="#">Figure 5-10</a> ) or has a <b>PICTURE</b> composed of nothing but P, 9, S and V symbols.
<b>NUMERIC-EDITED</b>	The <b>PICTURE</b> of any <b>NUMERIC-EDITED</b> data item is one that must have a <b>PICTURE</b> clause in it's definition, and that clause contains nothing but the symbol 9 and any editing symbol defined in <a href="#">Figure 5-7</a> .

3. The behavior of an **INITIALIZE** without a **VALUE** or **REPLACING** clause (either with or without a **DEFAULT** clause) will be to move zeros into every numeric or numeric-edited data item (as defined above) in the field list and, **SPACES** into all remaining fields in the initializable field list.

4. The behavior of an **INITIALIZE with a VALUE and/or REPLACING clause** will be as follows:

- a. If there is an “**ALL TO VALUE**” clause present then all data items in the field list having an explicit **VALUE** clause coded in their description or having an implicit **VALUE** clause inherited from their parent group item will be initialized to that compile-time value.

If there is a “*category-name TO VALUE*” clause present then all data items in the field list that fall into the specified category (see the list above) and have either an explicit **VALUE** clause coded in their description or have an implicit **VALUE** clause inherited from their parent group item will be initialized to that compile-time value.

Any data items in the field list that get initialized by this rule will be excluded from the remaining rules.

- b. If there is a “**REPLACING**” clause present, then all data items in the fields list that weren’t initialized by rule #4.a and that fall into the specified category (see the list above) will be initialized to the value specified by *literal-1* or *identifier-2*. You may specify multiple “*category-name BY value*” clauses, but each must specify a unique *category-name*.

Any data items in the field list that get initialized by this rule will be excluded from the remaining rules.

- c. Finally, if there are any data items in the field list that weren’t initialized either by rule #4.a or #4.b and there is a **DEFAULT** clause present, those remaining data items will be initialized according to rule #3.

The following example may help your understanding of how the INITIALIZE statement works. The sample code makes use of the COBDUMP program documented in section [10.2](#) to dump the storage that is (or is not) being **INITIALIZED**.

```

IDENTIFICATION DIVISION.
PROGRAM-ID. DemoInitialize.
DATA DIVISION.
WORKING-STORAGE SECTION.
01 Item-1.
 05 I1-A VALUE ALL '*'.
    10 FILLER          PIC X(1).
    10 I1-A-1         PIC 9(1) VALUE 9.
  05 I1-B           USAGE BINARY-CHAR.
  05 I1-C           PIC A(1) VALUE 'C'.
  05 I1-D           PIC X/X VALUE 'ZZ'.
  05 I1-E           OCCURS 2 TIMES PIC 9.

PROCEDURE DIVISION.
000-Main.
  DISPLAY "MOVE HIGH-VALUES TO Item-1"
  PERFORM 100-Init-Item-1
  CALL "COBDUMP" USING Item-1
  DISPLAY " "

  DISPLAY "INITIALIZE Item-1"
  INITIALIZE Item-1
  CALL "COBDUMP" USING Item-1
  PERFORM 100-Init-Item-1
  DISPLAY " "

  DISPLAY "INITIALIZE Item-1 WITH FILLER"
  MOVE HIGH-VALUES TO Item-1
  INITIALIZE Item-1 WITH FILLER
  CALL "COBDUMP" USING Item-1
  PERFORM 100-Init-Item-1
  DISPLAY " "

  DISPLAY "INITIALIZE Item-1 ALL TO VALUE"
  MOVE HIGH-VALUES TO Item-1
  INITIALIZE Item-1 ALPHANUMERIC TO VALUE
  CALL "COBDUMP" USING Item-1
  PERFORM 100-Init-Item-1
  DISPLAY " "

  DISPLAY "INITIALIZE Item-1 REPLACING NUMERIC BY 1"
  MOVE HIGH-VALUES TO Item-1
  INITIALIZE Item-1 REPLACING NUMERIC BY 1
  CALL "COBDUMP" USING Item-1
  PERFORM 100-Init-Item-1
  DISPLAY " "

STOP RUN
.

100-Init-Item-1.
  MOVE HIGH-VALUES TO Item-1
.

```

When executed, this program produces the following output:

```
MOVE HIGH-VALUES TO Item-1
<-Addr-> Byte <----- Hexadecimal -----> <---- Char ---->
===== ===== ===== ===== ===== ===== ===== ===== ===== =====
00404058    1 FF .....  
  
INITIALIZE Item-1
<-Addr-> Byte <----- Hexadecimal -----> <---- Char ---->
===== ===== ===== ===== ===== ===== ===== ===== ===== =====
00404058    1 FF 30 00 20 20 2F 20 30 30      .0. / 00  
  
INITIALIZE Item-1 WITH FILLER
<-Addr-> Byte <----- Hexadecimal -----> <---- Char ---->
===== ===== ===== ===== ===== ===== ===== ===== ===== =====
00404058    1 20 30 00 20 20 2F 20 30 30      0. / 00  
  
INITIALIZE Item-1 ALL TO VALUE
<-Addr-> Byte <----- Hexadecimal -----> <---- Char ---->
===== ===== ===== ===== ===== ===== ===== ===== ===== =====
00404058    1 2A 2A FF 43 5A 5A 20 FF FF      **.CZZ ..  
  
INITIALIZE Item-1 REPLACING NUMERIC BY 1
<-Addr-> Byte <----- Hexadecimal -----> <---- Char ---->
===== ===== ===== ===== ===== ===== ===== ===== ===== =====
00404058    1 FF 31 01 FF FF FF FF 31 31      .1.....11
```

### 6.2.23. INITIATE

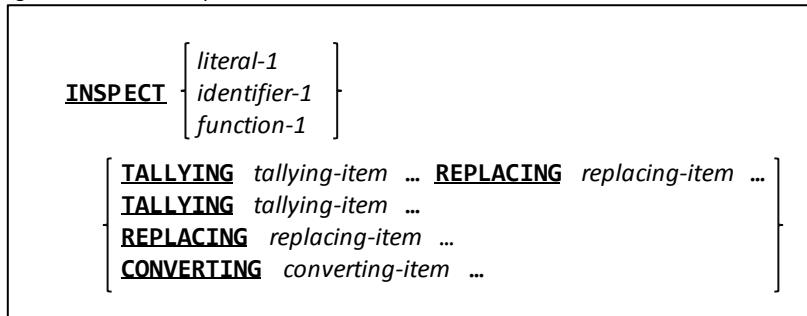
Figure 6-65 - INITIATE Syntax

```
INITIATE report-name-1 ...
```

Although syntactically recognized by the GNU COBOL compiler, the **INITIATE** statement is non-functional because the RWCS (COBOL Report Writer Control System) is not currently supported by GNU COBOL.

## 6.2.24. INSPECT

Figure 6-66 - INSPECT Syntax



The **INSPECT** statement is used to perform various counting or data-alteration operations against strings.

1. *Identifier-1* and *literal-1* must be explicitly or implicitly defined as alphanumeric **USAGE DISPLAY** data. *Identifier-1* may be a group item. If *function-1* is specified, it must be an invocation of an intrinsic function that returns a string result. This is referred to as the *inspect target*.
2. A **TALLYING** clause will count the number of occurrences of a string of characters in the *inspect target*.
3. A **REPLACING** clause will convert occurrences of strings in the *inspect target* to different (equally-sized) strings (for example, replacing all occurrences of "ABC" by "DEF"). The *inspect target* cannot be a literal or function result when using **REPLACING**.
4. A **CONVERTING** clause will perform any number of single character replacements in the *inspect target*. The *inspect target* cannot be a literal or function result when using **CONVERTING**.
5. If both **TALLYING** and **REPLACING** are specified on the same **INSPECT** statement, the effect will be as if two **INSPECT** statements had been coded – the first performing the **TALLYING** and the second performing the **REPLACING**.

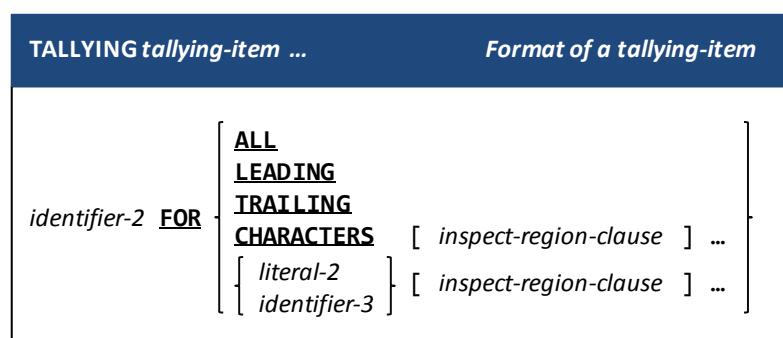
### 6.2.24.1. TALLYING Clause Syntax, Rules and Operation

The purpose of the **TALLYING** clause is to count how many occurrences of one or more strings appear within all or a subset of the *inspect target*.

Each search string is specified using a single *tallying-item* after the **TALLYING** keyword.

The syntax of a single *tallying item* is shown to the right.

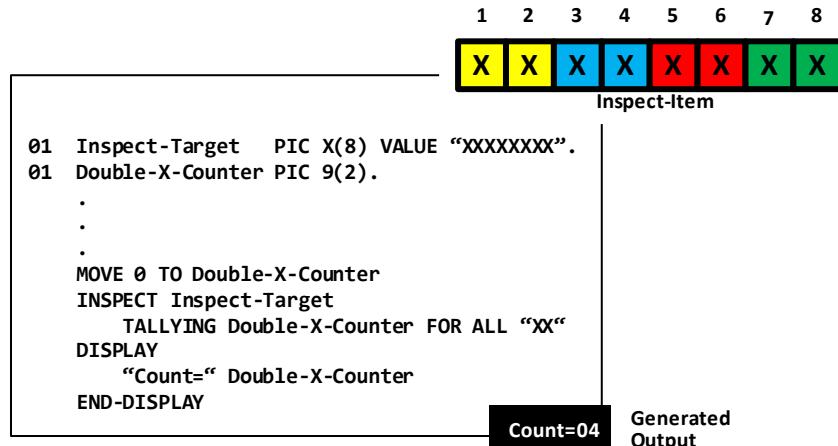
1. *Identifier-2* must be an unedited numeric item.
2. *Identifier-3* and *literal-2* must be explicitly or implicitly defined as alphanumeric **USAGE DISPLAY** data. *Identifier-3* may be a group item.
3. The *inspect-region-clause(s)* limit **TALLYING** processing to a specific subset of the *inspect target*. If no *inspect-region-clause* is specified, the entire *inspect target* will be searched.
4. *Identifier-2* may be specified in multiple *tallying-items*.
5. *Identifier-2* will be incremented by 1 each time the target string being searched for is found within the specified range of the *inspect target*. The target string will be:
  - a. Any single character if the **CHARACTERS** option is used; this form basically just counts total characters
  - b. **ALL**, all **LEADING** or all **TRAILING** occurrences of *Identifier-3* or *literal-2*.



6. Once an occurrence of the target string is found and **TALLYed**, the **INSPECT TALLYING** process will resume from the end of the found occurrence. This prevents the possibility of counting overlapping occurrences.

The example shows an 8-character item whose value is "XXXXXXXX" used as the object of an **INSPECT TALLYING** that is looking for "XX" occurrences:

Figure 6-67 - An INSPECT TALLYING Example



Only four (4) "XX" occurrences were found. Character positions 2-3, 4-5 and 6-7 – even though they are "XX" occurrences – weren't counted because they overlapped other occurrences.

### 6.2.24.2. REPLACING Clause Syntax, Rules and Operation

The purpose of the **REPLACING** clause is to replace occurrences of a substring within the inspect target with a different substring of the same length. If you need to replace one or more substrings with others of a different length, consider using the **SUBSTITUTE** or **SUBSTITUTE-CASE** intrinsic function.

<b>REPLACING</b> <i>replacing-item</i> ...	Format of a <i>replacing-item</i>
<b>CHARACTERS</b> $\left[ \begin{array}{l} \text{ALL} \\ \text{LEADING} \\ \text{FIRST} \\ \text{TRAILING} \end{array} \right] \left[ \begin{array}{l} \text{literal-3} \\ \text{identifier-4} \end{array} \right]$	$\text{BY } \left[ \begin{array}{l} \text{literal-4} \\ \text{identifier-5} \end{array} \right] [ \text{inspect-region-clause} ] \dots$

Each search and replace string is specified using a single *replacing-item* after the **REPLACING** keyword. The syntax of a single *replacing item* is shown above.

1. *Identifier-4* and *literal-3* (known as the **target string**) must be explicitly or implicitly defined as alphanumeric **USAGE DISPLAY** data. *Identifier-4* may be a group item.
2. *Identifier-5* and *literal-4* (known as the **replacement string**) must be explicitly or implicitly defined as alphanumeric **USAGE DISPLAY** data. *Identifier-5* may be a group item.
3. *Identifier-4 / literal-3* must be the same length as *identifier-5 / literal-4*.
4. Target strings are identified as:
  - a. Any sequence of characters as long as the length of the replacement string if the **CHARACTERS** option is used
  - b. **ALL**, all **LEADING**, only the **FIRST** or all **TRAILING** occurrences of *Identifier-4* or *literal-3*.
5. The *inspect-region-clause(s)* limit **REPLACING** processing of any one specific *replacing-item* to a specific region of the inspect target. If no *inspect-region-clause* is specified, the entire inspect target will be processed. Different *replacing-items* may have different regions specified.
6. **REPLACING** processing works as follows:
  - a. Processing begins with the first character of the inspect target an internal character pointer index to the first character position.
  - b. If the internal character pointer is pointing past the end of the inspect target, **REPLACING** processing is complete and the **INSPECT** statement will terminate.

- c. Each replacing-item is checked, in the sequence in which they are coded on the **INSPECT** statement, looking for one whose *inspect-region-clauses* allow its *target-string* to match the substring of the *inspect target* that begins with the current character of that *inspect target* currently being pointed to.
- d. If no replacing-items can match the *inspect target* from the current character position forward, the character pointer is advanced by one and processing returns to rule #6.b.
- e. If a match is found, that *replacing-item*'s replacement-string will replace the target-string in the *inspect target* (starting at the current character position). If the *replacing-item*'s coding specified the **FIRST** option, that *replacing-item* will be disabled for any further iterations during this execution of the **INSPECT** statement. The current character pointer into the *inspect target* will be set to the first character following the replaced string and processing returns to rule #6.b.

**See Also...**The **SUBSTITUTE** Intrinsic Function [6.1.14.77](#)The **SUBSTITUTE-CASE** Intrinsic Function [6.1.14.78](#)

### 6.2.24.3. CONVERTING Clause Syntax, Rules and Operation

The purpose of the **CONVERTING** clause is to perform a series of monocharacter substitutions against a data item.

Each search and replace character sequence is specified using a single *converting-item* after the **CONVERTING** keyword. The syntax of a single *converting item* is shown to the right.

<b>CONVERTING</b> <i>converting-item</i>	<b>Format of a</b> <i>converting-item</i>
	$\left[ \begin{array}{l} \text{literal-5} \\ \text{identifier-6} \end{array} \right] \text{TO} \left[ \begin{array}{l} \text{literal-6} \\ \text{identifier-7} \end{array} \right] [\text{inspect-region-clause}] \dots$

1. *Identifier-6, identifier-7, literal-5 and literal-6* must be explicitly or implicitly defined as alphanumeric **USAGE DISPLAY** data. *Identifier-6* and *identifier-7*, if used, may be group items.
2. *Identifier-6 / literal-5* (the “from string”) should be the same length as *identifier-7 / literal-6* (the “to string”). If they aren’t:
  - a. If the length of the *from string* exceeds the length of the *to string*, then the *to string* will be assumed to be padded to the right with spaces to make them the same length.
  - b. If the length of the *to string* exceeds the length of the *from string*, then the *to string* will be assumed to be truncated to the length of the *from string*.
3. Each character within the *inspect target* that lies within the range limits defined by the *inspect-region-clause(s)*, if any, will be searched for within the *from string*. If found, that *inspect target* character will be replaced by the *to string* character that corresponds (by relative position) to the character found in the *from string*.

### 6.2.24.4. INSPECT Region Clause, Rules and Operation

The purpose of an *inspect-region-clause* is to restrict the operation of a **TALLYING**, **REPLACING** or **CONVERTING** clause to a specific range of characters within the *inspect target*.

If multiple *inspect-region-clauses* are specified, the effects of them as a group will serve to define the range.

<b>Format of an</b> <i>inspect-region-clause</i>
$\left[ \begin{array}{l} \text{BEFORE} \\ \text{AFTER} \end{array} \right] \text{INITIAL} \left[ \begin{array}{l} \text{literal-7} \\ \text{identifier-8} \end{array} \right]$

1. *Identifier-8 and literal-7* must be explicitly or implicitly defined as alphanumeric **USAGE DISPLAY** data. *Identifier-8* may be a group item. They may be of any length.

The following example illustrates how a range clause works and how multiple range clauses can work together. It also illustrates how COBOL syntax allows potentially complicated operations to be coded in an easy-to-understand manner.

```
IDENTIFICATION DIVISION.  
PROGRAM-ID. DemoINSPECT.  
DATA DIVISION.  
WORKING-STORAGE SECTION.  
01 Inspect-Target          PIC X(100) VALUE  
    'THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG ' &  
    'AND WAS BITTEN ON THE TAIL. THE FOX YELPED!'.  
PROCEDURE DIVISION.  
P1. DISPLAY "Before: " Inspect-Target  
    INSPECT Inspect-Target  
        REPLACING ALL "THE" BY "HIS"  
        AFTER INITIAL "BITTEN"  
        BEFORE INITIAL "."  
    DISPLAY "After: " Inspect-Target  
    .
```

When executed, this code produces the following console output (the change made by the **INSPECT** is **highlighted**):

```
Before: THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG AND WAS BITTEN ON THE TAIL. THE FOX YELPED!  
After:  THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG AND WAS BITTEN ON HIS TAIL. THE FOX YELPED!
```

## 6.2.25. MERGE

Figure 6-68 - MERGE Syntax

```

MERGE sort-file-1
  { ON { ASCENDING } KEY identifier-1 ... } ...
  [ WITH DUPLICATES IN ORDER ]
  [ COLLATING SEQUENCE IS alphabet-name-1 ]
  USING file-name-1 file-name-2 ...
  [ GIVING file-name-3 ... ]
  [ OUTPUT PROCEDURE IS procedure-name-1 [ THRU|THROUGH procedure-name-2 ] ]
}

```

The **MERGE** statement merges two or more files that have each been pre-sorted on a set of specified identical keys.

1. The *sort-file-1* named on the **MERGE** statement must be defined using a sort description (**SD**) in the **FILE SECTION** of the **DATA DIVISION**. This file is referred to in the remainder of this discussion as the “*merge work file*”.
2. *File-name-1*, *file-name-2* and *file-name-3* (if specified) must reference **ORGANIZATION LINE SEQUENTIAL** or **ORGANIZATION RECORD BINARY SEQUENTIAL** files. These files must be defined using a file description (**FD**) in the **FILE SECTION** of the **DATA DIVISION**.
3. The *identifier-1* ... field(s) must be defined as field(s) within a record of *sort-file-1*.
4. The **WITH DUPLICATES IN ORDER** clause is supported for compatibility purposes with other versions of COBOL, but is non-functional in GNU COBOL

While any COBOL implementation’s **SORT** or **MERGE** facilities guarantee that records with duplicate key values will be in proper sequence with regard to other records with different key values, they generally make no promises as to the resulting relative sequence of records having duplicate key values with one another.

Some COBOL implementations provide this optional clause to force their **SORT** and **MERGE** facilities to retain duplicate key-value records in their original input sequence, relative to one another.

GNU COBOL always behaves as if the **WITH DUPLICATES IN ORDER** clause is specified, even if it isn’t.

5. The record descriptions of *file-name-1*, *file-name-2*, *file-name-3* (if any) and *sort-file-1* are assumed to be identical in layout and size. While the actual data names used for fields in these files’ records may differ, the structure of records, **PICTURE** of fields, size of fields and **USAGE** of data should match field-by-field across all files.

A common programming technique when using the **MERGE** statement is to define the records of all files involved on the **MERGE** as simple elementary items of the form “**01 record-name PIC X(n)**.” where *n* is the record size. The only file where records are actually described in detail would then be *sort-file-1*.

6. The following rules apply to the files named on the **USING** clause:
  - a. None of them may be **OPEN** at the time the **MERGE** is executed.
  - b. Each of those files is assumed to be already sorted according to the specifications set forth on the **MERGE** statement’s **KEY** clause.
  - c. No two of those files may be referenced on a **SAME RECORD AREA**, **SAME SORT AREA** or **SAME SORT-MERGE AREA** statement specified in the **I-O-CONTROL** paragraph.
7. As the **MERGE** begins execution, the first record in each of the **USING** files is read automatically.
8. As the **MERGE** statement executes, the current record from each of the **USING** files is examined and compared to each other according to the rules set forth by the **KEY** clause. The record that should be “next” in sequence (according to **KEY**) will be written to the merge work file and the **USING** file from which that record came will be read so that its next record is available. As end-of-file conditions are reached on **USING** files, those files will be

- excluded from further **MERGE** processing – processing continues with the remaining **USING** files until all **USING** files have been completely processed.
9. Once the merge work file has been populated, the merged data will be written to *file-name-3* if the **GIVING** clause was specified, or will be processed by utilizing an **OUTPUT PROCEDURE**.
  10. When **GIVING** is specified, none of the *file-name-3* ... files can be **OPEN** at the time the **MERGE** is executed.
  11. When an **OUTPUT PROCEDURE** is used, the procedure(s) specified on the **OUTPUT PROCEDURE** clause will be invoked as if by a procedural **PERFORM** statement with no **VARYING** or **UNTIL** options specified. Merged records may be read from the merge work file – one at a time – within the **OUTPUT PROCEDURE** using the **RETURN** statement.
  12. A **GO TO** statement that transfers control out of the **OUTPUT PROCEDURE** will terminate the **MERGE** but allows the program to continue executing from the point where the **GO TO** transferred control to. Once an **OUTPUT PROCEDURE** has been aborted using a **GO TO** it cannot be resumed, and the contents of the merge work file are lost. You may, however, re-execute the **MERGE** statement itself. **USING A "GO TO" TO PREMATURELY TERMINATE A MERGE, OR RE-STARTING A PREVIOUSLY-CANCELLED MERGE IS NOT CONSIDERED GOOD PROGRAMMING STYLE AND SHOULD BE AVOIDED.**
  13. An **OUTPUT PROCEDURE** is terminated in the same way a procedural **PERFORM** would be. Usually, this action will be taken once the **RETURN** statement indicates that all records in the merge work file have been processed, but termination could occur at any time if required. Once the **OUTPUT PROCEDURE** terminates, the output phase – and the **MERGE** statement itself - is complete.
  14. Neither a Format-1 **SORT** nor another **MERGE** may be executed within the scope of the procedures comprising the **OUTPUT PROCEDURE** unless those statements utilize a different sort or merge work file.

*See Also...*

The I-O-CONTROL Paragraph	<a href="#">4.2.2</a>	The OPEN Statement	<a href="#">6.4.29</a>
Describing the Structure of a File (FD/SD)	<a href="#">5.1</a>	The PERFORM Statement (Procedural)	<a href="#">6.2.30.1</a>
Defining a Data Item's PICTURE	<a href="#">5.2.1.6</a>	The RETURN Statement	<a href="#">6.2.35</a>
Storage Format of Data (USAGE)	<a href="#">5.2.1.11</a>	The SORT Statement (File Sort)	<a href="#">6.4.40.1</a>
The GO TO Statement	<a href="#">6.2.20</a>		

## 6.2.26. MOVE

### 6.2.26.1. MOVE Format 1 – Simple MOVE

Figure 6-69 - Simple MOVE Syntax

```
MOVE [ literal-1 ] identifier-1 TO identifier-2 ...
```

This statement moves a specific value to one or more receiving data items.

1. The **MOVE** statement will replace the contents of one or more receiving data items (*identifier-2* ...) with a new value – the one specified by *literal-1* or *identifier-1*.
2. Only numeric data can be moved to a numeric *identifier-2*. A **MOVE** involving numeric data will perform any necessary format conversions that might be necessary.
3. If *identifier-1* is specified as the source for a **MOVE**, its contents will not be changed<sup>31</sup>.

### 6.2.26.2. MOVE Format 2 – MOVE CORRESPONDING

Figure 6-70 - MOVE CORRESPONDING Syntax

```
MOVE CORRESPONDING identifier-1 TO identifier-2 ...
```

This statement moves similarly-named items from one group item to another.

1. The word **CORRESPONDING** may be abbreviated as **CORR**.
2. Both *identifier-1* and *identifier-2* must be group items.
3. When corresponding matches are established, the effect of a **MOVE CORRESPONDING** on those matches will be as if a series of individual **MOVEs** were done – one for each match.

*See Also...*

The **CORRESPONDING** Clause [6.1.12.2](#)

---

<sup>31</sup> Here's an instance where COBOL's strong dependence on the English language can get the inexperienced programmer into trouble – it probably would have been better for generations of beginning COBOL programmers if this verb had been named "COPY" rather than **MOVE**, as the process of **MOVEing** data from one place to another only affects the data items named after the "TO".

## 6.2.27. MULTIPLY

### 6.2.27.1. MULTIPLY Format 1 – MULTIPLY BY

Figure 6-71 - MULTIPLY BY Syntax

```
MULTIPLY { literal-1 } BY { identifier-2 [ rounding-option ] } ...
[ size-error-clause ]
[ END-MULTIPLY ]
```

1. *Identifier-1* and *identifier-2* must be numeric unedited data items, each *identifier-3* must be a numeric (edited or unedited) data item and *literal-1* and *literal-2* must be numeric literals.

2. The product of *identifier-1* or *literal-1* and each *identifier-2*, in turn, will be computed and moved to each of the *identifier-2* data items, replacing its old contents.
3. The value of *identifier-1* is not altered.
4. The optional “*rounding-option*” clause available to each *identifier-2* will control how non-integer results will be saved.
5. The optional *size-error-clause* may be used to detect arithmetic overflow situations where *identifier-2* is insufficiently sized to hold the generated results; this clause will also detect attempts to divide by zero.

*See Also...*

Handling Size Errors (**ON SIZE ERROR**) [6.1.12.6](#)

Rounding Options [6.1.12.7](#)

### 6.2.27.2. MULTIPLY Format 2 – MULTIPLY GIVING

Figure 6-72 - MULTIPLY GIVING Syntax

```
MULTIPLY { literal-1 } BY { literal-2 }
[ identifier-1 ] [ identifier-2 ]
GIVING { identifier-3 [ rounding-option ] } ...
[ size-error-clause ]
[ END-MULTIPLY ]
```

1. *Identifier-1* and *identifier-2* must be numeric unedited data items, *identifier-3* should be a numeric or numeric-edited data item and *literal-1* must be a numeric literal.

2. The product of *identifier-1* or *literal-1* and *identifier-2* or *literal-2* will be computed and moved to each of the *identifier-2* data item, replacing the old contents.
3. The optional “*rounding-option*” clause available to each *identifier-3* will control how non-integer results will be saved.
4. The optional *size-error-clause* may be used to detect arithmetic overflow situations where *identifier-3* is insufficiently sized to hold the generated results; this clause will also detect attempts to divide by zero.

*See Also...*

Handling Size Errors (**ON SIZE ERROR**) [6.1.12.6](#)

Rounding Options [6.1.12.7](#)

## 6.2.28. NEXT SENTENCE

Figure 6-73 - NEXT SENTENCE Syntax

**NEXT SENTENCE**

The **NEXT SENTENCE** statement is a means of “breaking out” of a series of nested “IF” statements.

1. The **NEXT SENTENCE** statement is valid only when used within the scope of an “IF” statement.
2. As its name implies, this statement causes control to transfer to the next sentence in the program.
3. The **NEXT SENTENCE** statement is needed for COBOL programs that are coded according to pre-1985 standards. Programs coded for 1985 (and beyond) standards don’t need it.
4. New GNU COBOL programs should be coded to use the **END-IF** scope terminator for **IF** statements, which invalidates the use of **NEXT SENTENCE** in favor of the **CONTINUE** statement.

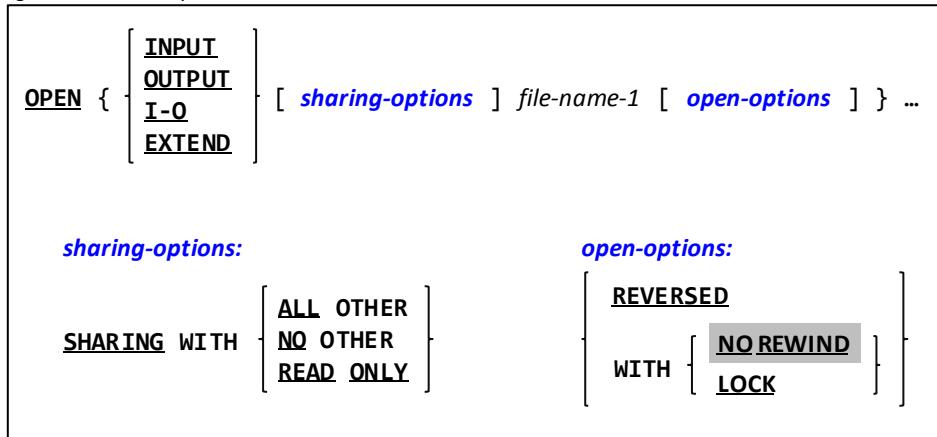
*See Also...*

Use of Periods (.) [6.1.5](#)

The **CONTINUE** Statement [6.4.10](#)

## 6.2.29. OPEN

Figure 6-74 - OPEN Syntax



The OPEN statement makes one or more files described in your program available for use.

1. Any file defined in a GNU COBOL program must be successfully **OPENed** before it or any of its record descriptions may be referenced on a **CLOSE**, **DELETE**, **READ**, **REWRITE**, **START**, **UNLOCK** or **WRITE** statement. Additionally, a file must be successfully **OPENed** for any of its record data names (or data elements subordinate to those records) to be referenced on any statement other than a **MERGE** or **SORT**.
2. Any attempt to **OPEN** a file that is already **OPEN** will fail with a **FILE STATUS** of 41 ("File Already OPEN"). This is a fatal error that will terminate the program.
3. Any **OPEN** failure (including "File Already OPEN") may be trapped using **DECLARATIVES** or an error procedure established using the **CBL\_ERROR\_PROC** built-in subroutine. When either of these trap routines exit, however, the GNU COBOL runtime system will terminate the program. Ultimately, you cannot recover from an **OPEN** failure.
4. The **INPUT**, **OUTPUT**, **I-O** and **EXTEND** options inform GNU COBOL of the manner in which you wish to use the file, as follows:

OPEN Mode	Effect
<b>INPUT</b>	You may only read the existing contents of the file - only the <b>CLOSE</b> , <b>READ</b> , <b>START</b> and <b>UNLOCK</b> statements will be allowed.
<b>OUTPUT</b>	You may only write new content (which will completely replace any previous file contents) to the file - only the <b>CLOSE</b> , <b>UNLOCK</b> and <b>WRITE</b> statements will be allowed.
<b>I-O</b>	You may perform any operation you wish against the file - all file I/O statements will be allowed.
<b>EXTEND</b>	You may only write new content (which will be appended after any previously existing file content) to the file - only the <b>CLOSE</b> , <b>UNLOCK</b> and <b>WRITE</b> statements will be allowed.

5. The **SHARING** clause informs GNU COBOL how you are willing to co-exist with any other GNU COBOL programs that may attempt to **OPEN** the same file after your program does.
6. The **WITH NO REWIND** option on the OPEN statement is supported syntactically but is otherwise non-functional. Note that the **CLOSE** statement (section 6.2.7) also has this option, which is supported by GNU COBOL. Devices that would be capable of supporting a **WITH NO REWIND** clause (tape drives) are pretty rare in the environments in which GNU COBOL is intended to operate, and only such a device will be responsive to the **WITH NO REWIND** option.
7. The **WITH LOCK** option will be functional only if your GNU COBOL build can support it. GNU COBOL built for MinGW or native Windows will not, because the Unix "fcntl()" primitive doesn't exist in those environments. GNU COBOL built for Cygwin or Unix will.
8. The **REVERSED** option will be syntactically accepted, but a compilation specifying either the "**-Wobsolete**" or "**-Wall**" options will yield a warning message that **REVERSED** is an obsolete feature.

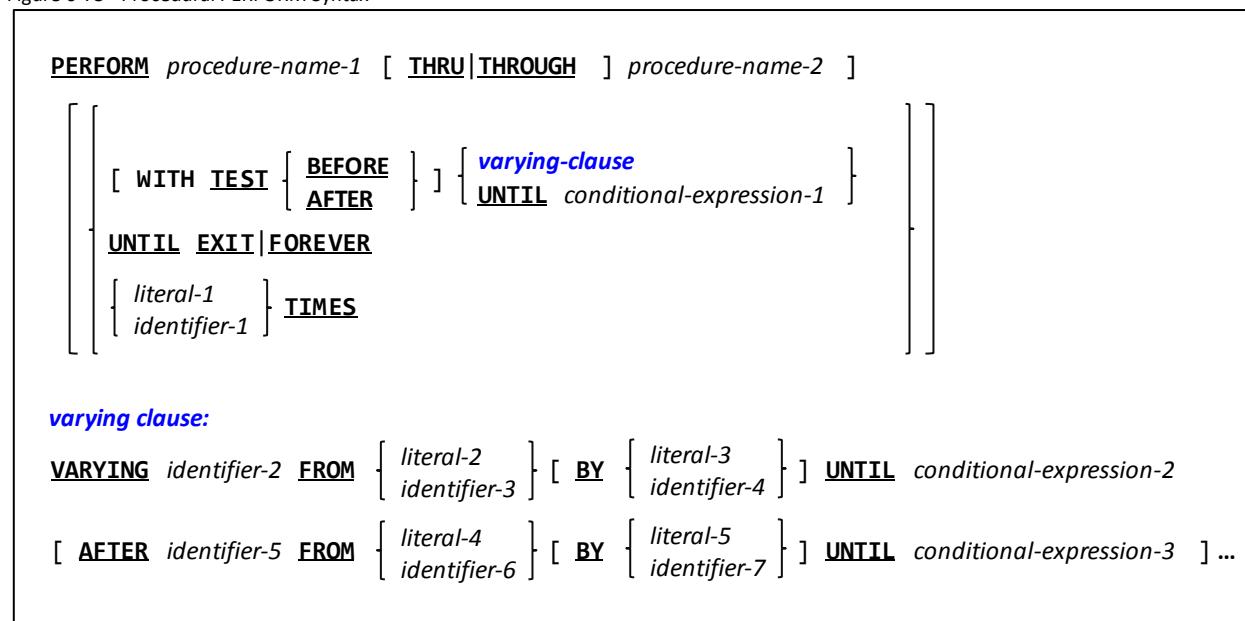
*See Also...*

FILE-STATUS Values	<a href="#">Figure 4-15</a>	The <b>READ</b> Statement	<a href="#">6.4.31</a>
File Sharing	<a href="#">6.1.9.1</a>	The <b>REWRITE</b> Statement	<a href="#">6.4.36</a>
Record Locking	<a href="#">6.1.9.2</a>	The <b>SORT</b> Statement (File Sort)	<a href="#">6.4.40.1</a>
Using <b>DECLARATIVES</b>	<a href="#">6.1.4</a>	The <b>START</b> Statement	<a href="#">6.2.41</a>
The <b>CLOSE</b> Statement	<a href="#">6.4.7</a>	The <b>UNLOCK</b> Statement	<a href="#">6.4.48</a>
The <b>DELETE</b> Statement	<a href="#">6.4.11</a>	The <b>WRITE</b> Statement	<a href="#">6.4.50</a>
The <b>MERGE</b> Statement	<a href="#">6.4.25</a>	The <b>CBL_ERROR_PROC</b> Subroutine	<a href="#">8.3.1.24</a>

## 6.2.30. PERFORM

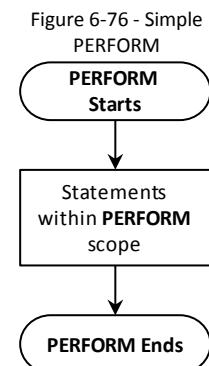
### 6.2.30.1. PERFORM Format 1 – Procedural

Figure 6-75 - Procedural PERFORM Syntax



This format of the **PERFORM** statement is used to transfer control to one or more procedures and to return control when execution of the specified procedure(s) is complete. This invocation of the procedure(s) can be done a single time, multiple times, repeatedly until a condition becomes TRUE or forever (with – presumably – some way of breaking out of the control of the **PERFORM** or of halting program execution within the procedure(s)).

1. The words **THROUGH** and **THRU** may be used interchangeably. Both *procedure-name-1* and *procedure-name-2* must be **PROCEDURE DIVISION** sections or paragraphs defined in the same program as the **PERFORM** statement. If *procedure-name-2* is specified, it must follow *procedure-name-1* in the program's source code. The scope of the **PERFORM** is defined as being the statements within *procedure-name-1*, the statements within *procedure-name-2* and all statements in all procedures defined between them.
2. All *identifier-n* entries shown must be elementary unedited numeric data items. All *literal-n* entries shown must be numeric literals (or references to functions that return a numeric value).
3. Without the **UNTIL**, **TIMES**, **VARYING** or **FOREVER** clauses, the code within the scope of the **PERFORM** will be executed (once) and control will return to the statement following the **PERFORM**. See [Figure 6-76](#).



4. The **UNTIL EXIT** option will repeatedly execute the code within the scope of the **PERFORM** with no conditions defined on the **PERFORM** statement itself for termination of the repetition. It will be up to the programmer to include an **EXIT PERFORM** within the scope of the **PERFORM** that will break out of the loop.
5. The **FOREVER** option has the same effect as **UNTIL EXIT**.

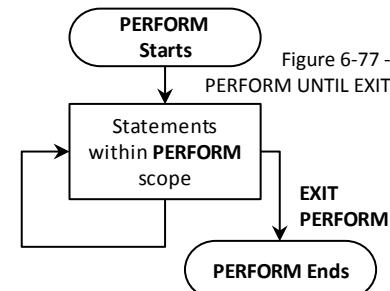


Figure 6-77 - PERFORM UNTIL EXIT

6. The **TIMES** option will repeat the execution of the code within the scope of the **PERFORM** a fixed number of times. When the **PERFORM** statement is executed, the repeat count will be set to the value of *literal-1* or the value within *identifier-1* at the time the **PERFORM** begins execution. Once that number of repetitions has concluded, control will fall into the next statement following the **PERFORM**<sup>32</sup>.

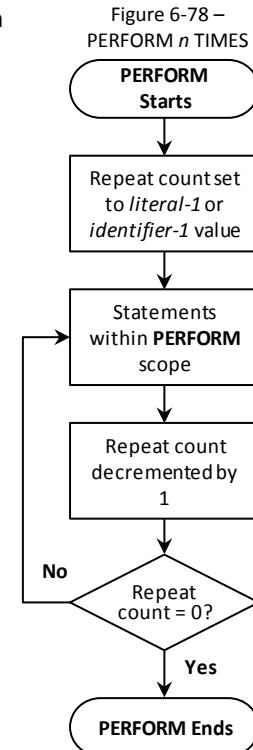
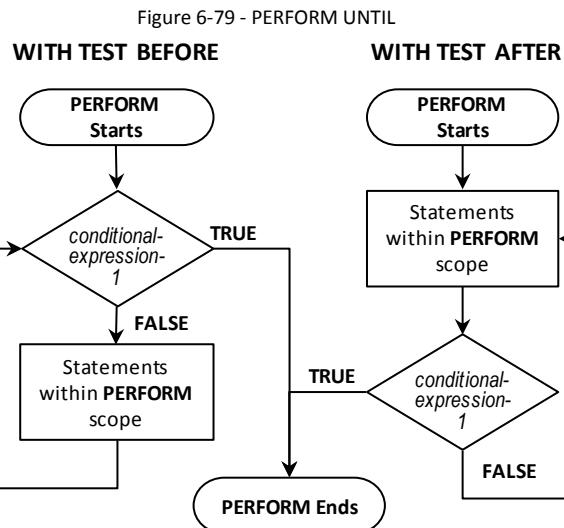


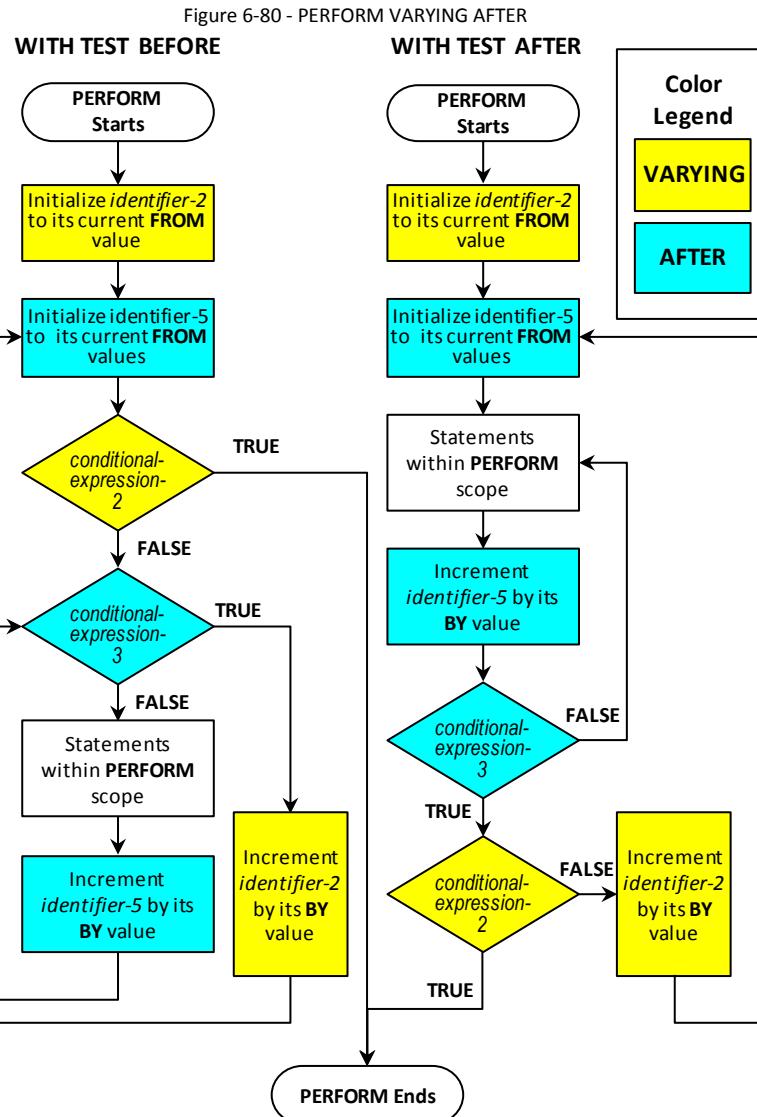
Figure 6-78 – PERFORM n TIMES

<sup>32</sup> Changing the contents of *identifier-1* within the scope of the **PERFORM** will have no effect on the repetition count, as that was determined the moment the **PERFORM** began executing.

7. The “**UNTIL** *conditional-expression-1*” option will repeat the code within the scope of the **PERFORM** until the specified conditional expression evaluates to a TRUE value.
8. The optional **WITH TEST** clause will control whether **UNTIL** testing occurs **BEFORE** the scope of the **PERFORM** is executed on each iteration or **AFTER**. The default, if no **WITH TEST** clause is specified, is **BEFORE**.



9. The **VARYING** clause allows for the definition of a data item (*identifier-2*) that will have a unique numeric value for each iteration of the execution of the statements within the scope of the **PERFORM**.
10. If a **VARYING** clause has been used, you may also use any number of additional **AFTER** clauses to create a secondary loop situation where each **AFTER** will create an additional series of iterations, will define an additional data item to be incremented during each iteration and will define an additional conditional expression to define the termination of that series of iterations. Functionally, this is basically a way of nesting a **PERFORM VARYING** within another **PERFORM VARYING** without the need to code multiple statements.
11. The flowchart in [Figure 6-80](#) shows how **PERFORM VARYING** (with an **AFTER** clause too!) works in both **TEST BEFORE** and **TEST AFTER** modes.



Observe the following code which defines a two-dimensional (3 row by 4 column) table and a pair of numeric data items to be used to subscript references to each element of the table:

```
01 PERFORM-DEMO.
  05 PD-ROW          OCCURS 3 TIMES.
    10 PD-COL        OCCURS 4 TIMES
      15 PD          PIC X(1).
  01 PD-Col-No      PIC 9 COMP.
  01 PD-Row-No      PIC 9 COMP.
```

PD (1, 1)	PD (1, 2)	PD (1, 3)	PD (1, 4)
PD (2, 1)	PD (2, 2)	PD (2, 3)	PD (2, 4)
PD (3, 1)	PD (3, 2)	PD (3, 3)	PD (3, 4)

Let's say we want to PERFORM a routine (100-Visit-Each-PD) which will – in turn – access each PD data item in the sequence shown to the right. Here's the PERFORM code:

```
PERFORM 100-Visit-Each-PD WITH TEST AFTER
  VARYING PD-Row-No FROM 1 BY 1 UNTIL PD-Row-No = 3
    AFTER PD-Col-No FROM 1 BY 1 UNTIL PD-Col-No = 4.
```

1	2	3	4
5	6	7	8
9	10	11	12

But, perhaps you needed to "visit" each PD in the sequence shown to the left. If so, then here's the PERFORM you need:

```
PERFORM 100-Visit-Each-PD WITH TEST BEFORE
  VARYING PD-Col-No FROM 1 BY 1 UNTIL PD-Col-No = 4
    VARYING PD-Row-No FROM 1 BY 1 UNTIL PD-Row-No = 3.
```

1	4	7	10
2	5	8	11
3	6	9	12

As a general rule of thumb, if you use WITH TEST AFTER on a PERFORM, the termination conditions specified on VARYING and AFTER clauses should test the identifier being varied for being EQUAL TO the maximum value it should receive. If you use WITH TEST BEFORE, the termination conditions specified on VARYING and AFTER clauses should test the identifier being varied for being GREATER THAN the maximum value it should receive.

Thus, the two PERFORM examples shown above could have been coded this way:

```
PERFORM 100-Visit-Each-PD WITH TEST BEFORE
  VARYING PD-Row-No FROM 1 BY 1 UNTIL PD-Row-No > 3
    AFTER PD-Col-No FROM 1 BY 1 UNTIL PD-Col-No > 4.
```

- and -

```
PERFORM 100-Visit-Each-PD WITH TEST BEFORE
  VARYING PD-Col-No FROM 1 BY 1 UNTIL PD-Col-No > 4
    VARYING PD-Row-No FROM 1 BY 1 UNTIL PD-Row-No > 3.
```

*See Also...*

Conditional Expressions	<a href="#">6.1.8.2</a>
-------------------------	-------------------------

### 6.2.30.2. PERFORM Format 2 – Inline

Figure 6-81 - Inline PERFORM Syntax

```

PERFORM
  [ [ WITH TEST { BEFORE } ] { varying-clause } ]
    [ UNTIL conditional-expression-1 ]
  [ UNTIL EXIT|FOREVER ]
  [ { literal-1 } identifier-1 ] TIMES
  [ imperative-statement-1 ] ...
[ END-PERFORM ]

varying clause:
VARYING identifier-2 FROM { literal-2 } [ BY { literal-3 } ] UNTIL conditional-expression-2
[ AFTER identifier-5 FROM { literal-4 } [ BY { literal-5 } ] UNTIL conditional-expression-3 ] ...

```

This format of the **PERFORM** statement is identical in operation to format 1, except for the fact that the statements that comprise the scope of the **PERFORM** are now specified in-line with the **PERFORM** code rather than in procedures located elsewhere within the program.

1. The various optional clauses have the same use and effect as in format 1 of the **PERFORM** statement.
2. The distinguishing characteristic of this format versus format 1 is that – with this version of the **PERFORM** statement – the code being executed is specified in-line (*imperative-statement-1 ...*) rather than in one or more separate procedures.

## 6.2.31. READ

### 6.2.31.1. READ Format 1 – Sequential READ

Figure 6-82 – READ (Sequential) Syntax

```
READ file-name-1 [ { NEXT  
PREVIOUS } ] RECORD  
[ INTO identifier-1 ]  
[ { IGNORING LOCK  
WITH LOCK  
WITH KEPT LOCK  
WITH NO LOCK  
WITH IGNORE LOCK  
WITH WAIT } ]  
[ at-end-clause ]  
[ END-READ ]
```

This form of the READ statement retrieves the next (or previous) record from a file.

1. *File-name-1* must currently be **OPEN** for **INPUT** or **I-O**.
2. If the **ACCESS MODE** of *file-name-1* is **RANDOM**, this format of the **READ** statement cannot be used.
3. If the **ACCESS MODE** is **SEQUENTIAL**, this is the only format of **READ** that is available.
4. If the **ACCESS MODE** is **DYNAMIC**, this format of the **READ** statement may be used as well as format 2. The following minimalist **READ** statement...

```
READ file-name-1
```

...is perfectly legal according to both **READ** formats. For that reason, when **ACCESS MODE DYNAMIC** has been specified and you want to tell the GNU COBOL compiler that a statement such as the one above should be treated as a sequential **READ**, you must add either **NEXT** or **PRIOR** to the statement (otherwise it will be treated as a random **READ**).

5. The keywords **NEXT** and **PREVIOUS** specify in what direction of travel the reading process will take through the file. If neither **NEXT** nor **PREVIOUS** clause is specified, **NEXT** is assumed.
6. The **PREVIOUS** option is available only for **ORGANIZATION INDEXED** files.
7. A successful sequential **READ** will retrieve the next available record from *file-name-1*, in either a “next” or “previous” direction from the most-recently-READ record, depending upon the use of the **NEXT** or **PREVIOUS** option. The newly-retrieved record data will be saved into the 01-level record structure(s) that immediately follow the file’s **FD** or **SD**. If the optional **INTO** clause is present, a copy of the just-retrieved record will be automatically **MOVED** to *identifier-1*.
8. The optional **LOCK** options may be used to control access to the file by other programs while this program is running.
9. The optional *at-end-clause* may be used to detect situations where all records in a file have been processed (known as an end-of-file condition). Without using one of these clauses, a program would need to test the returned **FILE STATUS** value after each **READ**.

#### See Also...

Types of Files <a href="#">1.3.3.5</a>	Describing the Structure of a File ( <b>FD/SD</b> ) <a href="#">5.1</a>
Defining File Characteristics ( <b>SELECT</b> ) <a href="#">4.2.1</a>	Record Locking <a href="#">6.1.11.2</a>
FILE-STATUS Values <a href="#">Figure 4-15</a>	Handling End-of-File Conditions ( <b>AT END</b> ) <a href="#">6.1.12.1</a>
	The <b>OPEN</b> Statement <a href="#">6.4.29</a>

### 6.2.31.2. READ Format 2 – Random Read

Figure 6-83 - READ (Random) Syntax

```

READ file-name-1 RECORD
  [ INTO identifier-1 ]
  [ [ IGNORING LOCK
      WITH LOCK
      WITH KEPT LOCK
      WITH NO LOCK
      WITH IGNORE LOCK
      WITH WAIT ] ]
  [ KEY IS identifier-2 ]
  [ invalid-key-clause ]
  [ END-READ ]
```

This form of the **READ** statement retrieves an arbitrary record from a **ORGANIZATION RELATIVE** or **ORGANIZATION INDEXED** file.

1. *File-name-1* must currently be **OPEN** for **INPUT** or **I-O**.
2. If the **ACCESS MODE** of *file-name-1* is **SEQUENTIAL**, this format of the **READ** statement cannot be used.
3. If the **ACCESS MODE** is **RANDOM**, this is the only format of **READ** that is available.
4. If the **ACCESS MODE** is **DYNAMIC**, this format of the **READ** statement may be used as well as format 1. The following minimalist **READ** statement...

**READ** *file-name-1*

...is perfectly legal according to both **READ** formats. For that reason, when **ACCESS MODE DYNAMIC** has been specified for a file, a **READ** statement such as the above will be automatically treated as a random **READ**.

5. The optional **KEY** clause tells the compiler how a record is to be located in the file.

If the **KEY** clause is absent:

If the file is an **ORGANIZATION RELATIVE** file, the contents of the field declared as the file's **RELATIVE KEY** will be used to identify a record. If the file is an **ORGANIZATION INDEXED** file, the contents of the field declared as the file's **RECORD KEY** (section will be used to identify a record.

If the **KEY** clause is specified:

If the file is an **ORGANIZATION RELATIVE** file, the contents of *identifier-2* will be used as the relative record number of the record to be accessed. *Identifier-2* does not have to be the **RELATIVE KEY** field of the file (although it could be if you wish). If the file is an **ORGANIZATION INDEXED** file, *identifier-2* must be the **PRIMARY RECORD KEY** or one of the file's **ALTERNATE RECORD KEY** fields (if any) – the current contents of that field will identify the record to be accessed. If an alternate record key is used, and that key allows duplicate values, the record accessed will be the 1<sup>st</sup> one having that key value.

6. The record identified by rule #5 will be retrieved from *file-name-1*. The newly-retrieved record data will be saved into the 01-level record structure(s) that immediately follow the file's **FD**. If the optional **INTO** clause is present, a copy of the just-retrieved record will be automatically **MOVED** to *identifier-1*.
7. The optional **LOCK** options may be used to control access to the file by other programs while this program is running.

8. The optional *invalid-key-clause* may be used to detect situations where the desired record cannot be read from the file (most likely because no record exists with the specified **RELATIVE KEY** or **RECORD KEY**). Without using one of these clauses, a program would need to test the returned **FILE STATUS** value after each **READ**.

*See Also...*

Types of Files	<a href="#">1.3.3.5</a>	Describing the Structure of a File ( <b>FD/SD</b> )	<a href="#">5.1</a>
Defining File Characteristics ( <b>SELECT</b> )	<a href="#">4.2.1</a>	Handling Invalid Keys ( <b>INVALID KEY</b> )	<a href="#">6.1.12.3</a>
FILE-STATUS Values	<a href="#">Figure 4-15</a>	The <b>OPEN</b> Statement	<a href="#">6.4.29</a>

### 6.2.32. READY TRACE

Figure 6-84 - READY TRACE Syntax

<b>READY TRACE</b>	The <b>READY TRACE</b> verb turns procedure or procedure+statement tracing on.
1. This statement will cause procedure or procedure+statement tracing to be turned on.	
2. In order for this statement to be functional, tracing code must have been generated into the compiled program using either the “-ftrace” (procedures only) or “-ftraceall” (procedures + statements) compiler options.	
3. Tracing may be turned off at any point by executing the <b>RESET TRACE</b> statement (section).	
4. See the <b>COB_SET_TRACE</b> environment variable for another way to control tracing.	

*See Also...*

The **RESET TRACE** Statement [6.4.34](#)

Execution-time Environment Variables [8.2.4](#)

Compiler Switches Reference [8.1.2](#)

### 6.2.33. RELEASE

Figure 6-85 - RELEASE Syntax

```
RELEASE record-name-1 [ FROM { literal-1  
identifier-1 } ]
```

The **RELEASE** statement adds a new record to a *sort work file*.

1. The **RELEASE** statement is valid only within the **INPUT PROCEDURE** of a **SORT** statement.
2. *Record-name-1* must be a record defined to a sort description (**SD**) entry.

*See Also...*

Describing the Structure of a File (**FD/SD**) [5.1](#)

The **SORT** Statement (File Sort) [6.4.40.1](#)

### 6.2.34. RESET TRACE

Figure 6-86 - RESET TRACE Syntax

<b>RESET TRACE</b>	The <b>RESET TRACE</b> verb turns procedure or procedure+statement tracing off.
<ol style="list-style-type: none"><li>1. This statement will cause procedure or procedure+statement tracing to be turned off.</li><li>2. By default, procedure and procedure+statement tracing is OFF as programs begin execution. Use the <b>READY TRACE</b> statement (section) to turn tracing on.</li><li>3. In order for this statement to be functional, tracing code must have been generated into the compiled program using either the “<b>-ftrace</b>” (procedures only) or “<b>-ftraceall</b>” (procedures + statements) compiler options.</li><li>4. See the <b>COB_SET_TRACE</b> environment variable for another way to control tracing.</li></ol>	

*See Also...*

The <b>READY TRACE</b> Statement <a href="#">6.2.32</a>	Execution-time Environment Variables <a href="#">8.2.4</a>
Compiler Switches Reference <a href="#">8.1.2</a>	

## 6.2.35. RETURN

Figure 6-87 - RETURN Syntax

```
RETURN sort-file-name-1 RECORD
  [ INTO identifier-1 ]
  [ at-end-clause ]
  [ END-RETURN ]
```

The **RETURN** statement reads a record from a sort- or merge work file.

1. The **RETURN** statement is valid only within the **OUTPUT PROCEDURE** of a **SORT** or **MERGE** statement.
2. *Sort-file-name-1* must be a sort- or merge work file defined with a sort description (**SD**) entry.
3. A successful **RETURN** will retrieve the next available record from *sort-file-name-1*. The newly-retrieved record data will be saved into the 01-level record structure(s) that immediately follow the file's **SD**. If the optional **INTO** clause is present, a copy of the just-retrieved record will be automatically **MOVED** to *identifier-1*.
4. The optional *at-end-clause* may be used to detect situations where all sorted records have been **RETURNed** (known as an end-of-file condition). Without using one of these clauses, a program would need to test the returned **FILE STATUS** value after each **RETURN**.

*See Also...*

Describing the Structure of a File ( <b>FD/SD</b> ) <a href="#">5.1</a>	The <b>MOVE Statement</b> <a href="#">6.2.26</a>
Handling End-of-File Conditions ( <b>AT END</b> ) <a href="#">6.1.12.1</a>	The <b>SORT Statement (File Sort)</b> <a href="#">6.4.40.1</a>
The <b>MERGE Statement</b> <a href="#">6.4.25</a>	

## 6.2.36. REWRITE

Figure 6-88 - REWRITE Syntax

```
REWRITE record-name-1
  [ FROM { literal-1
    identifier-1 } ]
  [ { WITH LOCK
    WITH NO LOCK } ]
  [ invalid-key-clause ]
  [ END-REWRITE ]
```

The **REWRITE** statement replaces a logical record on a disk file.

1. *Record-name-1* must be defined as an 01-level record subordinate to the File Description of a file that is currently **OPEN** for I-O.
2. The optional **FROM** clause will cause *literal-1* or *identifier-1* to be implicitly **MOVED** into *record-name-1* prior to writing *record-name-1* to the file.
3. The **REWRITE** statement may not be used with **ORGANIZATION IS LINE SEQUENTIAL** files.
4. If the optional **LOCK** clause is omitted, the effect will be as if **WITH NO LOCK** was coded – that is, the rewritten record will not be locked against access by other programs.
5. Rewriting a record does not cause the record contents of the file to be physically updated until the next block of the file is read, a **COMMIT** or **UNLOCK** statement is issued or that file is **CLOSED**.
6. If the file has **ORGANIZATION RECORD BINARY SEQUENTIAL**:
  - a. The record to be rewritten will be the one retrieved by the most-recently executed **READ** of the file.
  - b. If the FD of the file contains the **RECORD CONTAINS / RECORD IS VARYING** clause and it allows record size to vary, the size of *record-name-1* cannot be altered.
7. If the file has **ORGANIZATION RELATIVE** or **ORGANIZATION INDEXED**:
  - a. If the file has **ACCESS MODE SEQUENTIAL**, the record to be rewritten will be the one retrieved by the most-recently executed **READ** of the file. If the file has **ACCESS MODE RANDOM** or **ACCESS MODE DYNAMIC**, no **READ** is required before a record may be rewritten – the **RELATIVE KEY / RECORD KEY** definition for the file will specify the record to be updated.
  - b. The size of *record-name-1* may be updated.
8. The optional *invalid-key-clause* allows the program to detect and recover from attempts to rewrite non-existent records.

### See Also...

Types of Files <a href="#">1.3.3.5</a>	The <b>COMMIT</b> Statement <a href="#">6.4.8</a>
Describing the Structure of a File ( <b>FD/SD</b> ) <a href="#">5.1</a>	The <b>MOVE</b> Statement <a href="#">6.2.26</a>
Record Locking <a href="#">6.1.9.2</a>	The <b>OPEN</b> Statement <a href="#">6.4.29</a>
Handling Invalid Keys ( <b>INVALID KEY</b> ) <a href="#">6.1.12.3</a>	The <b>READ</b> Statement <a href="#">6.4.31</a>
The <b>CLOSE</b> Statement <a href="#">6.4.7</a>	The <b>UNLOCK</b> Statement <a href="#">6.4.48</a>

### 6.2.37. ROLLBACK

Figure 6-89 - ROLLBACK Syntax

A rectangular box containing the word "ROLLBACK" in bold capital letters.

The **ROLLBACK** verb reverts changes made to all files since the start of the program or since the last **COMMIT**.

1. GNU COBOL does not (currently, at least) support file rollback. The GNU COBOL **ROLLBACK** statement will have the same effect as the **COMMIT** verb.

*See Also...*

A rectangular box with a red border containing the text "The COMMIT Statement" followed by a blue link "6.4.8".

## 6.2.38. SEARCH

### 6.2.38.1. SEARCH Format 1 – Sequential Search

Figure 6-90 - Sequential SEARCH Syntax

```
SEARCH table-name-1
  [ VARYING index-name-1 ]
  [ AT END imperative-statement-1 ]
  { WHEN conditional-expression-1 imperative-statement-2 } ...
  [ END-SEARCH ]
```

The **SEARCH** statement is used to sequentially search a table, stopping either once a specific value is located within the table or when the table has been completely searched.

1. The *index-name-1* identifier specified on the **VARYING** clause must be **USAGE INDEX**.
  2. If no **VARYING** clause is specified, then the table being searched must have been created with an **INDEXED BY** clause.
  3. At the time the **SEARCH** statement is executed, the current value of *index-name-1* (or the table's defined **INDEXED BY** index if no **VARYING** clause is specified) will define the starting position in the table where the searching process will begin. Typically, one initializes that index to a value of 1 before starting the **SEARCH**, as follows:
- ```
SET index-name-1 TO 1
```
4. During the searching process, the *conditional-expression-1* will be evaluated and – if TRUE – will cause *imperative-statement-2* to be executed, after which control will fall into the next statement after the **SEARCH**.
  5. If multiple **WHEN** clauses exist, each *conditional-expression-n* will be evaluated in-turn and the first one that evaluates to TRUE will cause the corresponding *imperative-statement-n* to be executed, after which control will fall into the next statement after the **SEARCH**.
  6. If no *conditional-expression-n* evaluates to TRUE, the value of *index-name-1* will be incremented to point to the next entry in the table. If the value of *index-name-1* is still within the **OCCURS** scope of *table-name-1*, the **WHEN** clause(s) will again be re-evaluated. This process will continue until a **WHEN** clause *conditional-expression-n* evaluates to TRUE or until the value of *index-name-1* is no longer within the **OCCURS** scope of *table-name-1*.
  7. If no *conditional-expression-n* ever evaluates to TRUE and the value of *index-name-1* is no longer within the **OCCURS** scope of *table-name*, the *imperative-statement-1* which is part of the **AT END** clause will be executed. After this, control will fall into the next statement following the **SEARCH**. If there is no **AT END** clause, control simply falls into the next statement following the **SEARCH**.

*See Also...*

|                                                                  |                                                         |
|------------------------------------------------------------------|---------------------------------------------------------|
| Defining Tables ( <b>OCCURS</b> ) 0                              | The <b>SET index</b> Statement <a href="#">6.2.39.4</a> |
| Storage Format of Data ( <b>USAGE</b> ) <a href="#">5.2.1.11</a> |                                                         |

## 6.2.38.2. SEARCH Format 2 – Binary, or Half-interval Search (SEARCH ALL)

Figure 6-91 - Binary SEARCH (ALL) Syntax

```
SEARCH ALL table-name-1
  [ AT END imperative-statement-1 ]
  WHEN conditional-expression-1 imperative-statement-2
  [ END-SEARCH ]
```

This format of the **SEARCH** statement performs a binary, or half-interval, search against a sorted table.

1. The definition of *table-name-1* must include the **OCCURS**, **ASCENDING** (and/or **DESCENDING**) **KEY** and **INDEXED BY** clauses.
2. In order for a table to be searchable via the **SEARCH ALL** statement, each of the following must be true:
  - a. The table meets the requirements of rule #1 above.
  - b. Just because the table has one or more **KEY** clauses doesn't mean the data is actually in that sequence in the table – the actual sequence of the data must agree with the **KEY** clause(s)!<sup>33</sup>
  - c. No two records in the table may have the same **KEY** field values. If the table has multiple **KEY** definitions, then no two records in the table may have the same combination of **KEY** field values.

If rule "a" is violated, the compiler will reject the **SEARCH ALL**. If rules "b" and/or "c" are violated, there will be no message issued by the compiler, but the run-time results of a **SEARCH ALL** against the table will probably be incorrect.
3. The *conditional-expression-1* should involve the **KEY** fields, using the table's **INDEXED BY** index name as a subscript.
4. The **WHEN** clause is mandatory, unlike format 1 of the **SEARCH** statement.
5. There can only be one **WHEN** clause specified.
6. The function of the **WHEN** is to compare the key field(s) of the table, as indexed by the table's **INDEXED BY** index data item, against whatever literal and/or identifier values you are searching for in order to locate the desired entry in the table. The table's index will be automatically varied by the **SEARCH ALL** statement in a manner designed to require the minimum number of tests.
7. The internal processing of the **SEARCH ALL** statement begins by setting internal "first" and "last" pointers to the 1<sup>st</sup> and last entry locations of the table. Processing then proceeds as follows<sup>34</sup>:
  - a. The entry half-way between "first" and "last" is identified. We'll call this the "current" entry, and will set its table entry location into *index-name-1*.
  - b. The **WHEN** is evaluated. This comparison of the key(s) against the target literal/identifier values will have one of three possible outcomes:
    - i. If the key(s) and value(s) match, *imperative-statement-2* is executed, after which control falls thru into the next statement following the **SEARCH ALL**.
    - ii. If the key(s) are *LESS THAN* the value(s), then the table entry being searched for can only occur in the "current" to "last" range of the table, so a new "first" pointer value is set (it will be set to the "current" pointer).
    - iii. If the key(s) are *GREATER THAN* the value(s), then the table entry being searched for can only occur in the "first" to "current" range of the table, so a new "last" pointer value is set (it will be set to the "current" pointer).

<sup>33</sup> Of course, if the data sequence doesn't agree with the **KEY** clause, you can easily make it that way using a table **SORT**

<sup>34</sup> This is a simplified view of the algorithm intended purely as a pedagogical tool – an actual implementation of it requires a few additional picky little details to make it work (such as what to do when rule "a" identifies a "current" entry of 12.5!)

- c. If the new “first” and “last” pointers are different than the old “first” and “last” pointers, there’s more left to be searched, so return to step “a” and continue.
- d. If the new “first” and “last” pointers are the same as the old “first” and “last” pointers, the table has been exhausted and the entry being searched for cannot be found; *imperative-statement-1* is executed, after which control falls thru into the next statement following the **SEARCH ALL**. If there is no **AT END** clause coded, control simply falls into the next statement following the **SEARCH ALL**.

The net effect of the above algorithm is that only a fraction of the number of elements in the table need ever be tested in order to decide whether or not a particular entry exists. This is because the **SEARCH ALL** discards half the remaining entries in the table each time it checks an entry.

Computer scientists will compare these two search techniques as follows:

- ▶ A sequential search (format 1) will need an average of  $n/2$  tests and a worst case of  $n$  tests in order to find an entry and  $n$  tests to identify that an entry doesn’t exist ( $n$  = the number of entries in the table).
- ▶ A binary search (format 2) will need worst case of  $\log_2 n$  tests in order to find an entry and  $\log_2 n$  tests to identify that an entry doesn’t exist ( $n$  = the number of entries in the table).

Here’s a more practical view of the difference. Let’s say that a table has 1,000 entries in it. With a sequential (format 1) search, on average, you’ll have to check 500 of them to find an entry and you’ll have to look at all 1,000 of them to find that an entry doesn’t exist. With a binary search, express the number of entries as a binary number ( $1,000_{10} = 111101000_2$ ) and count the number of digits in the result (10) -THAT is the worst-case number of tests required to find an entry or to identify that it doesn’t exist. That’s quite an improvement!

#### *See Also...*

|                                                                  |                                                                 |
|------------------------------------------------------------------|-----------------------------------------------------------------|
| Defining Tables ( <b>OCCURS</b> )    0                           | The <b>SORT</b> Statement (Table Sort) <a href="#">6.4.40.2</a> |
| Storage Format of Data ( <b>USAGE</b> ) <a href="#">5.2.1.11</a> |                                                                 |

## 6.2.39. SET

### 6.2.39.1. SET Format 1 – SET ENVIRONMENT

Figure 6-92 - SET ENVIRONMENT Syntax

```
SET ENVIRONMENT { literal-1 } TO { literal-2 }
```

A **SET ENVIRONMENT** statement provides a straightforward means of setting environment values from within a program.

1. Environment variables created or changed from within GNU COBOL programs will be available to any sub-shell processes spawned by that program (i.e. **CALL "SYSTEM"**) but will not be known to the shell or console window that started the GNU COBOL program.
2. This is a much simpler and more readable means of setting environment variables than by using the **DISPLAY** statement. For example, these two code sequences produce identical results:

```
DISPLAY
  "VARNAME" UPON ENVIRONMENT-NAME
END-DISPLAY
DISPLAY
  "VALUE" UPON ENVIRONMENT-VALUE
END-DISPLAY
```

```
SET ENVIRONMENT "VARNAME" TO "VALUE"
```

*See Also...*

The DISPLAY Statement (Environment) [6.2.12.3](#)

### 6.2.39.2. SET Format 2 – SET Program-Pointer

Figure 6-93 - SET Program Pointer Syntax

```
SET program-pointer-1 TO ENTRY { literal-1 }
```

This form of **SET** allows you to retrieve the address of a **PROCEDURE DIVISION** code module – specifically a declared entry-point into the **PROCEDURE DIVISION**.

1. If you have used other versions of COBOL before (particularly mainframe implementations), you've possibly seen subroutine **CALLs** made passing a **PROCEDURE DIVISION** paragraph or **SECTION** name as an argument – that is not possible in GNU COBOL; instead, you need to know how to use this form of the **SET** statement.
2. The **USAGE** of *program-pointer-1* must be **PROGRAM-POINTER**.
3. The *literal-1* or *identifier-1* value specified must name a primary entry-point name (**PROGRAM-ID** of a subroutine or **FUNCTION-ID** of a user-defined function) or an alternate entry-point defined via an **ENTRY** statement within a subprogram.
4. Once the address of a **PROCEDURE DIVISION** code area has been acquired in this way, the address could be passed to a subroutine (usually written in C) for whatever use it needs it for. For examples of **PROGRAM-POINTERS** at work, see the discussions of the **CBL\_ERROR\_PROC** and **CBL\_EXIT\_PROC** built-in subroutines.

*See Also...*

|                                                                  |                                                               |
|------------------------------------------------------------------|---------------------------------------------------------------|
| Storage Format of Data ( <b>USAGE</b> ) <a href="#">5.2.1.11</a> | The <b>CBL_ERROR_PROC</b> Subroutine <a href="#">8.3.1.24</a> |
| The <b>ENTRY</b> Statement <a href="#">6.2.14</a>                | The <b>CBL_EXIT_PROC</b> Subroutine <a href="#">8.3.1.25</a>  |

### 6.2.39.3. SET Format 3 – SET ADDRESS

Figure 6-94 - SET ADDRESS Syntax

```
SET [ ADDRESS OF ] { pointer-name-1 } ...
                           identifier-1
TO [ ADDRESS OF ] { pointer-name-2 }
                           identifier-2
```

This form of the **SET** statement can be used to work with the addresses of data items rather than their contents.

1. When the **ADDRESS OF** clause is used before the **TO** you will be using the **SET** to alter the address of a **LINKAGE SECTION** or **BASED** data item. Without that clause you will be assigning an address to one or more **USAGE POINTER** data items.
2. When the **ADDRESS OF** clause is used after the **TO**, **SET** will be identifying the address of *identifier-2* as the address to be assigned to *identifier-1* or stored in *pointer-name-1*. If the “**ADDRESS OF**” clause is absent after the **TO**, the contents of *pointer-name-2* will serve as the address to be assigned.

*See Also...*

The DATA DIVISION 5

Storage Format of Data (USAGE) [5.2.1.11](#)

Dynamically Allocated Items (BASED) [5.2.1.2](#)

#### 6.2.39.4. SET Format 4 – SET Index

Figure 6-95 - SET Index Syntax

```
SET index-name-1 TO { literal-1
                           identifier-1 }
```

This **SET** statement assigns a value to a **USAGE INDEX** data item.

*See Also...*

Defining Tables (OCCURS) 0

Storage Format of Data (USAGE) [5.2.1.11](#)

#### 6.2.39.5. SET Format 5 – SET UP/DOWN

Figure 6-96 - SET UP/DOWN Syntax

```
SET identifier-1 { UP
                           DOWN }
BY [ LENGTH OF ] { literal-1
                           identifier-2 }
```

This format of **SET** is used to increment or decrement the value of an index or pointer by a specified amount.

1. The **USAGE** of *identifier-1* must be **INDEX**, **POINTER** or **PROGRAM-POINTER**.

2. The typical usage when *identifier-1* is a **USAGE INDEX** data item is to increment it's value **UP** or **DOWN** by 1, since an **INDEX** is usually being used to sequentially walk through the elements of a table.

*See Also...*

Defining Tables (OCCURS) 0

Storage Format of Data (USAGE) [5.2.1.11](#)

## 6.2.39.6. SET Format 6 – SET Condition Name

Figure 6-97 - SET Condition Name Syntax

```
SET { condition-name-1 } ... TO { TRUE }  
{ FALSE }
```

This format provides one method of specifying the TRUE / FALSE value of a level-88 condition name.

1. By setting the specified condition name(s) to a **TRUE** or **FALSE** value, you will actually be assigning a value to the parent data item(s) to which the condition name data item(s) is subordinate to.
2. When specifying **TRUE**, the value assigned to each parent data item will be the first **VALUE** specified on the condition name's definition.
3. When specifying **FALSE** on the **SET**, the value assigned to each parent data item will be the value specified for the **FALSE** clause of the condition name's definition; if any *condition-name-1* occurrence lacks a **FALSE** clause, the **SET** statement will be rejected by the compiler.

*See Also...*

|                                   |                       |
|-----------------------------------|-----------------------|
| Defining Level-88 Condition Names | <a href="#">5.2.7</a> |
|-----------------------------------|-----------------------|

## 6.2.39.7. SET Format 7 – SET Switch

Figure 6-98 - SET Switch Syntax

```
SET { mnemonic-name-1 } ... TO { ON }  
{ OFF }
```

Use this **SET** statement type to turn a switch **ON** or **OFF**.

1. Switches are defined using the **SPECIAL-NAMES** paragraph.
2. Switches may be tested via the **IF** statement and a *switch-status condition*.

*See Also...*

|                                    |                           |
|------------------------------------|---------------------------|
| The <b>SPECIAL-NAMES</b> Paragraph | <a href="#">4.1.4</a>     |
| Switch-Status Conditions           | <a href="#">6.1.4.2.4</a> |

|                         |                        |
|-------------------------|------------------------|
| The <b>IF</b> Statement | <a href="#">6.2.21</a> |
|-------------------------|------------------------|

## 6.2.39.8. SET Format 8 – SET ATTRIBUTE

Figure 6-99 - SET ATTRIBUTE Syntax

```
SET identifier-1 ATTRIBUTE { BELL  
BLINK  
HIGHLIGHT  
LEFTLINE  
LOWLIGHT  
OVERLINE  
REVERSE-VIDEO  
UNDERLINE } { ON }  
{ OFF }
```

The **SET ATTRIBUTE** statement may be used to modify one or more attributes of a **SCREEN SECTION** data item at run-time.

1. When making an attribute change to *identifier-1*, the change will not become visible on the screen until the **SCREEN SECTION** data item containing *identifier-1* is next **ACCEPTEd** (if *identifier-1* is an input field) or is next **DISPLAYed** (if *identifier-1* is not an input field).

*See Also...*

|                                           |                         |
|-------------------------------------------|-------------------------|
| Defining Screens                          | <a href="#">5.2.2</a>   |
| The <b>ACCEPT</b> Statement (Screen Data) | <a href="#">6.4.1.4</a> |

|                                            |                          |
|--------------------------------------------|--------------------------|
| The <b>DISPLAY</b> Statement (Screen Data) | <a href="#">6.4.12.4</a> |
|--------------------------------------------|--------------------------|

## 6.2.40. SORT

### 6.2.40.1. SORT Format 1 – File-based Sort

Figure 6-100 - File-Based SORT Syntax

```
SORT sort-file-1
  { ON [ ASCENDING | DESCENDING ] KEY identifier-1 ... } ...
    [ WITH DUPLICATES IN ORDER ]
    [ COLLATING SEQUENCE IS alphabet-name-1 ]
    [ USING file-name-1 ...
      INPUT PROCEDURE IS procedure-name-1 [ THRU|THROUGH procedure-name-2 ] ]
    [ GIVING file-name-2 ...
      OUTPUT PROCEDURE IS procedure-name-3 [ THRU|THROUGH procedure-name-4 ] ]
```

This format of the **SORT** statement is designed to sort large volumes of data according to one or more key fields.

1. The *sort-file-1* named on the **SORT** statement must be defined using a sort description (**SD**) in the **FILE SECTION** of the **DATA DIVISION**. This file is referred to as the “sort work file”.
2. If specified, *file-name-1* and *file-name-2* must reference **ORGANIZATION LINE SEQUENTIAL** or **ORGANIZATION RECORD BINARY SEQUENTIAL** files. These files must be defined using a file description (**FD**) in the **FILE SECTION** of the **DATA DIVISION**. The same file(s) may be used for *file-name-1* and *file-name-2*.
3. The *identifier-1 ...* field(s) must be defined as field(s) within a record of *sort-file*.
4. The **WITH DUPLICATES IN ORDER** clause is supported for compatibility purposes with other versions of COBOL, but is non-functional in GNU COBOL

While any COBOL implementation’s **SORT** or **MERGE** facilities guarantee that records with duplicate key values will be in proper sequence with regard to other records with different key values, they generally make no promises as to the resulting relative sequence of records having duplicate key values with one another.

Some COBOL implementations provide this optional clause to force their **SORT** and **MERGE** facilities to retain duplicate key-value records in their original input sequence, relative to one another.

GNU COBOL always behaves as if the **WITH DUPLICATES IN ORDER** clause is specified, even if it isn’t.

5. A sort work file (see #1) is never **OPENed** or **CLOSEd**.
6. The **SORT** statement works in three stages, as follows:

#### STAGE I (the input phase):

- a. The data to be sorted is loaded into the sort file. This is accomplished either by taking the entire contents of the file(s) named on the **USING** clause or by utilizing an **INPUT PROCEDURE** defined as *procedure-name 1* or *procedure-name-1 THRU procedure-name-2*.
- b. When **USING** is specified, *file-name-1 ...* must not be **OPEN** at the time the **SORT** is executed.
- c. When an **INPUT PROCEDURE** is used, the procedure(s) specified on the **INPUT PROCEDURE** clause will be invoked as if by a procedural **PERFORM** statement with no **VARYING** or **UNTIL** options specified. Records will be loaded into the sort work file – one at a time – within the **INPUT PROCEDURE** using the **RELEASE** statement.

As data is loaded into the sort file, it is actually being buffered in dynamically-allocated memory. Only if the amount of data to be sorted exceeds the amount of available sort memory (128 MB)<sup>35</sup> will actual disk files be allocated and utilized. These “sort work files” will be discussed again shortly.

A **GO TO** statement that transfers control out of the **INPUT PROCEDURE** will terminate the **SORT** but allows the program to continue executing from the point where the **GO TO** transferred control to. Once an **INPUT PROCEDURE** has been aborted using a **GO TO** it cannot be resumed, and the contents of the sort work file are lost. You may, however, re-execute the **SORT** statement itself. **USING A “GO TO” TO PREMATURELY TERMINATE A SORT, OR RE-STARTING A PREVIOUSLY-CANCELLED SORT IS NOT CONSIDERED GOOD PROGRAMMING STYLE AND SHOULD BE AVOIDED.**

An **INPUT PROCEDURE** is terminated in the same way a procedural **PERFORM** would be. Once the **INPUT PROCEDURE** terminates, the input phase is complete.

- d. The scope of the **INPUT PROCEDURE** must not allow a file-based **SORT**, **MERGE** or **RETURN** statement to be executed.

#### **STAGE 2 (the sort phase):**

- a. The sort will take place by arranging the data records in the sequence defined by the **ASCENDING KEY** and/or **DESCENDING KEY** specification(s) on the **SORT** statement according to the **COLLATING SEQUENCE** specified on the **SORT** (if any) or – if none was defined – the **PROGRAM COLLATING SEQUENCE** specified or implied by the **OBJECT-COMPUTER** paragraph. Keys may be any supported data type and **USAGE** except for level-78 or level-88 data items.

For example, let’s assume we’re sorting a series of financial transactions. The **SORT** statement might look like this:

```
SORT Sort-File
  ASCENDING KEY Transaction-Date
  ASCENDING KEY Account-Number
  DESCENDING KEY Transaction-Amount
  .
  .
  .
```

The effect of this statement will be to sort all transactions into ascending order of the date the transaction took place (oldest first, newest last). Unless the business running this program is going out of business, there are most-likely many transactions for any given date – therefore, within each grouping of transactions all with the same date, transactions will be sub-sorted into ascending sequence of the account number the transactions apply to. Since it’s quite possible there might be multiple transactions for an account on any given date, a third level sub-sort will arrange all transactions for the same account on the same date into descending sequence of the actual amount of the transaction (largest first, smallest last). If two or more transactions of \$100.00 were recorded for account #12345 on the 31<sup>st</sup> of August 2009, those transactions will be retained in the order in which they were read from the **USING** file(s) or were **RELEASED** to the **SORT**.

#### **Stage 3 (the output phase):**

- a. Once the sort phase is complete, a copy of the sorted data will be written to each *file-name-2* if the **GIVING** clause was specified. When **GIVING** is specified, none of the *file-name-2* files can be **OPEN** at the time the **SORT** is executed.
- b. When an **OUTPUT PROCEDURE** is used, the procedure(s) specified on the **OUTPUT PROCEDURE** clause will be invoked as if by a procedural **PERFORM** statement with no **VARYING** or **UNTIL** options specified. Records will be retrieved from the sort work file – one at a time and in sorted sequence – within the **INPUT PROCEDURE** using the **RETURN** statement.

A **GO TO** statement that transfers control out of the **OUTPUT PROCEDURE** will terminate the **SORT** but allows the program to continue executing from the point where the **GO TO** transferred control to. Once an **OUTPUT PROCEDURE** has been aborted using a **GO TO** it cannot be resumed. You may, however, re-execute the **SORT**

---

<sup>35</sup> There is a runtime environment variable (COB\_SORT\_MEMORY) that you may use to allocate more or less memory to the sorting process. See section [8.2.4](#).

- statement itself. **USING A “GO TO” TO PREMATURELY TERMINATE A SORT, OR RE-STARTING A PREVIOUSLY-CANCELLED SORT IS NOT CONSIDERED GOOD PROGRAMMING STYLE AND SHOULD BE AVOIDED.**
- c. Once the **OUTPUT PROCEDURE** terminates, the output phase – and the **SORT** statement itself - is complete. Any sorted records that have not yet been **RETURNed** from the sort work file will be lost.
  - d. The scope of the **OUTPUT PROCEDURE** must not allow a file-based **SORT**, **MERGE** or **RELEASE**.
  - 7. Should disk work files be necessary due to the amount of data being sorted, they will be automatically allocated to disk in a folder defined by the **TMPDIR**, **TMP** or **TEMP** environment variables (checked for existence in that sequence). These disk files will be automatically purged upon **SORT** termination or program execution termination (normal or otherwise).

*See Also...*

|                                                     |                          |                                      |                        |
|-----------------------------------------------------|--------------------------|--------------------------------------|------------------------|
| Types of Files                                      | <a href="#">1.3.3.5</a>  | The <b>MERGE</b> Statement           | <a href="#">6.4.25</a> |
| The <b>OBJECT-COMPUTER</b> Paragraph                | <a href="#">4.1.2</a>    | The <b>OPEN</b> Statement            | <a href="#">6.4.29</a> |
| Describing the Structure of a File ( <b>FD/SD</b> ) | <a href="#">5.1</a>      | The <b>RELEASE</b> Statement         | <a href="#">6.2.33</a> |
| Defining Data Items                                 | <a href="#">5.2</a>      | The <b>RETURN</b> Statement          | <a href="#">6.2.35</a> |
| Storage Format of Data ( <b>USAGE</b> )             | <a href="#">5.2.1.11</a> | Execution-time Environment Variables | <a href="#">8.2.4</a>  |
| The <b>CLOSE</b> Statement                          | <a href="#">6.4.7</a>    |                                      |                        |

### 6.2.40.2. SORT Format 2 – Table Sort

Figure 6-101 - Table SORT Syntax

```

SORT table-name-1
  [ ON [ ASCENDING | DESCENDING ] KEY identifier-1 ... ] ...
  [ WITH DUPLICATES IN ORDER ]
  [ COLLATING SEQUENCE IS alphabet-name-1 ]

```

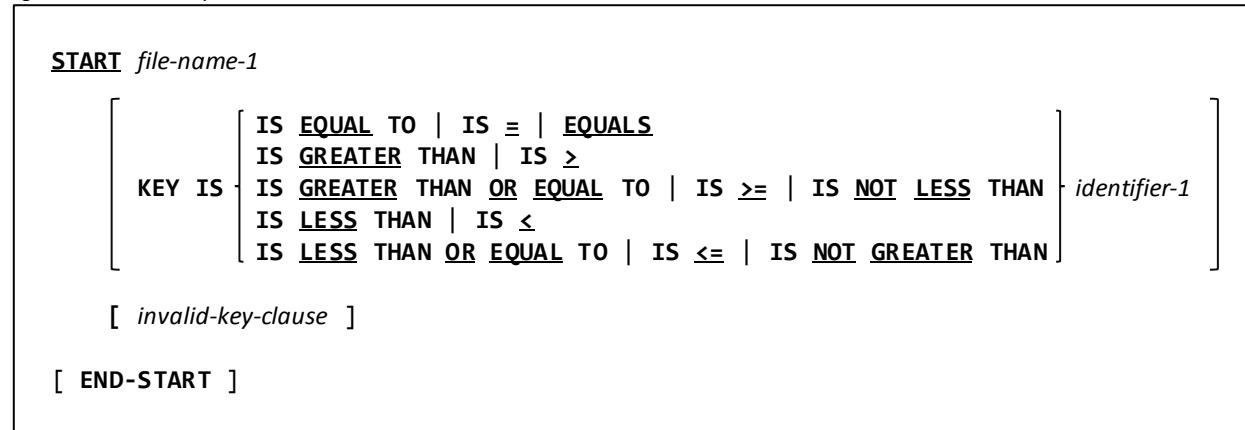
This format of the **SORT** statement sorts relatively small quantities of data – namely data contained in a **DATA DIVISION** table – according to one or more key fields.

1. The *table-name-1* data item must have an **OCCURS** clause in its definition.
2. The *identifier-1 ...* field(s), if any, must be defined as data items subordinate to *table-name-1*.
3. The **WITH DUPLICATES IN ORDER** clause is supported for compatibility purposes, but is non-functional. See the discussion of this clause in the previous section for more information.
4. The data within *table-name-1* will be sorted in-place (i.e. no sort file is required) according to the **KEY** specification(s) made on the **SORT** statement.
5. Although the specification of **KEY** clause(s) is optional<sup>36</sup>, currently, a table **SORT** with no **KEY** specification(s) made on the **SORT** statement is unsupported by GNU COBOL and will be rejected by the compiler.
6. The sort will take place by arranging the data records in the sequence defined by the **ASCENDING KEY** and/or **DESCENDING KEY** specification(s) on the **SORT** statement according to the **COLLATING SEQUENCE** specified on the **SORT** (if any) or – if none was defined – the **PROGRAM COLLATING SEQUENCE** specified or implied by the **OBJECT-COMPUTER** paragraph. Keys may be any supported data type and **USAGE** except for level-78 or level-88 data items.
7. The **SORT** will be performed in-place within *table-name-1* – no sort file is required.

<sup>36</sup> When lacking a **KEY** clause, according to the COBOL2002 standards, a table sort will use the table's **KEY** clause

## 6.2.41. START

Figure 6-102 - START Syntax



The **START** statement defines the logical starting point within a file for subsequent sequential read operations.

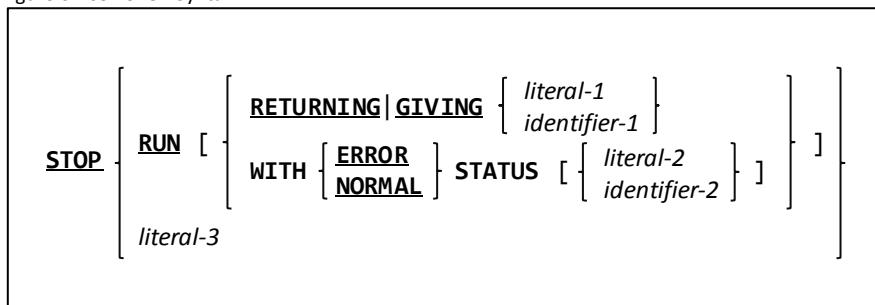
1. *File-name-1* must be an **ORGANIZATION RELATIVE** or **ORGANIZATION INDEXED** file.
2. *File-name-1* must have been **SELECTed** with an **ACCESS MODE DYNAMIC** or **ACCESS MODE SEQUENTIAL**.
3. *File-name-1* must be **OPEN** in either **INPUT** or **I-O** mode at the time the **START** is executed.
4. If no **KEY** clause is specified, “**KEY IS EQUAL TO** *identifier-1*” will be assumed (see the next point for the definition of *identifier-1*).
5. If *file-name-1* is an **ORGANIZATION RELATIVE** file, *identifier-1* must be the defined **RELATIVE KEY** of the file. If *file-name-1* is an **ORGANIZATION INDEXED** file, *identifier-1* must be the defined **RECORD KEY** of the file (if no **KEY** clause was specified) or may be the **RECORD KEY** or any of the **ALTERNATE RECORD KEY** fields for the file if a **KEY** clause is specified.
6. After successful execution of a **START** statement, the internal record pointer into the *file-name-1* data will be positioned such that the next sequential **READ** statement executed against *file-name-1* will read either:
  - a. The first record that satisfies the **KEY** clause specification if the relation check specified is **EQUAL TO**, **GREATER THAN** or **GREATER THAN OR EQUAL TO** (or any of their syntactical equivalents), or ...
  - b. The last record that satisfies the **KEY** clause specification if the relation check specified is **LESS THAN** or **LESS THAN OR EQUAL TO** (or any of their syntactical equivalents).
7. The **START** statement only positions the file for a subsequent sequential **READ** – it does not actually populate *file-name-1*'s 01-level records with new data. You must issue a sequential **READ** after a successful **START** to actually read the record that satisfies the **KEY** clause.
8. The optional *invalid-key-clause* may be used to detect and recover from errors encountered during execution of the **START**. Such errors might be actual I/O errors or “Key Not Exists” errors (**FILE STATUS** 23), indicating no record exists that satisfies the **KEY** clause requirements. Lacking such a clause, you'll need to test the file's **FILE STATUS** data item manually after the **START** in order to determine success or failure.

### See Also...

|                                                                                                                                                                   |                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Types of Files <a href="#">1.3.3.5</a><br>Defining File Characteristics ( <b>SELECT</b> ) <a href="#">4.2.1</a><br>FILE-STATUS Values <a href="#">Figure 4-15</a> | Relation Tests <a href="#">6.1.8.2.5</a><br>The <b>OPEN</b> Statement <a href="#">6.4.29</a><br>The <b>READ</b> Statement <a href="#">6.4.31</a> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|

## 6.2.42. STOP

Figure 6-103 - STOP Syntax



The **STOP** statement halts the program, returning control to the operating system.

1. The **RUN** clause halts the program without displaying any special message to that effect.
  2. The *literal-2* clause displays the specified text on **SYSOUT/STDOUT**, waits for the user to press the **Enter** key and then – once the key has been pressed – allows the program to continue execution.
  3. The optional **RETURNING/GIVING** clause (the **RETURNING** and **GIVING** clauses may be used interchangeably) provides the opportunity to return a numeric value to the operating system (a “return code”). The manner in which the return code may be interrogated by the operating system varies, but Windows can use %ERRORLEVEL% to query the return code while Unix shells such as sh, bash and ksh can query the return code as “\$?”. Other Unix shells may have different ways to access return code values.
  4. The **STATUS** clause provides another means of returning a return code. Using the **STATUS** clause with a literal/identifier specification is functionally equivalent to using the **RETURNING/GIVING** clause.
- Using the **STATUS** clause without a literal/identifier specification will return a return code of 0 if the **NORMAL** keyword is used or a 1 if **ERROR** was specified.
5. Your program will **ALWAYS** return a return code, even if no **RETURNING/GIVING** or **STATUS** clause is specified. In the absence of the use of these clauses, the value in the special register **RETURN-CODE** at the time the **STOP** statement is executed will be used as the return code.
  6. Any programmer-defined exit procedure (established via the **CBL\_EXIT\_PROC** built-in subroutine) will be executed by **STOP RUN**, but not by **STOP literal**.
  7. Valid return code values can be in the range -2147483648 to +2147483647.
  8. The code snippets below are all equivalent – they show different ways in which a GNU COBOL program may be coded to pass a return code value of 16 back to the operating system and then halt.

|                                      |                                                  |
|--------------------------------------|--------------------------------------------------|
| <b>STOP RUN RETURNING 16</b>         | <b>MOVE 16 TO RETURN-CODE</b><br><b>STOP RUN</b> |
| <b>STOP RUN WITH ERROR STATUS 16</b> |                                                  |

### See Also...

|                                                  |                                                              |
|--------------------------------------------------|--------------------------------------------------------------|
| Built-in Device Names <a href="#">Figure 4-8</a> | The <b>CBL_EXIT_PROC</b> Subroutine <a href="#">8.3.1.25</a> |
| Special Registers <a href="#">6.1.13</a>         |                                                              |

## 6.2.43. STRING

Figure 6-104 - STRING Syntax

```

STRING
{ [ literal-1 ] [ DELIMITED BY [ SIZE literal-2 ] ] } ...
    INTO identifier-3
    [ WITH POINTER identifier-4 ]
    [ overflow-clause ]
    [ END-STRING ]

```

The **STRING** statement is used to concatenate all or a part of one or strings together, forming a new string.

1. *Literal-1, literal-2, identifier-1, identifier-2* and *identifier-3* must be explicitly or implicitly defined as alphanumeric **USAGE DISPLAY** data. Any of those identifiers may be group items.
2. *Identifier-4* must be a non-edited elementary integer numeric data item with a value greater than zero.
3. Each *literal-1 / identifier-1* will be known as a sending item.
4. During the processing of the **STRING** statement, data will be copied from each sending item, in turn, into *identifier-3*, one character at a time at a position defined by the *current character pointer*.
5. The initial value of the *current character pointer* will be the value of *identifier-4* at the time the **STRING** statement began execution. If no **WITH POINTER** clause is coded, a value of 1 (meaning "the 1<sup>st</sup> character position") will be assumed for the *current character pointer*.
6. For each sending item, the contents of the sending item will be copied – character-by-character – into *identifier-3* at the character position specified by the *current character pointer*. After a character is copied, the *current character pointer* will be incremented by 1 so that it points to the position within *identifier-3* where the next character should be copied.
7. The **DELIMITED BY** clause specifies how much of each sending item will be copied into the *identifier-3*. **DELIMITED BY SIZE** (the default if no **DELIMITED BY** clause is specified) causes the entire contents of the sending item to be copied into *identifier-3*. Using **DELIMITED BY literal-2** or **DELIMITED BY identifier-2** causes only the contents of the sending item up to but not including the character sequence specified by the literal or identifier to be copied.
8. **STRING** processing will cease when one of the following occurs:
  - a. All sending items have been fully processed, or ...
  - b. The initial value of the *current character pointer* is less than 1, or ...
  - c. The value of the *current character pointer* exceeds the size of *identifier-3* at the point the **STRING** statement wants to copy a character into *identifier-3*
 Events b and c reflect an overflow condition, which may be handled by use of the optional *overflow-clause*. Note that in the case event b occurs, no data will be copied into *identifier-3*.
9. *Identifier-3* is neither automatically initialized (to **SPACES** or any other value) at the start of a **STRING** statement nor will it be **SPACE** filled should the total number of sending item characters copied into it be less than its size. You may explicitly initialize *identifier-3* yourself via the **INITIALIZE** or **MOVE** statements before executing the **STRING** if you wish.

### See Also...

|                                                                   |                                                        |
|-------------------------------------------------------------------|--------------------------------------------------------|
| Storage Format of Data ( <b>USAGE</b> ) <a href="#">5.2.1.11</a>  | The <b>INITIALIZE</b> Statement <a href="#">6.2.22</a> |
| Handling Overflow ( <b>ON OVERFLOW</b> ) <a href="#">6.1.12.5</a> | The <b>MOVE</b> Statement <a href="#">6.2.26</a>       |

## 6.2.44. SUBTRACT

### 6.2.44.1. SUBTRACT Format 1 – SUBTRACT FROM

Figure 6-105 - SUBTRACT FROM Syntax

```
SUBTRACT { literal-1  
          identifier-1 }  
  
FROM { identifier-2 [ rounding-option ] } ...  
[ size-error-clause ]  
[ END-SUBTRACT ]
```

This format of the **ADD** statement generates the arithmetic sum of all arguments that appear before the **FROM** (*identifier-1* or *literal-1*) and subtracts that sum from each *identifier-2*.

1. *Identifier-1* and *identifier-2* must be numeric unedited data items.
2. *Literal-1* must be a numeric literal.
3. The optional “*rounding-option*” clause available to each *identifier-2* will control how non-integer results will be saved.
4. The optional *size-error-clause* may be used to detect arithmetic overflow situations where *identifier-2* is insufficiently sized to hold the generated results.

*See Also...*

Handling Size Errors (**ON SIZE ERROR**) [6.1.12.6](#)

Rounding Options [6.1.12.7](#)

### 6.2.44.2. SUBTRACT Format 2 – SUBTRACT GIVING

Figure 6-106 - SUBTRACT GIVING Syntax

```
SUBTRACT { literal-1  
          identifier-1 }  
  
FROM identifier-2  
  
GIVING { identifier-3 [ rounding-option ] } ...  
[ size-error-clause ]  
[ END-SUBTRACT ]
```

This format of the **SUBTRACT** statement generates the arithmetic sum of all arguments that appear before the **FROM** (*identifier-1* or *literal-1*), subtracts that sum from the contents of *identifier-2* and then replaces the contents of the identifiers listed after the **GIVING** (*identifier-3*) with that result.

1. *Identifier-1* and *identifier-2* must be numeric unedited data items.
2. *Identifier-3* must be a numeric (edited or unedited) data item.
3. *Literal-1* must be a numeric literal.
4. The optional “*rounding-option*” clause available to each *identifier-2* will control how non-integer results will be saved.
5. The optional *size-error-clause* may be used to detect arithmetic overflow situations where *identifier-2* is insufficiently sized to hold the generated results.

*See Also...*

Handling Size Errors (**ON SIZE ERROR**) [6.1.12.6](#)

Rounding Options [6.1.12.7](#)

### 6.2.44.3. SUBTRACT Format 3 – SUBTRACT CORRESPONDING

Figure 6-107 - SUBTRACT CORRESPONDING Syntax

```
SUBTRACT CORRESPONDING identifier-1
    FROM identifier-2 [ rounding-option ]
    [ size-error-clause ]
[ END-SUBTRACT ]
```

This format of the **SUBTRACT** statement generates code equivalent to individual **SUBTRACT FROM** statements for corresponding matches of data items found subordinate to the two identifiers.

4. When corresponding matches are established, the effect of a **SUBTRACT CORRESPONDING** on those matches will be as if a series of individual **SUBTRACT FROM** statements were done – one for each match.
5. The optional “*rounding-option*” clause available to each *identifier-2* will control how non-integer results will be saved.
6. The optional *size-error-clause* may be used to detect arithmetic overflow situations where *identifier-2* is insufficiently sized to hold the generated results.

*See Also...*

The **CORRESPONDING** Clause [6.1.12.2](#)

Rounding Options [6.1.12.7](#)

Handling Size Errors (**ON SIZE ERROR**) [6.1.12.6](#)

## 6.2.45. SUPPRESS

Figure 6-108 - SUPPRESS Syntax



**SUPPRESS PRINTING**

Although syntactically recognized by the GNU COBOL compiler, the **SUPPRESS** statement is non-functional because the RWCS (COBOL Report Writer) is not currently supported by GNU COBOL.

## 6.2.46. TERMINATE

Figure 6-109 - TERMINATE Syntax

```
TERMINATE identifier-1 ...
```

Although syntactically recognized by the GNU COBOL compiler, the **TERMINATE** statement is non-functional because the RWCS (COBOL Report Writer) is not currently supported by GNU COBOL.

## 6.2.47. TRANSFORM

Figure 6-110 - TRANSFORM Syntax

```
TRANSFORM identifier-1 FROM [ literal-1  
                  identifier-2 ] TO [ literal-2  
                  identifier-3 ]
```

The **TRANSFORM** statement scans a data item performing a series of monoalphabetic substitutions, defined by the arguments before and after the “**TO**” clause.

1. Both *literal-1* and/or *literal-2* must be alphanumeric literals.
2. All of *identifier-1*, *identifier-2* and *identifier-3* must either be group items or alphanumeric data items. Data items that are **PICTURE 9 USAGE DISPLAY** are accepted, but will generate warning messages from the compiler.
3. The **TRANSFORM** statement will replace characters within *identifier-1* that are found in the string specified before the **TO** keyword with the corresponding characters from the string specified after the **TO** keyword.
4. This statement exists within GNU COBOL only to provide compatibility with COBOL programs written to pre-1985 standards. The **TRANSFORM** verb was made obsolete in the 1985 standard of COBOL, having been replaced by the **CONVERTING** clause of the **INSPECT** statement. New programs should be coded to use **INSPECT CONVERTING** rather than **TRANSFORM**.

*See Also...*

Defining a Data Item's **PICTURE** [5.2.1.6](#)

The **INSPECT** Statement [6.2.24.3](#)

Storage Format of Data (**USAGE**) [5.2.1.11](#)

## 6.2.48. UNLOCK

Figure 6-111 - UNLOCK Syntax

```
UNLOCK file-name-1 { RECORD }  
{ RECORDS }
```

This statement syncs any as-yet unwritten file I/O buffers to the specified file (if any) and releases any record locks held for records belonging to the named file.

1. If *file-name-1* is a Sort/Merge work file, no action will be taken.
2. Not all GNU COBOL implementations support locking. Whether they do or not depends upon the operating system they were built for and the build options that were used when GNU COBOL was generated.<sup>37</sup> When a program using one of those GNU COBOL implementations issues an **UNLOCK**, it will ignored. There will be no compiler message issued. Buffer syncing, if needed, will still occur.

*See Also...*

Record Locking [6.1.9.1](#)

<sup>37</sup> The author of this manual – for example – uses a GNU COBOL build for Windows that utilizes the MinGW build/runtime environment and uses the Berkeley Database module for advanced file I/O. That GNU COBOL build does NOT support LOCKing. Generally speaking, UNIX builds will support record locking.

## 6.2.49. UNSTRING

Figure 6-112 - UNSTRING Syntax

```
UNSTRING identifier-1
  DELIMITED BY [ [ ALL ] literal-1 ] [ OR [ [ ALL ] literal-2 ] ] ...
    [ INTO { identifier-4 [ DELIMITER IN identifier-5 ] [ COUNT IN identifier-6 ] } ... ]
    [ WITH POINTER identifier-7 ]
    [ TALLYING IN identifier-8 ]
    [ overflow-clause ]
  [ END-UNSTRING ]
```

The **UNSTRING** statement parses a string, extracting any number of substrings from it.

1. *Identifier-1* through *identifier-5* must be explicitly or implicitly defined as alphanumeric **USAGE DISPLAY** data. Any of those identifiers may be group items.
2. *Literal-1* and *literal-2* must be alphanumeric literals.
3. *Identifier-7* and *identifier-8* must be elementary non-edited integer numeric items.
4. *Identifier-7* must have a value greater than 0.
5. *Identifier-1* is known as the *source string*. *Identifier-4* is known as the *destination field*.
6. The source string will be broken up into substrings starting from the character position indicated by *identifier-7* (or from position 1 if there is no **WITH POINTER** clause). If the initial value of *identifier-7* is less than 1 or greater than the size of the source string, an “overflow” condition results. An overflow condition can be detected and dealt with using the optional *overflow-clause*.
7. Substrings are identified by using the various delimiter strings specified on the **DELIMITED BY** clause as inter-substring separators. Using the “**ALL**” option allows a delimiter sequence to be an arbitrarily long sequence of occurrences of the delimiter literal whereas its absence treats each occurrence as a separate delimiter. When multiple delimiters are specified, they will be looked for in the source string in the sequence in which they are coded.
8. Two consecutive delimiter sequences will identify a null substring.
9. Each destination field may have an optional **DELIMITER** clause. If a **DELIMITER** clause is specified, *identifier-5* will have the delimiter character string used to identify the substring for the destination field **MOVED** to it **if and only if** data was actually found for that destination field (if not, *identifier-5* remains unchanged).
10. Each destination field may have an optional **COUNT** clause. If a **COUNT** clause is specified, *identifier-6* will have the size of the substring for the destination field **MOVED** to it **if and only if** data was actually found for that destination field (if not, *identifier-6* remains unchanged).
11. The **TALLYING** clause – if present – will be incremented by 1 each time a parsed substring is **MOVED** to a destination field.
12. None of *identifier-4*, *identifier-5*, *identifier-6*, *identifier-7* or *identifier-8* are initialized by the **UNSTRING** statement. You need to do that yourself via **MOVE** or **INITIALIZE**.

The following sample program illustrates the **UNSTRING** statement.

```

IDENTIFICATION DIVISION.
PROGRAM-ID. DEMOUNSTRING.
DATA DIVISION.
WORKING-STORAGE SECTION.
01 Full-Name          PIC X(40).
01 Parsed-Info.
  05 Last-Name        PIC X(15).
  05 First-Name       PIC X(15).
  05 MI               PIC X(1).
  05 Delim-LN         PIC X(1).
  05 Delim-FN         PIC X(1).
  05 Delim-MI         PIC X(1).
  05 Count-LN          BINARY-CHAR.
  05 Count-FN          BINARY-CHAR.
  05 Count-MI          BINARY-CHAR.
  05 Tallying-Ctr     BINARY-CHAR.

PROCEDURE DIVISION.
P1. PERFORM UNTIL EXIT
  DISPLAY "Enter Full Name (null quits):"
    WITH NO ADVANCING
  ACCEPT Full-Name
  IF Full-Name = SPACES
    EXIT PERFORM
  END-IF
  INITIALIZE Parsed-Info
  UNSTRING Full-Name DELIMITED BY ", "
    OR ","
    OR ALL SPACES
    INTO Last-Name  DELIMITER IN Delim-LN
    COUNT IN Count-LN
    First-Name   DELIMITER IN Delim-FN
    COUNT IN Count-FN
    MI          DELIMITER IN Delim-MI
    COUNT IN Count-MI
    TALLYING Tallying-Ctr
  DISPLAY "First-Name=" First-Name
    " Delim=''" Delim-FN
    "' Count=" Count-FN
  DISPLAY "MI      =" MI " "
    " Delim=''" Delim-MI
    "' Count=" Count-MI
  DISPLAY "Last-Name =" Last-Name
    " Delim=''" Delim-LN
    "' Count=" Count-LN
  DISPLAY "Tally=     " Tallying-Ctr
END-PERFORM
DISPLAY "Bye!"
STOP RUN
.

```

The following is sample output from the program:

```

Enter Full Name (null quits):Cutler, Gary L
First-Name=Gary           Delim=' ' Count=+004
MI      =L                Delim=' ' Count=+001
Last-Name =Cutler         Delim=',' Count=+006
Tally= +003
Enter Full Name (null quits):Snoddgrass,Throckmorton,P
First-Name=Throckmorton  Delim=',' Count=+012
MI      =P                Delim=' ' Count=+001
Last-Name =Snoddgrass     Delim=',' Count=+010
Tally= +003
Enter Full Name (null quits):Munster Herman
First-Name=Herman         Delim=' ' Count=+006
MI      =                 Delim=' ' Count=+000
Last-Name =Munster        Delim=' ' Count=+007
Tally= +002
Enter Full Name (null quits):
Bye!

```

#### See Also...

|                                          |                          |
|------------------------------------------|--------------------------|
| Storage Format of Data ( <b>USAGE</b> )  | <a href="#">5.2.1.11</a> |
| Handling Overflow ( <b>ON OVERFLOW</b> ) | <a href="#">6.1.12.5</a> |

|                                 |                        |
|---------------------------------|------------------------|
| The <b>INITIALIZE</b> Statement | <a href="#">6.2.22</a> |
| The <b>MOVE</b> Statement       | <a href="#">6.2.26</a> |

## 6.2.50. WRITE

Figure 6-113 - WRITE Syntax

```

WRITE record-name-1
  [ FROM { literal-1
    identifier-1 } ]
  [ { WITH LOCK
    WITH NO LOCK } ]
  [ { AFTER
    BEFORE } ADVANCING { { literal-2
    identifier-2 } LINE | LINES
    mnemonic-name-1
    PAGE } ]
  [ AT END-OF-PAGE | EOP imperative-statement-1 ]
  [ NOT AT END-OF-PAGE | EOP imperative-statement-2 ]
  [ invalid-key-clause ]
  [ END-WRITE ]

```

The **WRITE** statement writes a new record to an **OPEN** file.

1. *Record-name-1* must be defined as an 01-level record subordinate to the File Description (**FD**) of a file that is currently **OPEN** for **OUTPUT**, **I-O** or **EXTEND**.
2. *Literal-1* or *identifier-1* must be explicitly or implicitly defined as alphanumeric **USAGE DISPLAY** data. *Identifier-1* may be a group item.
3. The optional **FROM** clause will cause *literal-1* or *identifier-1* to be implicitly **MOVED** into *record-name-1* prior to writing *record-name-1* to the file.
4. The optional **LOCK** clauses allow you to lock the newly-written record (**LOCK**) or to explicitly state that it should not be locked (**NO LOCK**). The default is **WITH NO LOCK**.
5. The optional *invalid-key-clause* is legal only on **WRITE** statements used against **ORGANIZATION RELATIVE** or **ORGANIZATION INDEXED** files; it may be used to detect and recover from situations where a non-zero **FILE STATUS** results from the **WRITE** (as might be the case if you try to **WRITE** a relative file record that already exists (use **REWRITE** instead) or attempt to duplicate a **RECORD KEY** value when **WRITING** to an **INDEXED** file.

The following points apply exclusively to files **SELECTed** and **ASSIGNED** to a **LINE ADVANCING** file, or to files with an **ORGANIZATION** of **LINE SEQUENTIAL**

6. The **ADVANCING** and **END-OF-PAGE** clauses are intended for use only with these types of files. Using this clause with any other **ORGANIZATION** will either be rejected outright by the compiler (**ORGANIZATION IS RELATIVE** or **ORGANIZATION IS INDEXED**) or may introduce unwanted characters into the file (**ORGANIZATION IS RECORD BINARY SEQUENTIAL**).
7. Both of these file types will use an end-of-record delimiter character sequence to signify where one record ends and the next record begins. This delimiter sequence may be any of the following:
  - a. A line-terminator sequence consisting of an ASCII carriage-return/line-feed character sequence (X'0D0A') if you are running a MinGW or native Windows build of GNU COBOL
  - b. A line-terminator sequence consisting of an ASCII line-feed character (X'0A') if you are running a Cygwin, Linix, Unix or OSX build of GNU COBOL
  - c. An ASCII formfeed character
8. If no **ADVANCING** clause is specified on a **WRITE** to an **ORGANIZATION LINE SEQUENTIAL** file, **BEFORE ADVANCING**

The following points apply exclusively to files **SELECTed** and **ASSIGNED** to a **LINE ADVANCING** file, or to files with an **ORGANIZATION** of **LINE SEQUENTIAL**

- 1 **LINE** will be assumed.
9. If no **ADVANCING** clause is specified on a **WRITE** to a **LINE ADVANCING** file, **AFTER ADVANCING 1 LINE** will be assumed.
10. When **BEFORE ADVANCING** is used (or implied), the record is written to the file before the **ADVANCING** action writes line-terminator characters to the file.
11. If **AFTER ADVANCING** is used (or implied), the **ADVANCING** action takes place and then the record data is written to the file.
12. The **ADVANCING n LINES** clause will introduce the specified number of line-terminator character sequences into the file either before the written record (**AFTER ADVANCING**) or after the written record (**BEFORE ADVANCING**).
13. If the **LINAGE** clause is absent from the file's **FD**:
  - a. The **ADVANCING PAGE** clause will introduce an ASCII formfeed character into the file either before the written record (**AFTER PAGE**) or after the written record (**BEFORE ADVANCING**).
  - b. Management of areas on the printed page such as top-of page headers, bottom-of-page footers, dealing with "full page" situations and the like are the complete responsibility of the programmer
14. If the **LINAGE** clause is present in the file's **FD**:
  - a. The **ADVANCING PAGE** clause will introduce the appropriate number of line-terminator character sequences into the file either before the written record (**AFTER ADVANCING**) or after the written record (**BEFORE ADVANCING**) so as to force the printer to automatically advance to a new sheet of paper when the file prints. When LINAGE is specified, no formfeed characters will be generated. Instead, it is assumed that the printer to which the report will be printed will be loaded with special forms with specific characteristics as to page body size (the total number of printable lines on the paper) and skipped top- and/or bottom-of-page margins within which printing physically could occur, but in the case of these forms shouldn't.
  - b. Management of areas on the printed page such as top-of page headers, bottom-of-page footers, dealing with "full page" situations and the like are now the joint responsibility of the programmer and the GNU COBOL run-time library, which provides tools such as the **LINAGE-COUNTER** special; register and the **AT END-OF-PAGE** clause on the **WRITE** statement to deal with page formatting issues.
  - c. The **AT END-OF-PAGE** and **NOT AT END-OF-PAGE** clauses are legal only for **ORGANIZATION LINE SEQUENTIAL** or **ORGANIZATION RECORD BINARY SEQUENTIAL** files whose file descriptions contain a **LINAGE** clause. The **AT END-OF-PAGE** clause will be triggered (thus executing *imperative-statement-1*) if the **WRITE** statement introduces a data line or line-feed character into the file at a line position within the Page Footer area (see [Figure 5-3](#)). The **NOT AT END-OF-PAGE** clause will be triggered (thus executing *imperative-statement-2*) if no end-of-page condition occurred during the **WRITE**.

A report is to be written to a special form that consists of 24 total possible printed lines; the layout of the report is shown to the right.

The GNU COBOL LINAGE clause that describes this layout is as follows. Colors in the code below relate to the colored areas on the page layout.

```
LINAGE IS 20 LINES
FOOTING 19
LINES AT TOP 2
LINES AT BOTTOM 2
```

The total vertical size of the form (as measured in printable lines) is the sum of the **LINES AT TOP**, **LINAGE** and **LINES AT BOTTOM** clause values. The **FOOTING** clause indicates at what relative line number within the

|    |                          |                                                           |    |
|----|--------------------------|-----------------------------------------------------------|----|
| 1  | <b>2 Blank Lines</b>     |                                                           | 1  |
| 2  |                          |                                                           | 2  |
| 3  |                          | <b>2-Line Page Header<br/>(2<sup>nd</sup> line blank)</b> | 3  |
| 4  |                          |                                                           | 4  |
| 5  |                          |                                                           | 5  |
| 6  |                          |                                                           | 6  |
| 7  |                          |                                                           | 7  |
| 8  |                          |                                                           | 8  |
| 9  |                          |                                                           | 9  |
| 10 |                          |                                                           | 10 |
| 11 |                          |                                                           | 11 |
| 12 | <b>20-Line Page Body</b> | <b>16-LINE DETAIL AREA</b>                                | 12 |
| 13 |                          |                                                           | 13 |
| 14 |                          |                                                           | 14 |
| 15 |                          |                                                           | 15 |
| 16 |                          |                                                           | 16 |
| 17 |                          |                                                           | 17 |
| 18 |                          |                                                           | 18 |
| 19 |                          |                                                           | 19 |
| 20 |                          |                                                           | 20 |
| 21 |                          | <b>2-Line Page Footer<br/>(1<sup>st</sup> line blank)</b> | 21 |
| 22 |                          |                                                           | 22 |
| 23 |                          | <b>2 Blank Lines</b>                                      | 23 |
| 24 |                          |                                                           | 24 |

page body (the value specified on the **LINAGE** clause) the detail area is to end and the footer area is to begin. It is at the point where printing reaches this **FOOTING** point that an **END-OF-PAGE** condition exists.

The following program generates a test report (of 25 detail lines) using the page layout just described.

```

IDENTIFICATION DIVISION.
PROGRAM-ID. DEMOLINAGE.
ENVIRONMENT DIVISION.
INPUT-OUTPUT SECTION.
FILE-CONTROL.
  SELECT Data-File      ASSIGN TO
          "linage-ls.txt"
          LINE SEQUENTIAL.

DATA DIVISION.
FILE SECTION.
FD Data-File
  LINAGE IS 20 LINES
  FOOTING 19
  LINES AT TOP 2
  LINES AT BOTTOM 2.

01 Data-Rec.
  05 FILLER           PIC X(7).
  05 DR-Write-No      PIC 9(2).
  05 FILLER           PIC X(28).
  05 DR-LINAGE-COUNTER PIC 9(3).

WORKING-STORAGE SECTION.
01 Flags.
  05 Report-Complete-Flag PIC X(1).
    88 Report-Complete VALUE 'Y' FALSE IS 'N'.
01 I                  PIC 9(2).

PROCEDURE DIVISION.
000-Main.

*>-----
*> Open the report file and print the initial page
*> header
*>-----
OPEN OUTPUT Data-File
  SET Report-Complete TO FALSE
  PERFORM 100-Page-Header
*>-----
*> Print 25 report detail lines
*>-----
  PERFORM VARYING I FROM 1 BY 1 UNTIL I > 25
    MOVE "Detail NN"           LINAGE-COUNTER="
          TO Data-Rec
    MOVE I TO DR-Write-No
    MOVE LINAGE-COUNTER OF Data-File
          TO DR-LINAGE-COUNTER
    WRITE Data-Rec
      AT EOP
        IF LINAGE-COUNTER >= 19
          PERFORM 200-Page-Footer
          PERFORM 100-Page-Header
        ELSE
          PERFORM 100-Page-Header
        END-IF
    END-WRITE
  END-PERFORM
*>-----
*> Print enough blank detail lines to produce the
*> final page footer
*>-----
  SET Report-Complete TO TRUE
  PERFORM UNTIL LINAGE-COUNTER OF DATA-FILE >= 19
    MOVE ''
          LINAGE-COUNTER=
          TO Data-Rec
    MOVE LINAGE-COUNTER OF Data-File
          TO DR-LINAGE-COUNTER
    WRITE Data-Rec
      AT EOP
        PERFORM 200-Page-Footer
        EXIT PERFORM
    END-WRITE
  END-PERFORM

```

And here are the pages of the generated report:

|     |             |                     |
|-----|-------------|---------------------|
| 1.  |             |                     |
| 2.  |             |                     |
| 3.  | Page Header | LINAGE-COUNTER= 001 |
| 4.  |             |                     |
| 5.  | Detail 01   | LINAGE-COUNTER= 003 |
| 6.  | Detail 02   | LINAGE-COUNTER= 004 |
| 7.  | Detail 03   | LINAGE-COUNTER= 005 |
| 8.  | Detail 04   | LINAGE-COUNTER= 006 |
| 9.  | Detail 05   | LINAGE-COUNTER= 007 |
| 10. | Detail 06   | LINAGE-COUNTER= 008 |
| 11. | Detail 07   | LINAGE-COUNTER= 009 |
| 12. | Detail 08   | LINAGE-COUNTER= 010 |
| 13. | Detail 09   | LINAGE-COUNTER= 011 |
| 14. | Detail 10   | LINAGE-COUNTER= 012 |
| 15. | Detail 11   | LINAGE-COUNTER= 013 |
| 16. | Detail 12   | LINAGE-COUNTER= 014 |
| 17. | Detail 13   | LINAGE-COUNTER= 015 |
| 18. | Detail 14   | LINAGE-COUNTER= 016 |
| 19. | Detail 15   | LINAGE-COUNTER= 017 |
| 20. | Detail 16   | LINAGE-COUNTER= 018 |
| 21. |             |                     |
| 22. | Page Footer | LINAGE-COUNTER= 020 |
| 23. |             |                     |
| 24. |             |                     |
| 1.  |             |                     |
| 2.  |             |                     |
| 3.  | Page Header | LINAGE-COUNTER= 001 |
| 4.  |             |                     |
| 5.  | Detail 17   | LINAGE-COUNTER= 003 |
| 6.  | Detail 18   | LINAGE-COUNTER= 004 |
| 7.  | Detail 19   | LINAGE-COUNTER= 005 |
| 8.  | Detail 20   | LINAGE-COUNTER= 006 |
| 9.  | Detail 21   | LINAGE-COUNTER= 007 |
| 10. | Detail 22   | LINAGE-COUNTER= 008 |
| 11. | Detail 23   | LINAGE-COUNTER= 009 |
| 12. | Detail 24   | LINAGE-COUNTER= 010 |
| 13. | Detail 25   | LINAGE-COUNTER= 011 |
| 14. |             |                     |
| 15. |             |                     |
| 16. |             |                     |
| 17. |             |                     |
| 18. |             |                     |
| 19. |             |                     |
| 20. |             |                     |
| 21. |             |                     |
| 22. | Page Footer | LINAGE-COUNTER= 020 |
| 23. |             |                     |
| 24. |             |                     |

```

*>-----
** All done!
*>-----
    CLOSE Data-File
    STOP RUN
.

100-Page-Header.
MOVE "Page Header"           LINAGE-COUNTER="
    TO Data-Rec
MOVE LINAGE-COUNTER OF Data-File TO
    DR-LINAGE-COUNTER
WRITE Data-Rec BEFORE ADVANCING 2 LINES

.
200-Page-Footer.
WRITE Data-Rec FROM SPACES
    BEFORE ADVANCING 1 LINES
MOVE "Page Footer"           LINAGE-COUNTER="
    TO Data-Rec
MOVE LINAGE-COUNTER OF Data-File
    TO DR-LINAGE-COUNTER
IF Report-Complete
*->-----*
*-> "BEFORE 0 LINES" Won't push into the next page
*->-----*
    WRITE Data-Rec BEFORE ADVANCING 0 LINES
ELSE
    WRITE Data-Rec BEFORE ADVANCING PAGE
END-IF
.

```

*See Also...*

|                                                                         |                                                                       |
|-------------------------------------------------------------------------|-----------------------------------------------------------------------|
| Types of Files <a href="#">1.3.3.5</a>                                  | Storage Format of Data ( <b>USAGE</b> ) <a href="#">5.2.1.11</a>      |
| Defining File Characteristics ( <b>SELECT</b> ) <a href="#">4.2.1</a>   | Handling Invalid Keys ( <b>INVALID KEY</b> ) <a href="#">6.1.12.3</a> |
| FILE-STATUS Values <a href="#">Figure 4-15</a>                          | The <b>CLOSE</b> Statement <a href="#">6.4.7</a>                      |
| Describing the Structure of a File ( <b>FD/SD</b> ) <a href="#">5.1</a> | The <b>MOVE</b> Statement <a href="#">6.2.26</a>                      |
| Describing Record Layouts <a href="#">5.1.1</a>                         | The <b>OPEN</b> Statement <a href="#">6.4.29</a>                      |
|                                                                         | The <b>REWRITE</b> Statement <a href="#">6.4.36</a>                   |



## 7. Sub-Programming with GNU COBOL

### 7.1. Subprograms, Subroutines and User-Defined Functions

Simply stated, a **SUBPROGRAM** is a program that is invoked by another program; the subprogram performs whatever its designed operations are and – when complete – typically returns control back to the program that invoked it.

There are two different types of subprograms supported by GNU COBOL – subroutines and user-defined functions. The distinction between these two subprogram types lies in the manner in which they are executed.

When program “A” invokes subprogram “B” as a **SUBROUTINE**, it does so using a special statement dedicated to that function – the **CALL** statement – just as if “B” were one of the built-in system subroutines. When program “A” invokes program “B” as a **USER-DEFINED FUNCTION**, it does so in a manner identical to how “B” would have been invoked had it been one of the many built-in intrinsic functions. In either instance, program “A” is referred to as the **CALLING PROGRAM** while program- “B” is known as the **CALLED PROGRAM**. GNU COBOL programs may be a calling program, a called program or both. A program written in the C programming language may serve as either the calling or called program too. A called program may act as a calling program to a called program. When a calling program does not serve as a called program to any program, that calling program is known as a **MAIN PROGRAM**.

Both subroutines and user-defined functions may return a value. The value they return will be a **USAGE BINARY LONG SIGNED** integer in the range -2147483648 to +2147483647. This value will be available in the register **RETURN-CODE** and also as the value of the data item specified on the **RETURNING/GIVING** clause of a subroutine’s **CALL**.

*See Also...*

|                                         |                          |                             |                       |
|-----------------------------------------|--------------------------|-----------------------------|-----------------------|
| Storage Format of Data ( <b>USAGE</b> ) | <a href="#">5.2.1.11</a> | The <b>CALL</b> Statement   | <a href="#">6.4.5</a> |
| Intrinsic Functions                     | <a href="#">6.1.7</a>    | Built-in System Subroutines | <a href="#">8.3</a>   |
| Special Registers                       | <a href="#">6.1.13</a>   |                             |                       |

### 7.2. Specifying and Using Alternate Entry Points

Any subroutine (but not a user-defined function) may have multiple entry-points defined within it. This means the subroutine could be called either via a “**CALL ‘effective-program-name’**” or a “**CALL ‘entry-point’**” statement. There may be any number of alternate entry-points defined within a subroutine.

The intent of alternate entry-points is to provide multiple ways in which the same subroutine could be **CALLED**, under the assumption that each entry-point will provide some different functionality to the calling program. For example, if you wished to write a subroutine that manipulates “student” records in a database, you might have the primary entry-point name (section 3) be for the coding that retrieves a student record from the database, while the alternate entry points “ADD-STUDENT”, “UPDATE-STUDENT” and “DELETE-STUDENT” provide the alternate functions implied by their entry-point names. The alternative to using multiple entry points in your subroutine, by the way, would be to include an additional argument to the primary (and only) entry point of the subroutine; this new argument might be named “STUDENT-FUNCTION” and might have values of “FETCH”, “ADD”, “UPDATE” or “DELETE”.

The primary entry-point for any subroutine is always the first executable (and non-**DECLARATIVES**) statement in the **PROCEDURE DIVISION**. The name of that entry-point (the name that will be **CALLED**) is the subroutine’s **PROGRAM-ID**.

Alternate entry points are added to a subroutine simply by adding **ENTRY** statements to the subroutine.

When an alternate entry-point is **CALLED**, execution within the subroutine will begin at the first executable statement following the **ENTRY** statement.

*See Also...*

|                                    |                       |                            |                        |
|------------------------------------|-----------------------|----------------------------|------------------------|
| The <b>IDENTIFICATION DIVISION</b> | 3                     | The <b>CALL</b> Statement  | <a href="#">6.4.5</a>  |
| Using <b>DECLARATIVES</b>          | <a href="#">6.1.4</a> | The <b>ENTRY</b> Statement | <a href="#">6.2.14</a> |

### 7.3. Dynamic Versus Static Subprograms

Any subprogram may be either statically or dynamically loaded into memory.

**STATICALLY-LOADED** (or simply **STATIC**) subprograms are part of the same executable file as their calling program and are loaded into memory as part of and at the same time as the calling program. **DYNAMICALLY-LOADED** (or **DYNAMIC**) subprograms exist as an executable file separate from that containing the calling program; these dynamic subprograms are located and loaded into memory the first time they are executed. Dynamic subprograms may be unloaded from memory via the **CANCEL** statement, if desired.

There are no functional differences between static and dynamic subprograms other than how they are compiled and when they are loaded into memory.

Here are the rules about GNU COBOL dynamically-loadable subprogram modules:

1. There may be any number of GNU COBOL subprograms contained within a single dynamically-loadable module.
2. Dynamically-loadable modules will be named “xxxxxxxx.dll” on a Windows system or “xxxxxxxx.so” on a Unix system, where “xxxxxxxx” exactly matches, including the usage of upper- and lower-case letters, the primary entry-point name (**PROGRAM-ID**) or an alternate entry point name defined via the **ENTRY** statement of one of the GNU COBOL programs included in that module.
3. The first time any of the GNU COBOL subprograms in the dynamically-loadable module are invoked, the entry-point referenced must be the one for which the “.dll” or “.so” file is named (see rule #2).
4. The dynamically-loadable module file will be sought in the same directory from which the main program was loaded. If it cannot be found there, each directory named in the PATH that is in-effect for the main program’s execution will be searched. If it still cannot be found, execution will be terminated with an error message (“libcob: Cannot find module ‘xxxxxxxx’”).
5. Once the dynamically-loadable module has been successfully loaded (see rule #3), any of the entry-points contained within it are now available for reference, even if the dynamically-loadable module is subsequently **CANCELED**.

#### See Also...

|                                                   |                                                              |
|---------------------------------------------------|--------------------------------------------------------------|
| The <b>IDENTIFICATION DIVISION</b> 3              | Compiling & Dynamic-Linking Programs <a href="#">8.1.3.2</a> |
| The <b>CANCEL</b> Statement <a href="#">6.2.6</a> | Compiling & Static-Linking Programs <a href="#">8.1.3.3</a>  |
| The <b>ENTRY</b> Statement <a href="#">6.2.14</a> |                                                              |

## 7.4. Subprogram Execution Flow

When a subprogram is invoked, the flow of execution will differ slightly depending on whether the subprogram is a subroutine or a user-defined function.

### 7.4.1. Subroutine Execution Flow

1. The calling program issues a statement of the form **CALL “entry-point” USING ...** to transfer control to the subroutine.
2. The called program will be located. If it is a STATIC subroutine it will already be part of the executable program issuing the **CALL**. If it is a DYNAMIC subroutine, it will be located and loaded as needed.
3. Execution of the calling program is suspended and control will transfer to the called program, as follows:
  - a. If the **PROGRAM-ID** clause of the subprogram included the **INITIAL** clause (section 3), the program will be reinitialized back to its compile-time state.
  - b. **LOCAL-STORAGE**, if any, will be allocated and initialized.
  - c. Execution will begin at the first executable statement following the subprograms entry-point. The entry point will be either:
    - ▶ The top of the **PROCEDURE DIVISION**, following any **DECLARATIVES** that might be present, if the subprogram was invoked using its primary entry-point name.

- ▶ The first executable statement following the **ENTRY** statement naming the entry-point specified on the **CALL** if the subprogram was invoked using an alternate entry point.
4. The flow of execution will then progress through the coding of the subprogram as it would with any other program.
  5. If the subprogram issues a **STOP RUN** statement, program execution ceases and control returns to the operating system or whatever execution monitor invoked the main program.
  6. If the subprogram wishes to return control back to the calling program, it will do so using either the **GOBACK** or **EXIT PROGRAM** statement. At this time:
    - a. If the subprograms **PROCEDURE DIVISION** header or **ENTRY** statements included a **RETURNING** clause, the value of the data item found on that clause is **MOVEd** to the **RETURN-CODE** special register<sup>38</sup>.
    - b. **LOCAL-STORAGE**, if any, is de-allocated.
    - c. If the calling program included a **RETURNING** clause on the **CALL** statement that invoked the subprogram, the value of the “**RETURNING**” data item in the subroutine (see #6.a above) is **MOVEd** to that data item.
    - d. Execution will resume back in the calling program with the first executable statement following the **CALL** that invoked the subprogram.

*See Also...*

|                             |                        |                               |                        |
|-----------------------------|------------------------|-------------------------------|------------------------|
| The IDENTIFICATION DIVISION | 3                      | The ENTRY Statement           | <a href="#">6.2.14</a> |
| The DATA DIVISION           | 5                      | The EXIT PROGRAM Statement    | <a href="#">6.2.16</a> |
| The PROCEDURE DIVISION      | 6                      | The GOBACK Statement          | <a href="#">6.2.19</a> |
| Special Registers           | <a href="#">6.1.13</a> | The STOP RUN Statement        | <a href="#">6.4.42</a> |
| Using DECLARATIVES          | <a href="#">6.1.4</a>  | Dynamic vs Static Subprograms | <a href="#">7.3</a>    |
| The CALL Statement          | <a href="#">6.4.5</a>  |                               |                        |

#### 7.4.2. User-Defined Function Execution Flow

1. The calling program, while in the process of evaluating an expression, encounters a reference to a user-defined function. Note that, unlike the built-in intrinsic functions, user-defined functions need never have the “**FUNCTION**” keyword coded in their references; the reason for this is that any program referencing a user-defined function must include that function in its **REPOSITORY** paragraph – that is sufficient to allow the compiler to recognize the function name as a function when it encounters a reference to it.
2. The called program which is that user-defined function will be located. If it is a STATIC user-defined function it will already be part of the executable program. If it is a DYNAMIC user-defined function, it will be located and loaded. Note that user-defined functions can only have primary entry points – the **ENTRY** statement is not valid within a user-defined function.
3. Execution of the calling program is suspended and control will transfer to the called program, as follows:
  - a. **LOCAL-STORAGE**, if any, will be allocated and initialized.
  - b. Execution will begin at the top of the **PROCEDURE DIVISION**, following any **DECLARATIVES** that might be present.
4. The flow of execution will then progress through the coding of the subprogram as it would with any other program.
5. If the subprogram issues a **STOP RUN** statement, program execution ceases and control returns to the operating system or whatever execution monitor invoked the main program.

<sup>38</sup> This behavior can be altered utilizing the **CALL-CONVENTION** feature of the **SPECIAL-NAMES** paragraph to define a subroutine calling convention that leaves **RETURN-CODE** unchanged, and then using that calling convention on the **CALL** that invokes the subroutine.

6. If the subprogram wishes to return control back to the calling program, it will do so using either the **GOBACK** or **EXIT FUNCTION** statement. At this time:
- The value of the data item found on the user-defined functions **PROCEDURE DIVISION RETURNING** clause is **MOVED** to the **RETURN-CODE** special register.
  - LOCAL-STORAGE**, if any, is de-allocated.
  - Execution will resume back in the calling program at the point in the expression evaluation process where the returned value of the function is needed. At that point, the value in the **RETURN-CODE** special register will be used for the functions value.

**See Also...**

|                                                       |                                                           |
|-------------------------------------------------------|-----------------------------------------------------------|
| The <b>REPOSITORY</b> Paragraph <a href="#">4.1.3</a> | The <b>EXIT FUNCTION</b> Statement <a href="#">6.2.16</a> |
| The <b>DATA DIVISION</b> <a href="#">5</a>            | The <b>GOBACK</b> Statement <a href="#">6.2.19</a>        |
| Special Registers <a href="#">6.1.13</a>              | The <b>STOP RUN</b> Statement <a href="#">6.4.42</a>      |
| Using <b>DECLARATIVES</b> <a href="#">6.1.4</a>       | Dynamic vs Static Subprograms <a href="#">7.3</a>         |
| The <b>ENTRY</b> Statement <a href="#">6.2.14</a>     |                                                           |

## 7.5. Sharing Data Between Calling and Called Programs

### 7.5.1. Subprogram Arguments

#### 7.5.1.1. Calling Program Considerations

Data items defined in a calling program may be passed to either type of called program (subroutine or user-defined function) as **ARGUMENTS**.

Arguments must be described in both the calling and called programs, and should be described in an identical manner with regard to the following characteristics:

- ▶ **PICTURE** (including both type and length)
- ▶ **SIGN**
- ▶ **SYNCHRONIZED**
- ▶ **USAGE**

A subroutine may be passed a maximum of 36 arguments<sup>39</sup>. There is no built-in GNU COBOL limit to how many arguments a user-defined function may be passed.

Whether or not changes made to an argument within a subroutine will be “visible” to the calling program depends on how the argument was passed. There are three ways in which arguments may be passed from a calling program to a subroutine, as defined by the use of optional “**BY**” clauses in the **CALL** statement’s list of arguments.

As an example, the following **CALL** statement passes three arguments to a subroutine – each argument is passed differently.

```
CALL "subroutine" USING BY REFERENCE arg-1
      BY CONTENT arg-2
      BY VALUE arg-3
END-CALL
```

The three ways arguments are passed are as follows.

**BY REFERENCE** When a subroutine argument is passed **BY REFERENCE**, the subroutine is passed the address of the actual data item being passed as an argument. The item may anything defined within the **DATA DIVISION** of the program. If the subroutine modifies the contents of this argument, the calling

<sup>39</sup> If you build the GNU COBOL software yourself from the distributed source, you CAN change this value by altering the defined value of COB\_MAX\_FIELD\_PARAMS in the “common.h” header file.

program will “see” the results of that change when the subroutine returns control. This is the default manner in which GNU COBOL passes arguments to a subroutine, should no “**BY**” clauses be included on the **CALL**.

|                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>BY CONTENT</b> | When a subroutine is passed an argument <b>BY CONTENT</b> , the subroutine is passed the <u>address</u> of a <u>copy</u> of the actual data being passed as an argument. The item may anything defined within the <b>DATA DIVISION</b> of the program. The copy is made each time the <b>CALL</b> statement is executed, immediately before the <b>CALL</b> is actually executed. If the subroutine modifies the contents of this argument, it will be the <u>copy</u> that is modified, not the original data item specified on the <b>CALL</b> ; the calling program will therefore <u>not</u> “see” the results of that change when the subroutine returns control. |
| <b>BY VALUE</b>   | Passing a subroutine argument <b>BY VALUE</b> passes the actual value of the data being passed as an argument. The item may any elementary binary numeric item (see <a href="#">Figure 7-1</a> ) defined within the <b>DATA DIVISION</b> of the program. If the subroutine modifies the contents of this argument, the calling program will <u>not</u> “see” the results of that change when the subroutine returns control.                                                                                                                                                                                                                                           |

The first two ways in which arguments may be passed (**BY REFERENCE** and **BY CONTENT**) are intended for use when a GNU COBOL program, is being called, while the first and third (**BY REFERENCE** and **BY VALUE**) are intended for use when a C program is being called. You can use **BY VALUE** arguments when calling GNU COBOL subroutines, but remember that those arguments are limited to being a numeric binary data type.

Each “**BY**” clause on a **CALL** statement may list multiple arguments.

Arguments to user-defined functions are automatically passed **BY REFERENCE**.

#### See Also...

|                                         |                                                           |
|-----------------------------------------|-----------------------------------------------------------|
| Defining Data Items <a href="#">5.2</a> | Subprograms: Subroutines vs Functions <a href="#">7.1</a> |
|-----------------------------------------|-----------------------------------------------------------|

|                                                 |
|-------------------------------------------------|
| The <b>CALL</b> Statement <a href="#">6.4.5</a> |
|-------------------------------------------------|

### 7.5.1.2. Called Program Considerations

When coding a GNU COBOL subprogram (a subroutine or user-defined function), all arguments to the subprogram must be defined in the subprogram’s **LINKAGE SECTION**. These arguments must be explicitly included on the **PROCEDURE DIVISION** header via a “**USING**” clause that lists the arguments in the sequence in which they will be passed to the subprogram.

These arguments listed in a **USING** clause included on the **PROCEDURE DIVISION** header may each be defined as either “**BY REFERENCE**”, if they are being passed to the subprogram as “**BY REFERENCE**” or “**BY CONTENT**” arguments (on the **CALL**) or as “**BY VALUE**” if they are being passed “**BY VALUE**”. By default, all arguments are assumed to be “**BY REFERENCE**” unless explicitly stated otherwise. Arguments to a user-defined function are always to be specified as “**BY REFERENCE**” (either explicitly or by not using any “**BY**”).

If the subprogram returns a value, the data item in which the value is returned must also be defined in the subprogram’s **LINKAGE SECTION**, with an effective **PICTURE** and **USAGE** of **BINARY-LONG SIGNED**.

#### See Also...

|                                                               |                                                 |
|---------------------------------------------------------------|-------------------------------------------------|
| Defining a Data Item’s <b>PICTURE</b> <a href="#">5.2.1.6</a> | The <b>PROCEDURE DIVISION</b> <a href="#">6</a> |
|---------------------------------------------------------------|-------------------------------------------------|

|                                                                  |
|------------------------------------------------------------------|
| Storage Format of Data ( <b>USAGE</b> ) <a href="#">5.2.1.11</a> |
|------------------------------------------------------------------|

### 7.5.2. GLOBAL Data Items

Another way in which a data item may be shared between a calling program (“A”) and a called program (“B”) is by defining the data item in the calling program and attaching the **GLOBAL** clause to it so that it may be used within the called program. In order for this to work, program “B” (the one called by program “A”) must be a *nested subprogram* within program “A”.

Here's a small example:

| Program Source Code                                                                                                                                                                                                                                                                                                                                                                                                                                           | DISPLAYed Output When Executed |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <pre> IDENTIFICATION DIVISION. PROGRAM-ID. DemoGLOBAL. ENVIRONMENT DIVISION. DATA DIVISION. WORKING-STORAGE SECTION. 01 Arg GLOBAL          PIC X(10). PROCEDURE DIVISION. 000-Main.   MOVE ALL "X" TO Arg   CALL "DemoSub" END-CALL   DISPLAY "DemoGLOBAL: " Arg END-DISPLAY   GOBACK .  IDENTIFICATION DIVISION. PROGRAM-ID. DemoSub. PROCEDURE DIVISION. 000-Main.   MOVE ALL "*" TO Arg.   GOBACK .  END PROGRAM DemoSub.  END PROGRAM DemoGLOBAL. </pre> | DemoGLOBAL: ****               |

*See Also...*

Details of Nested Subprograms [7.6](#)

### 7.5.3. EXTERNAL Data Items

The final way in which a data item may be shared between a calling program ("A") and a called program ("B") is by defining the data item (with the same name) in both programs and attaching the **EXTERNAL** clause to it (again, in both programs). This approach works regardless of whether the called program is nested within the calling program or not. It also works even if the two programs are compiled separately.

Here's a small example:

| Program Source Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | DISPLAYed Output When Executed |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <pre> IDENTIFICATION DIVISION. PROGRAM-ID. DemoEXTERNAL. ENVIRONMENT DIVISION. DATA DIVISION. WORKING-STORAGE SECTION. 01 Arg EXTERNAL          PIC X(10). PROCEDURE DIVISION. 000-Main.   MOVE ALL "X" TO Arg   CALL "DemoSub" END-CALL   DISPLAY "DemoEXTERNAL: " Arg END-DISPLAY   GOBACK .  END PROGRAM DemoEXTERNAL.  IDENTIFICATION DIVISION. PROGRAM-ID. DemoSub. DATA DIVISION. WORKING-STORAGE SECTION. 01 Arg EXTERNAL          PIC X(10). PROCEDURE DIVISION. 000-Main.   MOVE ALL "*" TO Arg.   GOBACK .  END PROGRAM DemoSub. </pre> | DemoEXTERNAL: ****             |

## 7.6. Nested Subprograms

Normally, GNU COBOL source files contain the coding for a single program; that program may be a main program or a subprogram.

There's no reason, however, why you cannot include multiple GNU COBOL programs into a single source file – one after the other – provided you structure the programs in the source file as follows:

**IDENTIFICATION DIVISION.**      Program source code may be concatenated as shown here, provided an  
**PROGRAM-ID.** PROG1.      “**END PROGRAM**” statement naming the **PROGRAM-ID** of the just-completed program is used to separate one program from another.  
...  
...

**IDENTIFICATION DIVISION.**      There's no reason that user-defined functions cannot be included too –  
**PROGRAM-ID.** PROG2.      they'll just have **FUNCTION-IDs** and will be ended by “**END FUNCTION**” statements.  
...  
...

The last program in any GNU COBOL source file need not have an **END PROGRAM** (or **END FUNCTION**) statement.

When multiple programs occur in a source file, it is assumed that the programs are related to one another in that they will be **CALLED** or executed as functions from the others.

It is also possible to create source files where GNU COBOL programs are nested inside each other. Take for example these four GNU COBOL programs:

**IDENTIFICATION DIVISION.**      Here we see that PROG2 is nested inside of PROG1 because there is no  
**PROGRAM-ID.** PROG1.      **END PROGRAM** statement separating them. This means that data items or files defined within PROG1 can be used within PROG2 simply by attaching the “**GLOBAL**” attribute to them back in PROG1 when they are defined.  
...  
**IDENTIFICATION DIVISION.**      Similarly, since there is no **END PROGRAM** statement separating PROG3 from PROG2, it is possible for PROG3 to access GLOBAL files and data items defined within PROG2. Since PROG2 is nested within PROG1, any **GLOBAL** resources defined within PROG1 will be available to PROG3 as well.  
**PROGRAM-ID.** PROG2.  
...  
**IDENTIFICATION DIVISION.**

**PROGRAM-ID.** PROG3.      The two **END PROGRAM** statements for PROG3 and PROG2 (note their sequence) mean that PROG4 is nested within PROG1 only. It will not have access to any **GLOBAL** resources defined within either PROG2 or PROG3.  
...  
**IDENTIFICATION DIVISION.**  
**PROGRAM-ID.** PROG4.  
...  
**IDENTIFICATION DIVISION.**

### See Also...

Program Structure [1.5.2](#)

The CALL Statement [6.4.5](#)

The IDENTIFICATION DIVISION 3

## 7.7. Recursive GNU COBOL Subprograms

It is possible for a subroutine to **CALL** itself, either directly or indirectly from another subroutine that it **CALLS**. Any subroutine that indulges in this sort of behavior (called **RECURSION**) is called a **RECURSIVE SUBROUTINE**. A GNU COBOL subroutine can be recursively invoked *only if it is defined to the GNU COBOL compiler as being a recursive subroutine*. This is accomplished by adding the **RECURSIVE** attribute to the subroutines **PROGRAM-ID** clause.

All User-defined functions can be invoked recursively.

Here is an example of a main program (DEMOFACT) that **CALLS** both a subprogram (RECURSIVESUB) and a user-defined function (RECURSIVEFUNC) to compute the factorial value of a number.

DEMOFACT  
(Main Program)

```

IDENTIFICATION DIVISION.
PROGRAM-ID. DEMOFACT.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
REPOSITORY.
    FUNCTION RECURSIVEFUNC.
DATA DIVISION.
WORKING-STORAGE SECTION.
01 Result      USAGE BINARY-LONG.
01 Arg         USAGE BINARY-LONG VALUE 6.
PROCEDURE DIVISION.
000-Main.
    CALL "RECURSIVESUB"
        USING BY CONTENT Arg
        RETURNING Result
        DISPLAY Arg "!" =
            Result
        DISPLAY Arg "!" =
            RECURSIVEFUNC(Arg)
    GOBACK
    .
END PROGRAM DEMOFACT.

```

| RECURSIVESUB<br>(a RECURSIVE subroutine)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | RECURSIVEFUNC<br>(a user-defined function)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre> IDENTIFICATION DIVISION. PROGRAM-ID. RECURSIVESUB RECURSIVE. DATA DIVISION. WORKING-STORAGE SECTION. 01 Result      USAGE BINARY-LONG. 01 Next-Arg   USAGE BINARY-LONG. 01 Next-Result USAGE BINARY-LONG. LINKAGE SECTION. 01 Arg         USAGE BINARY-LONG. PROCEDURE DIVISION USING Arg RETURNING Result. 000-Main.     DISPLAY "Entering RECURSIVESUB Arg=" Arg     IF Arg = 1         MOVE 1 TO Result         DISPLAY "Leaving RECURSIVESUB Returning "     Result     ELSE         SUBTRACT 1 FROM Arg GIVING Next-Arg         CALL "RECURSIVESUB"             USING BY CONTENT Next-Arg             RETURNING Next-Result         COMPUTE Result = Arg * Next-Result         DISPLAY "Leaving RECURSIVESUB Returning "             Result "==" Arg "*" Next-Result     END-IF     GOBACK     . END PROGRAM RECURSIVESUB. </pre> | <pre> IDENTIFICATION DIVISION. FUNCTION-ID. RECURSIVEFUNC. ENVIRONMENT DIVISION. CONFIGURATION SECTION. REPOSITORY.     FUNCTION RECURSIVEFUNC. DATA DIVISION. WORKING-STORAGE SECTION. LINKAGE SECTION. 01 Arg      USAGE BINARY-LONG. 01 Result  USAGE BINARY-LONG SIGNED. PROCEDURE DIVISION USING Arg RETURNING Result. 000-Main.     DISPLAY "Entering RECURSIVEFUNC Arg=" Arg     IF Arg = 1         MOVE 1 TO Result     ELSE         COMPUTE Result = Arg *                     RECURSIVEFUNC(Arg - 1)     END-IF     DISPLAY "Leaving RECURSIVEFUNC Returning "     Result     GOBACK     . END FUNCTION RECURSIVEFUNC. </pre> |

When DEMOFACT is executed, the output shown to the right is generated.

```

E:\Programs\Demos>demofact
Entering RECURSIVESUB Arg=+0000000006
Entering RECURSIVESUB Arg=+0000000005
Entering RECURSIVESUB Arg=+0000000004
Entering RECURSIVESUB Arg=+0000000003
Entering RECURSIVESUB Arg=+0000000002
Entering RECURSIVESUB Arg=+0000000001
Leaving RECURSIVESUB Returning +0000000001
Leaving RECURSIVESUB Returning +0000000002=+0000000002*+0000000001
Leaving RECURSIVESUB Returning +0000000006=+0000000003*+0000000002
Leaving RECURSIVESUB Returning +0000000024=+0000000004*+0000000006
Leaving RECURSIVESUB Returning +0000000120=+0000000005*+0000000024
Leaving RECURSIVESUB Returning +0000000720=+0000000006*+0000000120
+0000000006! = +0000000720
Entering RECURSIVEFUNC Arg=+0000000006
Entering RECURSIVEFUNC Arg=+0000000005
Entering RECURSIVEFUNC Arg=+0000000004
Entering RECURSIVEFUNC Arg=+0000000003
Entering RECURSIVEFUNC Arg=+0000000002
Entering RECURSIVEFUNC Arg=+0000000001
Leaving RECURSIVEFUNC Returning +000000000001
Leaving RECURSIVEFUNC Returning +000000000002

```

```

Leaving RECURSIVEFUNC Returning +0000000006
Leaving RECURSIVEFUNC Returning +0000000024
Leaving RECURSIVEFUNC Returning +0000000120
Leaving RECURSIVEFUNC Returning +0000000720
+0000000006! = +0000000720

```

*See Also...*

The IDENTIFICATION DIVISION [3](#)

Subprograms: Subroutines vs Functions [7.1](#)

The CALL Statement [6.4.5](#)

## 7.8. Combining COBOL and C Programs

Linkage between GNU COBOL and C language programs is possible, but may require a little bit of special coding in one program or the other in order to meaningfully pass data between them. The issues involved deal predominantly with three topics, as follows. Each issue is discussed, with upcoming coding samples illustrating specifics as to how those issues are overcome in actual program code.

### 7.8.1. GNU COBOL Run-Time Library Requirements

Like most other implementations of the COBOL language, GNU COBOL utilizes a run-time library. When the first program executed in a given execution sequence is a GNU COBOL program, any run-time library initialization will be performed by that COBOL code in a manner that is transparent to the C-language programmer. If, however, a C program is the first to execute, the burden of perform GNU COBOL run-time library initialization falls upon the C program.

### 7.8.2. String Allocation Differences Between GNU COBOL and C

Both languages store strings as a fixed-length continuous sequence of characters.

COBOL stores these character sequences up to a specific quantity limit imposed by the **PICTURE** cause of the data item. For example:

```
01 LastName PIC X(15).
```

There is never an issue of exactly what the length of a string contained in a **USAGE DISPLAY** data item is – there are always exactly how ever many characters as were allowed for by the **PICTURE** clause. In the example above, “LastName” will always contain exactly fifteen characters; of course, there may be anywhere from 0 to 15 trailing **SPACES** as part of the current LastName value.

C actually has no “string” datatype – rather, it stores strings as an array of “char” datatype items where each element of the array is a single character. Being an array, there is an upper limit to how many characters may be stored in a given “string”. For example:

```
char lastName[15]; /* 15 chars: lastName[0] thru lastName[14] */
```

C provides a robust set of string-manipulation functions to copy strings from one char array to another, search strings for certain characters, compare one char array to another, concatenate char arrays and so forth. To make these functions possible, it was necessary to be able to define the logical end of a string. C accomplishes this via the expectation that all strings (char arrays) will be terminated by a NULL character (x'00'). Of course, no one forces a programmer to do this, but if [s]he ever expects to use any of the C standard functions to manipulate that string they had better be doing it.

So, GNU COBOL programmers expecting to pass strings to or receive strings from C programs had best be prepared to deal with the null-termination issue.

*See Also...*

Defining Data Items [5.2](#)

### 7.8.3. Matching C Data Types with GNU COBOL USAGES

This is pretty simple, the GNU COBOL and C programmer must just be aware of the following correspondence between C data types and COBOL USAGE specifications:

Figure 7-1 - C/GNU COBOL Data Type Matches

| This COBOL USAGE...<br>(no PICTURE allowed) | Occupies this<br>space... | Holds these numeric values...                                                            | And corresponds to this C<br>data type...                                               |
|---------------------------------------------|---------------------------|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| BINARY-CHAR                                 | 1 byte                    | 0 to 255                                                                                 | unsigned char                                                                           |
| BINARY-CHAR UNSIGNED                        |                           |                                                                                          |                                                                                         |
| BINARY-CHAR SIGNED                          | 1 byte                    | -128 to +127                                                                             | signed char                                                                             |
| BINARY-SHORT                                | 2 bytes                   | 0 to 65535                                                                               | unsigned                                                                                |
| BINARY-SHORT UNSIGNED                       |                           |                                                                                          | unsigned int                                                                            |
| BINARY-SHORT SIGNED                         | 2 bytes                   | -32768 to +32767                                                                         | unsigned short                                                                          |
|                                             |                           |                                                                                          | unsigned short int                                                                      |
| BINARY-LONG                                 | 4 bytes                   | 0 to 4294967295                                                                          | int                                                                                     |
| BINARY-LONG UNSIGNED                        |                           |                                                                                          | short                                                                                   |
| BINARY-LONG SIGNED                          | 4 bytes                   | -2147483648 to +2147483647                                                               | short int                                                                               |
| BINARY-INT                                  |                           |                                                                                          | signed int                                                                              |
| BINARY-C-LONG SIGNED                        | 4 bytes or 8<br>bytes     | -2147483648 to +2147483647<br>Or<br>-9223372036854775808 to<br>+9223372036854775807      | signed short                                                                            |
| BINARY-DOUBLE                               | 8 bytes                   | 0 to 18446744073709551615                                                                | signed short int                                                                        |
| BINARY-DOUBLE UNSIGNED                      |                           |                                                                                          | long                                                                                    |
| BINARY-DOUBLE SIGNED                        | 8 bytes                   | -9223372036854775808 to<br>+9223372036854775807                                          | long (see the description of<br>USAGE BINARY-C-LONG in<br><a href="#">Figure 5-10</a> ) |
| BINARY-LONG-LONG                            |                           |                                                                                          | long int                                                                                |
| COMPUTATIONAL-1                             | 4 bytes                   | $-3.4 \times 10^{38}$ to $+3.4 \times 10^{38}$<br>(six decimal digits of precision)      | signed long long int                                                                    |
| COMPUTATIONAL-2                             | 8 bytes                   | $-1.7 \times 10^{308}$ to $+1.7 \times 10^{308}$<br>(15 decimal digits of precision)     | signed long long                                                                        |
| N/A (no GNU COBOL<br>equivalent)            | 12 bytes                  | $-1.19 \times 10^{4932}$ to $+1.19 \times 10^{4932}$<br>(18 decimal digits of precision) | double                                                                                  |
|                                             |                           |                                                                                          | long double                                                                             |

There are other GNU COBOL PICTURE/USAGE combinations that can define the same storage size and value range combinations, but (with the exception of COMP-1 and COMP-2), these are the ANSI2002 standard specifications for C-program data compatibility and GNU COBOL programmers should get used to using them when data is being shared with C programs (they're good documentation too, highlighting the fact that the data will be "shared" with a C program).

The minimum values shown for the various SIGNED integer USAGES are appropriate for a computer system that uses 2s-complement representation for negative signed binary values (such as those CPUs typically found in Windows PCs). A computer system using 1s-complement representation for negative signed binary values would have minimum values that are 1 greater (-127 instead of -128, for example).

## 7.8.4. GNU COBOL Main Programs CALLing C Subprograms

Here are samples of a GNU COBOL program that **CALLs** a C subprogram.

Figure 7-2 - GNU COBOL CALLing C

| (maincob.cbl)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | (subc.c)                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| This GNU COBOL MAIN PROGRAM...                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ...wants to CALL this C SubProgram                                                                                                                                                                                                                                                                                                                                               |
| <pre> IDENTIFICATION DIVISION. PROGRAM-ID. maincob. DATA DIVISION. WORKING-STORAGE SECTION. 01 Arg1          PIC X(7). 01 Arg2          PIC X(7). 01 Arg3          USAGE BINARY-LONG. PROCEDURE DIVISION. 000-Main.     DISPLAY 'Starting cobmain'.     MOVE 123456789 TO Arg3.     STRING 'Arg1'         X'00'         DELIMITED SIZE         INTO Arg1     END-STRING.     STRING 'Arg2'         X'00'         DELIMITED SIZE         INTO Arg2     END-STRING.     CALL 'subc' USING BY CONTENT Arg1,             BY REFERENCE Arg2,             BY REFERENCE Arg3.     DISPLAY 'Back'.     DISPLAY 'Arg1=' Arg1.     DISPLAY 'Arg2=' Arg2.     DISPLAY 'Arg3=' Arg3.     DISPLAY 'Returned value='             RETURN-CODE. STOP RUN. </pre> | <pre> #include &lt;stdio.h&gt;  int subc(char *arg1,           char *arg2,           unsigned long *arg3) {     char nu1[7] = "New1";     char nu2[7] = "New2";     printf("Starting subc\n");     printf("Arg1=%s\n", arg1);     printf("Arg2=%s\n", arg2);     printf("Arg3=%d\n", *arg3);     arg1[0] = 'X';     arg2[0] = 'Y';     *arg3 = 987654321;     return 2; } </pre> |

The idea is to pass two string and one full-word unsigned arguments to the subprogram, have the subprogram print them out, change all three and pass a return code of 2 back to the caller . The caller will then re-display the three arguments (showing changes only to the two BY REFERENCE arguments), display the return code and halt. While simple, these two programs illustrate the techniques required quite nicely.

Note how the COBOL program ensures that a null end-of-string terminator is present on both string arguments.

Since the C program is planning on making changes to all three arguments, it declares all three as pointers in the function header and references the third argument as a pointer in the function body.<sup>40</sup>

<sup>40</sup> It actually had no choice for the two string (char array) arguments – they must be defined as pointers in the function even though the function code references them without the leading "\*" that normally signifies pointers.

These programs are compiled and executed as follows. The example assumes a UNIX system with a GNU COBOL build that uses the native C compiler on that system; the technique works equally well regardless of which C compiler and which operating system you're using.

```
$ cc -c subc.c
$ cobc -x maincob.cbl subc.o
$ maincob
Starting cobmain
Starting subc
Arg1=Arg1
Arg2=Arg2
Arg3=123456789
Back
Arg1=Arg1
Arg2=Yrg2
Arg3=+0987654321
Returned value=+000000002
$
```

Remember that the null characters are actually in the GNU COBOL "Arg1" and "Arg2" data items. They don't appear in the output, but they ARE there. When passing character strings to C programs, it's probably a good idea to make a null-terminated copy of the string items and pass those copies to the C program.

### 7.8.5. C Main Programs CALLING GNU COBOL Subprograms

Now, the roles of the two languages in the previous section will be reversed, having a C main program execute a GNU COBOL subprogram.

Figure 7-3 - C CALLING GNU COBOL

| (mainc.c)<br>This C MAIN PROGRAM...                                                                                                                                                                                                                                                                                                                                                                                                                            | (subcob.cbl)<br>...wants to CALL this GNU COBOL SubProgram                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre>#include &lt;stdio.h&gt;  int main (int argc, char **argv) {     int returnCode;     char arg1[7] = "Arg1";     char arg2[7] = "Arg2";     unsigned long arg3 = 123456789;     printf("Starting mainc...\n");      returnCode = subcob(arg1,arg2,&amp;arg3);     printf("Back\n");     printf("Arg1=%s\n",arg1);     printf("Arg2=%s\n",arg2);     printf("Arg3=%d\n",arg3);     printf("Returned value=%d\n",returnCode);     return returnCode; }</pre> | <pre>IDENTIFICATION DIVISION. PROGRAM-ID. subcob. DATA DIVISION. LINKAGE SECTION.     01 Arg1          PIC X(7).     01 Arg2          PIC X(7).     01 Arg3          USAGE BINARY-LONG. PROCEDURE DIVISION USING     BY VALUE      Arg1,     BY REFERENCE Arg2,     BY REFERENCE Arg3. 000-Main.     DISPLAY 'Starting cobsub.cbl'.     DISPLAY 'Arg1=' Arg1.     DISPLAY 'Arg2=' Arg2.     DISPLAY 'Arg3=' Arg3.     MOVE 'X' TO Arg1 (1:1).     MOVE 'Y' TO Arg2 (1:1).     MOVE 987654321 TO Arg3.     MOVE 2 TO RETURN-CODE. GOBACK.</pre> |

Since the C program is the one that will execute first, before the GNU COBOL subroutine, the burden of initializing the GNU COBOL run-time environment lies with that C program; it will have to invoke the "cob\_init" function, which is part of the "libcob" library. The two required C statements are shown .

The arguments to the "cob\_init" routine are the argument count and value parameters passed to the main function when the program began execution. By passing them into the GNU COBOL subprogram, it will be possible for that GNU COBOL program to retrieve the command line or individual command-line arguments. If that won't be necessary, "cob\_init(0,NULL);" could be specified instead.

Since the C program wants to allow "arg3" to be changed by the subprogram, it prefixes it with a "&" to force a **CALL BY REFERENCE** for that argument. Since "arg1" and "arg2" are strings (char arrays), they are automatically passed by reference.

Here's the output of the compilation process as well as the program's execution. The example assumes a Windows system with a GNU COBOL build that uses the GNU C compiler on that system; the technique works equally well regardless of which C compiler and which operating system you're using.

```
C:\Users\Gary\Documents\Programs> cobc -S subcob.cbl
C:\Users\Gary\Documents\Programs> gcc mainc.c subcob.s -o mainc.exe -llibcob
C:\Users\Gary\Documents\Programs> mainc.exe
Starting mainc...
Starting cobsub.cbl
Arg1=Arg1
Arg2=Arg2
Arg3=+0123456789
Back
Arg1=Xrg1
Arg2=Yrg2
Arg3=987654321
Returned value=2
C:\Users\Gary\Documents\Programs>
```

Note that even though we told GNU COBOL that the 1<sup>st</sup> argument was to be BY VALUE, it was treated as if it were BY REFERENCE anyway. String (char array) arguments passed from C callers to GNU COBOL subprograms will be modifiable by the subprogram. It's best to pass a copy of such data if you want to ensure that the subprogram doesn't change it.

The third argument is different, however. Since it's not an array you have the choice of passing it either BY REFERENCE<sup>41</sup> or BY VALUE<sup>42</sup>.

---

<sup>41</sup> Use "&" with the argument in the C calling program; specify the argument as BY REFERENCE in the COBOL subprogram

<sup>42</sup> Don't use "&" with the argument in the C calling program; specify the argument as BY VALUE in the COBOL subprogram

## 8. The GNU COBOL System Interface

### 8.1. Using the GNU COBOL Compiler (cobic)

#### 8.1.1. Introduction

Program source files should have extensions of “.cob” or “.cbl”.

Program filenames should match exactly the specification of PROGRAM-ID (including case). The reason for this was discussed in section 3.

Spaces cannot be included in primary entry-point names (section 3) and therefore should not be included in program filenames.

The GNU COBOL compiler will translate your COBOL program into C source code, compile that C source code into executable binary form using the “C” compiler specified when GNU COBOL was built and link that executable binary into either directly executable form, static-linkable form or dynamically-loadable executable form.

The GNU COBOL compiler is named “cobic” (“cobic.exe” on a Windows system).

#### 8.1.2. Syntax and Options

The following describes the syntax and option switches of the cobic command. This information may be displayed by entering the command “cobic --help”.

Usage: cobic [options] file ...

Options:

|                   |                                                                                                                                                                                                                                                                                                                                                        |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -help             | Display this message                                                                                                                                                                                                                                                                                                                                   |
| -version, -V      | Display compiler version                                                                                                                                                                                                                                                                                                                               |
| -info, -i         | Display compiler build information                                                                                                                                                                                                                                                                                                                     |
| -v                | Display the commands invoked by the compiler                                                                                                                                                                                                                                                                                                           |
| -x                | Build an executable program                                                                                                                                                                                                                                                                                                                            |
| -m                | Build a dynamically loadable module (default)                                                                                                                                                                                                                                                                                                          |
| -std=<dialect>    | Warnings/features for a specific dialect : <ul style="list-style-type: none"> <li>cobol2002 Cobol 2002</li> <li>cobol85 Cobol 85</li> <li>ibm IBM Compatible</li> <li>mvs MVS Compatible</li> <li>bs2000 BS2000 Compatible</li> <li>mf Micro Focus Compatible</li> <li>default When not specified</li> </ul> See config/default.conf and config/*.conf |
| -free             | Use free source format                                                                                                                                                                                                                                                                                                                                 |
| -fixed            | Use fixed source format (default)                                                                                                                                                                                                                                                                                                                      |
| -O, -O2, -Os      | Enable optimization                                                                                                                                                                                                                                                                                                                                    |
| -g                | Enable C compiler debug / stack check / trace                                                                                                                                                                                                                                                                                                          |
| -debug            | Enable all run-time error checking                                                                                                                                                                                                                                                                                                                     |
| -o <file>         | Place the output into <file>                                                                                                                                                                                                                                                                                                                           |
| -b                | Combine all input files into a single dynamically loadable module                                                                                                                                                                                                                                                                                      |
| -E                | Preprocess only; do not compile or link                                                                                                                                                                                                                                                                                                                |
| -C                | Translation only; convert COBOL to C                                                                                                                                                                                                                                                                                                                   |
| -S                | Compile only; output assembly file                                                                                                                                                                                                                                                                                                                     |
| -c                | Compile and assemble, but do not link                                                                                                                                                                                                                                                                                                                  |
| -P(<dir or file>) | Generate preprocessed program listing (.lst)                                                                                                                                                                                                                                                                                                           |
| -Xref             | Generate cross reference through 'cobicxref' (V. Coen's 'cobicxref' must be in path)                                                                                                                                                                                                                                                                   |
| -I <directory>    | Add <directory> to copy/include search path                                                                                                                                                                                                                                                                                                            |
| -L <directory>    | Add <directory> to library search path                                                                                                                                                                                                                                                                                                                 |
| -l <lib>          | Link the library <lib>                                                                                                                                                                                                                                                                                                                                 |
| -A <options>      | Add <options> to the C compile phase                                                                                                                                                                                                                                                                                                                   |
| -Q <options>      | Add <options> to the C link phase                                                                                                                                                                                                                                                                                                                      |
| -D <define>       | DEFINE <define> to the COBOL compiler                                                                                                                                                                                                                                                                                                                  |

```

-K <entry>           Generate CALL to <entry> as static
-conf=<file>         User defined dialect configuration - See -std=
-list-reserved        Display reserved words
-list-intrinsics       Display intrinsic functions
-list-mnemonics        Display mnemonic names
-list-system           Display system routines
-save-temp(<dir>)     Save intermediate files
                      - Default : current directory
-ext <extension>      Add default file extension

-W                     Enable ALL warnings
-Wall                 Enable all warnings except as noted below
-Wobsolete             Warn if obsolete features are used
-Warchaic              Warn if archaic features are used
-Wredefinition         Warn incompatible redefinition of data items
-Wconstant             Warn inconsistent constant
-Woverlap              Warn overlapping MOVE items
-Wparentheses          Warn lack of parentheses around AND within OR
-Wstrict-typing        Warn type mismatch strictly
-Wimplicit-define      Warn implicitly defined data items
-Wcorresponding        Warn CORRESPONDING with no matching items
-Wexternal-value       Warn EXTERNAL item with VALUE clause
-Wcall-params          Warn non 01/77 items for CALL params
                      - NOT set with -Wall
-Wcolumn-overflow      Warn text after column 72, FIXED format
                      - NOT set with -Wall
-Wterminator           Warn lack of scope terminator END-XXX
                      - NOT set with -Wall
-Wtruncate              Warn possible field truncation
                      - NOT set with -Wall
-Wlinkage              Warn dangling LINKAGE items
                      - NOT set with -Wall
-Wunreachable          Warn unreachable statements
                      - NOT set with -Wall

-fsign=<value>         Define display sign representation
                      - ASCII or EBCDIC (Default : machine native)
-ffold-copy=<value>     Fold COPY subject to value
                      - UPPER or LOWER (Default : no transformation)
-ffold-call=<value>     Fold PROGRAM-ID, CALL, CANCEL subject to value
                      - UPPER or LOWER (Default : no transformation)
-fdefaultbyte=<value>   Initialize fields without VALUE to decimal value
                      - 0 to 255 (Default : initialize to picture)
-fintrinsics=<value>    Intrinsics to be used without FUNCTION keyword
                      - ALL or intrinsic function name (,name,...)
-ftrace                Generate trace code
                      - Executed SECTION/PARAGRAPH
-ftraceall              Generate trace code
                      - Executed SECTION/PARAGRAPH/STATEMENTS
                      - Turned on by -debug
-fsyntax-only           Syntax error checking only; don't emit any output
-fdebugging-line        Enable debugging lines
                      - 'D' in indicator column or floating >>D
-fsource-location       Generate source location code
                      - Turned on by -debug/-g/-ftraceall
-fimplicit-init         Automatic initialization of the Cobol runtime system
-fstack-check            PERFORM stack checking
                      - Turned on by -debug or -g
-fsyntax-extension      Allow syntax extensions
                      - eg. Switch name SW1, etc.
-fwrite-after            Use AFTER 1 for WRITE of LINE SEQUENTIAL
                      - Default : BEFORE 1
-fmfcomment              '*' or '/' in column 1 treated as comment
                      - FIXED format only
-fnotrunc               Allow numeric field overflow
                      - Non-ANSI behaviour

```

|                   |                                                                                            |
|-------------------|--------------------------------------------------------------------------------------------|
| -fodoslide        | Adjust items following OCCURS DEPENDING                                                    |
| -fsingle-quote    | - Requires implicit/explicit relaxed syntax<br>Use a single quote (apostrophe) for QUOTE   |
| -frecursive-check | - Default : double quote                                                                   |
| -frelax-syntax    | Check recursive program call<br>Relax syntax checking                                      |
| -foptional-file   | - eg. REDEFINES position<br>Treat all files as OPTIONAL<br>- unless NOT OPTIONAL specified |

As discussed in section 2, program compilation groups may consist of multiple programs defined sequentially in a single source file. By specifying multiple source files on the “cdbc” command, it is possible for a single execution of the “cdbc” command to process multiple compilation groups.

### 8.1.3. Compiling GNU COBOL Programs

#### 8.1.3.1. Compiling Directly-Executable GNU COBOL Programs

The simplest mode of compilation is to generate a single executable file from one or more GNU COBOL source files:

```
cdbc -x prog1.cbl prog2.cbl prog3.cbl
```

The main program must be the first program found in the “prog1.cbl” file. The remainder of “prog1.cbl” as well as all of “prog2.cbl” and “prog3.cbl” must be subprograms (subroutines or user-defined functions) or nested subprograms.

This will generate a single executable file (UNIX) or exe file (Windows) which has all COBOL programs contained within the source files specified on the “cdbc” command included in the file. The first program found in the first specified source file is presumed to be the main program and all other programs found in the remainder of that first source file as well as in all the remaining source files will be static subroutines and/or user-defined functions. Any subroutines or user-defined functions that weren’t included in any of the source files will be treated as dynamically loadable subprograms.

Optionally, the “-o” option may be used to specify the name of the generated executable file. If “-o” is not specified, otherwise, the filename of the 1<sup>st</sup> source file named on the command will be used. The appropriate extension for the generated file (“exe”, on a Windows computer, for example) will be added to the filename that is explicitly or implicitly used for the output file.

#### 8.1.3.2. Compiling Dynamically-Loadable GNU COBOL Subprograms

Subprograms that are to be dynamically loaded into memory at execution time must be compiled using the “-m” option on the cdbc command, as follows:

```
cdbc -m sprog1.cbl
cdbc -m sprog1.cbl sprog2.cbl sprog3.cbl
cdbc -m -b sprog1.cbl sprog2.cbl sprog3.cbl
```

The first command above generates a single dynamically-loadable module. The second example generates three dynamically-loadable modules (one for each source file). The third command generates a single dynamically-loadable module.

Optionally, when a single output file is being generated, the “-o” option may be used to specify its name (otherwise, the filename of the 1<sup>st</sup> source file named on the command will be used). The appropriate extension for the generated file (“dll”, on a Windows computer, for example) will be added to the filename that is explicitly or implicitly used for the output file.

It is also possible to generate main programs as dynamically-loadable libraries. Just use the “-m” option (as shown here) rather than the “-x” option. To execute these main programs, you’ll need to utilize the cobcrun command, as discussed in section [8.2.2](#).

#### 8.1.3.3. Compiling Static GNU COBOL Subprograms

You may compile GNU COBOL subprograms into assembler source code which can then be assembled and linked with a main program when that main program is compiled. To create such an assembler source file, compile the subprogram(s) as follows:

```
cobc -S sprog1.cbl
```

(Note: “-S” is an uppercase-S)

This will create an assembler source file named “sprog1.s”. If you specify multiple input files, they’ll each create their own “.s” files.

To compile a main program, assemble an assembler source file and static-link it all together:

```
cobc -x mainprog.cbl sprog1.s
```

If multiple subprograms are needed, simply add their “.s” files to the command line. Any subprogram *entry-points* for which “.s” files were not specified will be **CALLED** at runtime as dynamically-loadable modules.

Precompiled subroutines intended to be statically linked (usually they end in “.o”) may be automatically located by the GNU COBOL compiler (cobc) and the loader (ld) by using the LD\_LIBRARY\_PATH environment variable (section [8.1.4](#)).

## 8.1.4. Important Compilation-Time Environment Variables

The following chart documents the various environment variables that can play a role in the compilation of GNU COBOL programs.

Figure 8-1 - Compiler Environment Variables

| Environment Variable             | Use                                                                                                                                                                                                                                                                         |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>COB_CC</b>                    | Set to the name of the C compiler you wish GNU COBOL to use.<br><br><b>USE THIS FEATURE AT YOUR OWN RISK – YOU SHOULD ALWAYS USE THE C COMPILER YOUR GNU COBOL BUILD WAS GENERATED FOR</b>                                                                                  |
| <b>COB_CFLAGS</b> <sup>43</sup>  | Set to any switches that you’d like to pass on to the C compiler from the cobc compiler (in addition to any that cobc will specify). The default is “-Iprefix/include”, where “prefix” is the path prefix specified when the GNU COBOL binaries you are using were created. |
| <b>COB_CONFIG_DIR</b>            | Set to the path to the folder where GNU COBOL “config” files are kept.                                                                                                                                                                                                      |
| <b>COB_COPY_DIR</b>              | If copybooks your program needs are NOT stored in the same directory as your program, set this environment variable to the folder in which the copybooks may be found (IBM mainframe programmers will recognize this as “SYSLIB”).                                          |
| <b>COB_LDADD</b> <sup>41</sup>   | Set to any additional linker switches (ld) that can specify where standard libraries that must be linked with the program can be found. The default is “” (null).                                                                                                           |
| <b>COB_LDFLAGS</b> <sup>41</sup> | Set to any linker/loader (ld) switches that you’d like to pass on to the C compiler from the cobc compiler (in addition to any that cobc will specify). The default is none.                                                                                                |

<sup>43</sup> These switches are intended for use only in very special circumstances by very advanced users; their usage is discouraged. A future release of GNU COBOL will introduce a better way to pass switched to the C compiler and/or the loader from the cobc command.

| Environment Variable                                   | Use                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>COB_LIBS</b> <sup>41</sup>                          | Set to any linker switches (ld) that specify where standard libraries that must be linked with the program can be found. The default is “-Lprefix/lib -lcob”, where “prefix” is the path prefix specified when the GNU COBOL binaries you are using were created.                                                                                                                                                                                   |
| <b>COBCPY</b>                                          | This environment variable provides an additional means of specifying where copybooks may be found by the compiler (see also <b>COB_COPY_DIR</b> , above).                                                                                                                                                                                                                                                                                           |
| <b>LD_LIBRARY_PATH</b>                                 | If you are planning on using static-linked subroutine libraries, set this variable to the path to the directory containing your libraries.                                                                                                                                                                                                                                                                                                          |
| <b>TMPDIR</b><br><b>TMP</b><br>(checked in this order) | Set to a directory/folder appropriate to create temporary files in. The intermediate working files created by cobc will be created here (and deleted once they’re no longer needed).<br><br>On a Windows system, the TMP environment variable is normally set for you when you logon. If you wish to use a <u>different</u> temporary folder, you may set TMPDIR yourself and have no fear of disrupting other Windows software that relies on TMP. |

**See Also...**

|                                                 |                                                   |
|-------------------------------------------------|---------------------------------------------------|
| Copybooks <a href="#">1.3.3.3</a>               | Compiler Switches Reference <a href="#">8.1.2</a> |
| The <b>COPY</b> Statement <a href="#">2.1.1</a> | GNU COBOL “config” Files <a href="#">8.1.6</a>    |

### 8.1.5. Locating Copybooks at Compilation Time

The GNU COBOL compiler will attempt to locate copybooks by searching for them in the following folders. The search will occur in the sequence shown below, and will terminate once a copybook is found.

- ▶ The folder named as the *library-name-1* on the **COPY** statement.
- ▶ The folder in which the program being compiled resides.
- ▶ The folder named on the “-I” compiler switch
- ▶ Each of the folders named on the COBCPY environment variable (see section **Error! Reference source not found.**). A single folder may be named or multiple folders may be specified, separated by a system-appropriate delimiter character.<sup>44</sup> When multiple folders are specified, they will be searched in the order they are named on the environment variable.
- ▶ The folder specified on the COB\_COPY\_DIR environment variable.

As each of the above folders is searched for a copybook – “COPY XXXXXXXX.”, for example – the GNU COBOL compiler will attempt to locate the copybook file by any of the following names, in the sequence shown:

- ▶ XXXXXXXX.CPY
- ▶ XXXXXXXX.CBL
- ▶ XXXXXXXX.COB
- ▶ XXXXXXXX.cpy
- ▶ XXXXXXXX.cbl
- ▶ XXXXXXXX.cob
- ▶ XXXXXXXX

The COPY command is case-sensitive on UNIX systems; “COPY copybookname” and “COPY COPYBOOKNAME” will both fail to locate the “CopyBookName” copybook on a UNIX system. Windows implementations of GNU COBOL may or

---

<sup>44</sup> If the GNU COBOL compiler you are using was built to utilize a native Windows environment, use a semicolon (;). If, however, the GNU COBOL compiler was built for a Unix or Linux environment, or was built for a Windows environment utilizing either the Cygwin or MinGW Unix “emulators”, use a colon character (:) as the separator.

may not be similarly case sensitive with regard to copybook names, depending upon the Windows version and GNU COBOL build options – it is safest to simply treat the COPY command as case-sensitive in all environments.

*See Also...*

Copybooks [1.3.3.3](#)

The COPY Statement [2.1.1](#)

Compiler Switches Reference [8.1.2](#)

Compilation-time Environment Variables [8.1.4](#)

## 8.1.6. Using Compiler Configuration Files

GNU COBOL uses compiler configuration files to define various options that will control the compilation process. These configuration files are specified using the “-conf” compilation switch or are found in the folder defined by the COB\_CONFIG\_PATH environment variable.

The following is a verbatim listing of the “default” configuration file (the one used if you don’t specify the “-conf” switch), just to show you the types of settings that may appear:

```
# COBOL compiler configuration                                -*- sh -*-

# Value: any string
name: "GNU COBOL"

# Value: int
tab-width: 8
text-column: 72

# Value: 'cobol2002', 'mf', 'ibm'
#
assign-clause: mf

# If yes, file names are resolved at run time using environment variables.
# For example, given ASSIGN TO "DATAFILE", the actual file name will be
# 1. the value of environment variable 'DD_DATAFILE' or
# 2. the value of environment variable 'dd_DATAFILE' or
# 3. the value of environment variable 'DATAFILE' or
# 4. the literal "DATAFILE"
# If no, the value of the assign clause is the file name.
#
# Value: 'yes', 'no'
filename-mapping: yes

# Value: 'yes', 'no'
pretty-display: yes

# Value: 'yes', 'no'
auto-initialize: yes

# Value: 'yes', 'no'
complex-odo: no

# Value: 'yes', 'no'
indirect-redefines: no

# Binary byte size - defines the allocated bytes according to PIC
# Value:      signed    unsigned   bytes
#          -----  -----  -----
# '2-4-8'     1 - 4           2
#             5 - 9           4
#             10 - 18          8
#
# '1-2-4-8'   1 - 2           1
#             3 - 4           2
#             5 - 9           4
#             10 - 18          8
#
```

```

# '1--8'      1 - 2      1 - 2      1
#             3 - 4      3 - 4      2
#             5 - 6      5 - 7      3
#             7 - 9      8 - 9      4
#            10 - 11    10 - 12    5
#            12 - 14    13 - 14    6
#            15 - 16    15 - 16    7
#            17 - 18    17 - 18    8
binary-size: 1-2-4-8

# Value: 'yes', 'no'
binary-truncate: yes

# Value: 'native', 'big-endian'
binary-byteorder: big-endian

# Value: 'yes', 'no'
larger-redefines-ok: no

# Value: 'yes', 'no'
relaxed-syntax-check: no

# Perform type OSVS - If yes, the exit point of any currently executing perform
# is recognized if reached.
# Value: 'yes', 'no'
perform-osvs: no

# If yes, linkage-section items remain allocated
# between invocations.
# Value: 'yes', 'no'
sticky-linkage: no

# If yes, allow non-matching level numbers
# Value: 'yes', 'no'
relax-level-hierarchy: no

# not-reserved:
# Value: Word to be taken out of the reserved words list
# (case independent)

# Dialect features
# Value: 'ok', 'archaic', 'obsolete', 'skip', 'ignore', 'unconformable'
author-Paragraph          obsolete
memory-size-clause:       obsolete
multiple-file-tape-clause: obsolete
label-records-clause:     obsolete
value-of-clause:           obsolete
data-records-clause:       obsolete
top-level-occurs-clause:   skip
synchronized-clause:       ok
goto-statement-without-name: obsolete
stop-literal-Statement:   obsolete
debugging-line:            obsolete
padding-character-clause:  obsolete
next-sentence-phrase:      archaic
eject-Statement:           skip
entry-Statement:           obsolete
move-noninteger-to-alphanumeric: error
odo-without-to:            ok

```

## 8.2. Running GNU COBOL Programs

### 8.2.1. Executing Programs Directly

GNU COBOL programs compiled with the “-x” option will be generated as directly-executable programs. For example, on a Windows system, the “-x” option will be generated as an “.exe” file.

These native executables are appropriate for execution as non-graphical user interface programs.

On a UNIX system this means the programs may be executed from a command shell such as bash, csh, ksh and so forth. When a GNU COBOL program runs on a Windows system, it runs within a console window (i.e. “cmd.exe”).

Interactions between the program and the user will take place using the standard input, standard output and standard error streams. Any SCREEN SECTION I/O performed by the program will take place within the command shell “window”.

Direct program execution syntax is as follows:

**[path]program [arguments]**

For example:

**/usr/local/printaccount ACCT=6625378**

Or...

**C:\Users\Me\Documents\Programs\printaccount.exe ACCT=6625378**

## 8.2.2. Using the “cobcrun” Utility

It is possible to generate executable modules for all GNU COBOL programs, not just subroutines, by choosing to use the “-m” option to specify the compiler output format even for main programs.

Some may prefer to compile their GNU COBOL main programs into these dynamically-loadable modules in the interests of using the same general compilation command for all programs without having to think “Is it a main program or a subroutine?”.

Main programs compiled in this manner should be executed as follows:

**[path]cobcrun program [arguments]**

Do not specify the “.so” or “.dll” extension on the program name. The “*program*” value must exactly match the primary entry-point name (section 3) of the main program (including upper- and lower-case letters).

The general usage and syntax of cobcrun is as follows:

```
Usage: cobcrun PROGRAM [param ...]
or   : cobcrun --help (-h)
      Print this help
or   : cobcrun --version (-V)
      Print version information
or   : cobcrun --info (-i)
      Print build information
```

For an example of the use of cobcrun:

```
cd /usr/local
cobcrun printaccount ACCT=6625378
```

Or...

```
cd C:\Users\Me\Documents\Programs
cobcrun printaccount.exe ACCT=6625378
```

Note how the cobcrun command does not allow a path to be specified with the program name –the directory in which the programs dynamically loadable module exists must either be the current directory or must be defined in the current PATH.

*See Also...*

|                             |                       |
|-----------------------------|-----------------------|
| Compiler Switches Reference | <a href="#">8.1.2</a> |
|-----------------------------|-----------------------|

### 8.2.3. Program Arguments

Regardless of the manner in which a program is executed, any arguments specified to the program may be retrieved via either of the following,:

- ▶ ACCEPT ... FROM COMMAND-LINE
- ▶ ACCEPT ... FROM ARGUMENT-VALUE

▶ *See Also...*

The ACCEPT Statement (Command Line) [6.2.1.2](#)

### 8.2.4. Important Execution-Time Environment Variables

The following chart documents the various environment variables that can play a role in the execution of GNU COBOL programs.

Figure 8-2 - Run-Time Environment Variables

| Environment Variable         | Use                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>COB_DISPLAY_WARNINGS</b>  | If set to a value of "Y", any run-time warnings (such as noting the implicit <b>CLOSE</b> of open files when a <b>GOBACK</b> or <b>STOP RUN</b> is executed) will be displayed. Any other value for this environment variable (including not setting the variable at all) will suppress such messages.                                                                                                                                        |
| <b>COB_LIBRARY_PATH</b>      | At runtime, GNU COBOL will attempt to locate and load any application dynamically-loadable libraries from the <b>PATH</b> and the directory in which the program executable was found. If these library files could be somewhere else, specify the directory path using this variable.                                                                                                                                                        |
| <b>COB_PRE_LOAD</b>          | If set to any non-null value, this variable will cause all dynamically-loadable libraries to be loaded when the program begins execution (rather than searching for and loading the module upon first use).                                                                                                                                                                                                                                   |
| <b>COB_SET_DEBUG</b>         | If a <b>USE FOR DEBUGGING</b> section is included in <b>DECLARATIVES</b> , the code within it will be disabled unless this environment variable is set to a value of "Y", "y" or "1".                                                                                                                                                                                                                                                         |
| <b>COB_SET_TRACE</b>         | If the " <b>-ftrace</b> " or " <b>-ftraceall</b> " options were used when the program was compiled, setting this environment variable to a value of "Y" will activate the trace at the point the program begins execution. Setting this environment variable to any other value (or never setting it to ANY value) will disable tracing. See the <b>READY TRACE</b> and <b>RESET TRACE</b> statements for additional ways to control tracing. |
| <b>COB_SCREEN_ESC</b>        | If set to any non-blank value, this variable allows the <b>ACCEPT</b> verb to detect the Esc key. See <a href="#">Figure 6-23</a> for additional information.                                                                                                                                                                                                                                                                                 |
| <b>COB_SCREEN_EXCEPTIONS</b> | Setting this variable to any non-blank value will allow the <b>ACCEPT</b> verb to detect the Esc, PgUp and PgDn keys. See <a href="#">Figure 6-23</a> for additional information.                                                                                                                                                                                                                                                             |

| Environment Variable                                                  | Use                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>COB_SORT_MEMORY</b>                                                | The value of this variable (an integer) will be used to define how much memory will be allocated for use in sorting. If the value is 1048576 or greater, that value will be used "as is" as the amount of memory (in bytes) to allocate. If the value is less than 1048576. The default sort memory amount is 128 MB.                                                                                             |
| <b>COB_SWITCH_n</b>                                                   | (n=0 to 15); These environment variables correspond to <b>SWITCH-0</b> through <b>SWITCH-15</b> , defined in the <b>SPECIAL-NAMES</b> paragraph. Setting them to "ON" will activate them; any other value turns them off.                                                                                                                                                                                         |
| <b>COB_SYNC</b>                                                       | If set to a value of upper- or lowercase "p", this variable will force a file commit every time a file is written to (ensuring that data is <u>immediately</u> written to the file rather than retained in memory until a future commit occurs). This will slow-down update access to files, but will provide for better integrity in the event of a program failure.                                             |
| <b>COB_TRACE_FILE</b>                                                 | If set to a value, this environment variable specifies the file to which all <b>-ftrace</b> and <b>-ftraceall</b> output will be written.<br><br>If this is NOT set to a value, all <b>-ftrace</b> and <b>-ftraceall</b> output will be written to STDERR, where it may be piped via a "2> filename" on the command that executes the program.                                                                    |
| <b>DB_HOME</b>                                                        | If your GNU COBOL build uses the Berkeley Database (BDB) package, use this environment variable to specify the folder in which the lock management files to be associated with all non- <b>SORT</b> files opened by the program will be stored <sup>45</sup> . Having this variable defined will activate record locking features on the <b>READ</b> , <b>REWRITE</b> and <b>WRITE</b> statements <sup>46</sup> . |
| <b>PATH</b>                                                           | The GNU COBOL "bin" directory should be defined in the <b>PATH</b> .                                                                                                                                                                                                                                                                                                                                              |
| <b>TMPDIR</b><br><b>TMP</b><br><b>TEMP</b><br>(checked in this order) | Set to a directory/folder appropriate to create temporary files in. This will be used by <b>SORT</b> and <b>MERGE</b> to create temporary work files. You may also use this folder for any temporary files your application may require.<br><br>Good form dictates that – if your application DOES create temporary working files – it should clean-up after itself. <sup>47</sup>                                |

**See Also...**<sup>45</sup> **ORGANIZATION INDEXED** files will also have their data file allocated in the DB\_HOME folder, if DB\_HOME exists.<sup>46</sup> Even with DB\_HOME, locking will not work with **ORGANIZATION SEQUENTIAL** (either type) or **ORGANIZATION RELATIVE** files with GNU COBOL builds created for Windows/MinGW. **ORGANIZATION INDEXED** locks will work with Windows/MinGW + BDB and all locks will work for all file organizations with UNIX GNU COBOL builds.<sup>47</sup> Take a look at the **C\$DELETE** and **CBL\_DELETE\_FILE** built-in subroutines.

|                                                            |                                                         |
|------------------------------------------------------------|---------------------------------------------------------|
| The SPECIAL-NAMES Paragraph <a href="#">4.1.4</a>          | The READY TRACE Statement <a href="#">6.2.32</a>        |
| Using DECLARATIVES <a href="#">6.1.4</a>                   | The RESET TRACE Statement <a href="#">6.4.34</a>        |
| The ACCEPT Statement (Screen Data) <a href="#">6.4.1.4</a> | The REWRITE Statement <a href="#">6.4.36</a>            |
| The CLOSE Statement <a href="#">6.4.7</a>                  | The SORT Statement (File Sort) <a href="#">6.4.40.1</a> |
| The GOBACK Statement <a href="#">6.2.19</a>                | The STOP RUN Statement <a href="#">6.4.42</a>           |
| The MERGE Statement <a href="#">6.4.25</a>                 | The WRITE Statement <a href="#">6.4.50</a>              |
| The READ Statement <a href="#">6.4.31</a>                  | Compiler Switches Reference <a href="#">8.1.2</a>       |

## 8.3. Built-In System Subroutines

### 8.3.1. “Call by Name” Routines

There are a number of built-in system subroutines included with GNU COBOL. Generally, these routines are intended to match those available in Micro Focus COBOL (CBL...) or ACUCOBOL (C\$...).

These routines, all executed via their UPPERCASE NAMES, are capable of performing the following Functions

- ▶ Changing the current directory
- ▶ Copying files
- ▶ Creating a directory
- ▶ Creating, Opening, Closing, Reading and Writing byte-stream files
- ▶ Deleting directories (folders)
- ▶ Deleting files
- ▶ Determining how many arguments were passed to a subroutine
- ▶ Getting file information (size and last-modification date/time)
- ▶ Getting the length (in bytes) of an argument passed to a subroutine
- ▶ Justifying a field left-, right- or center-aligned
- ▶ Moving files (a destructive “copy”)
- ▶ Putting the program ‘to sleep’, specifying the sleep time in seconds
- ▶ Putting the program ‘to sleep’, specifying the sleep time in nanoseconds; CAVEAT: although you’ll express the time in nanoseconds, Windows systems will only be able to sleep at a millisecond granularity
- ▶ Retrieving information about the currently-executing program
- ▶ Submitting a command to the shell environment appropriate for the version of GNU COBOL you are using for execution

The following table describes the various built-in subroutines. ALL SUBROUTINE ARGUMENTS ARE MANDATORY EXCEPT WHERE EXPLICITLY NOTED TO THE CONTRARY. Any subroutine returning a value to **RETURN-CODE** could utilize the **RETURNING/GIVING** clause on the **CALL** to return the result back to the full-word binary COMP-5 data item of your choice.

*See Also...*

|                                          |
|------------------------------------------|
| The CALL Statement <a href="#">6.4.5</a> |
|------------------------------------------|

#### 8.3.1.1. CALL “C\$CALLEDBY” USING *prog-name-area*

This routine returns the name of the program that **CALLED** the currently-executing program. The program name will be returned, left-justified and SPACE filled, in the specified *prog-name-area* argument, which should be a PIC X

elementary item or a group item. If *prog-name-area* is too small to receive the entire program name, the program name value will be truncated to fit the size of the argument.

The **RETURN-CODE** register will be set to one of the following values:

- 1 An error occurred. The *prog-name-area* contents will be unchanged.
- 0 The program **CALLING** “C\$CALLED BY” was not called by any other program (in other words, it is a main program,). The *prog-name-area* contents will be set entirely to SPACES.
- 1 The program **CALLING** “C\$CALLED BY” was indeed called by another program, and that program’s name has been saved in *prog-name-area*.

### 8.3.1.2. CALL “C\$CHDIR” USING *directory-path*, *result*

This routine makes *directory-path* (an alphanumeric literal or identifier) the current directory.

The return code of the operation is returned both in the *result* argument (any non-edited numeric identifier) as well as in the **RETURN-CODE** special register. The return code of the operation will be either 0=Success or 128=failure.

The directory change remains in effect until the program terminates (in which the original current directory at the time the program was restarted will be automatically restored) or until another C\$CHDIR is executed.

### 8.3.1.3. CALL “C\$COPY” USING *src-file-path*, *dest-file-path*, 0

Use this subroutine to copy file *src-file-path* to *dest-file-path* as if it were done via the “CP” (Unix) or “COPY” (Windows) command.

Both file path arguments may be alphanumeric literals or identifiers.

The third argument is required, but is unused.

If the attempt to copy the file fails (for example, it or the destination directory doesn’t exist), **RETURN-CODE** will be set to 128; on successful completion it will be set to 0.

### 8.3.1.4. CALL “C\$DELETE” USING *file-path*, 0

This routine deletes the file specified by the file-path argument (an alphanumeric literal or identifier) just as if that were done using the “RM” (Unix) or “ERASE” (Windows) command.

The second argument is required, but is unused.

If the attempt to delete the file fails (for example, it doesn’t exist), **RETURN-CODE** will be set to 128; on successful completion it will be set to 0.

### 8.3.1.5. CALL “C\$FILEINFO” USING *file-path*, *file-info*

With this routine you may retrieve the size of the file<sup>48</sup> specified as the *file-path* argument (an alphanumeric literal or identifier) and the date/time that file was last modified. The information is returned to the *file-info* argument, which is defined as the following 16-byte area:

```
01 File-Info.
05 File-Size-In-Bytes  PIC 9(18) COMP.
05 Mod-YYYYMMDD      PIC 9(8)  COMP. *> Modification Date
05 Mod-HHMMSS00       PIC 9(8)  COMP. *> Modification Time
```

---

<sup>48</sup> File size information may not be available in the particular GNU COBOL build / Operating System combination you are using and may therefore always be returned as zero.

The last two decimal digits in the modification time will always be 0.

If the subroutine is successful, a value of 0 will be returned in **RETURN-CODE**. Failure to retrieve the needed statistics on the file will cause a **RETURN-CODE** value of 35 to be passed back. Supplying less than two arguments will generate a 128 **RETURN-CODE** value.

### 8.3.1.6. CALL “C\$GETPID”

Use the C\$GETPID to return the PID of the executing GNU COBOL program. The PID value is returned into the **RETURN-CODE** register.

As you can see, there are no arguments to this routine.

### 8.3.1.7. CALL “C\$JUSTIFY” USING *data-item*, “*justification-type*”

Use C\$JUSTIFY to left, right or center-justify an alphabetic, alphanumeric or numeric edited *data-item*. The *justification-type* argument indicates the type of the justification to be performed. The value of that argument will be interpreted as follows:

|               |                                                                                              |
|---------------|----------------------------------------------------------------------------------------------|
| absent        | Treated the same as if it were "R"                                                           |
| Cxxx...       | If it begins with a capital "C", the value will be centered                                  |
| Rxxx...       | If it begins with a capital "R", the value will be right-justified, space-filled to the left |
| Lxxx...       | If it begins with a capital "L", the value will be left-justified, space-filled to the right |
| anything else | Treated as if it were "R"                                                                    |

### 8.3.1.8. CALL “C\$MAKEDIR” USING *dir-path*

With this routine you may create a new directory – the name of which is supplied as the *dir-path* argument (an alphanumeric literal or identifier).

Only the lowest-level directory (last) in the specified path can be created – all others must already exist. This subroutine will NOT behave as a “mkdir -p” (Unix) or “mkdir /p” (Windows).

**RETURN-CODE** will be set to the return code of the operation; the value will be either 0=Success or 128=failure.

### 8.3.1.9. CALL “C\$NARG” USING *arg-count-result*

C\$NARG returns the number of arguments passed to a subroutine that calls C\$NARG back to the numeric field *arg-count-result*. When called from within a user-defined function, a value of one (1) is returned if any arguments were passed to the function or a zero (0) otherwise.

When **CALLED** from a main program, the returned value will always be 0.

### 8.3.1.10. CALL “C\$PARAMSIZE” USING *argument-number*

This subroutine returns the size (in bytes) of the subroutine argument supplied using the argument-number parameter (a numeric literal or data item).

The size is returned in the **RETURN-CODE** special register.

If the specified argument does not exist, or an invalid argument number is specified, a value of 0 is returned.

### 8.3.1.11. CALL “C\$PRINTABLE” USING *data-item* [ , *char* ]

The C\$PRINTABLE subroutine converts the contents of the *data-item* specified as the first argument to printable characters. Those characters that are deemed printable (as defined by the characterset used by *data-item*) will remain unchanged, while those that are NOT printable will be converted to the character specified as the second argument. If no second argument is provided, a period (“.”) will be used.

### 8.3.1.12. CALL “C\$SLEEP” USING *seconds-to-sleep*

C\$SLEEP puts the program to sleep for the specified number of seconds. The seconds-to-sleep argument may be a numeric literal or data item.

Sleep times less than 1 will be interpreted as 0, which immediately returns without any sleep delay.

### 8.3.1.13. CALL “C\$TOLOWER” USING *data-item*, BY VALUE *convert-length*

This routine will converts *convert-length* (a numeric literal or data item) leading characters of *data-item* (an alphanumeric identifier) to lower-case.

The *convert-length* argument must be specified . It specifies how many (leading) characters in *data-item* will be converted – any characters after that will remain unchanged.

If *convert-length* is negative or zero, no conversion will be performed.

### 8.3.1.14. CALL “C\$TOUPPER” USING *data-item*, BY VALUE *convert-length*

Use the C\$TOUPPER subroutine to change the *convert-length* (a numeric literal or data item) leading characters of *data-item* (an alphanumeric identifier) to upper-case.

The *convert-length* argument must be specified . It specifies how many (leading) characters in *data-item* will be converted – any characters after that will remain unchanged.

If *convert-length* is negative or zero, no conversion will be performed.

### 8.3.1.15. CALL “CBL\_AND” USING *item-1*, *item-2*, BY VALUE *byte-length*

This subroutine performs a bit-by-bit logical AND operation between the left-most 8\**byte-length* corresponding bits of *item-1* and *item-2*, storing the resulting bit string into *item-2*.

*Item-1* may be an alphanumeric literal or a data item. *Item-2* must be a data item. The length of both *item-1* and *item-2* must be at least 8\**byte-length*.

*Byte-length* may be a numeric literal or data item, and must be specified using .

The truth table shown to the right documents the “AND” process.

Any bits in *item-2* after the 8\**byte-length* point will be unaffected.

A result of zero will be passed back in the **RETURN-CODE** register.

| Arg #1<br>bit | Arg #2<br>bit | New<br>Arg #2<br>bit |
|---------------|---------------|----------------------|
| 0             | 0             | 0                    |
| 0             | 1             | 0                    |
| 1             | 0             | 0                    |
| 1             | 1             | 1                    |

### 8.3.1.16. CALL “CBL\_CHANGE\_DIR” USING *directory-path*

This routine makes *directory-path* (an alphanumeric literal or identifier) the current directory.

The directory change remains in effect until the program terminates (in which the original current directory at the time the program was restarted will be automatically restored) or until another CBL\_CHANGE\_DIR (or C\$CHDIR) is executed.

The return code of the operation is returned in the **RETURN-CODE** special register. The return code of the operation will be either 0=Success or 128=failure.

### 8.3.1.17. CALL “CBL\_CHECK\_FILE\_EXIST” USING *file-path*,*file-info*

With this routine you may retrieve the size of the file<sup>49</sup> specified as the *file-path* argument (an alphanumeric literal or identifier) and the date/time that file was last modified. The information is returned to the *file-info* argument, which is defined as the following 16-byte area:

```

01 Argument-2.
05 File-Size-In-Bytes  PIC 9(18)  COMP.
05 Mod-DD             PIC 9(2)   COMP.  *> Modification Time
05 Mod-MO             PIC 9(2)   COMP.
05 Mod-YYYY           PIC 9(4)   COMP.  *> Modification Date
05 Mod-HH             PIC 9(2)   COMP.
05 Mod-MM             PIC 9(2)   COMP.
05 Mod-SS             PIC 9(2)   COMP.
05 FILLER             PIC 9(2)   COMP.  *> This will always be 00

```

If the subroutine is successful, a value of 0 will be returned in **RETURN-CODE**. Failure to retrieve the needed statistics on the file will cause a **RETURN-CODE** value of 35 to be passed back. Supplying less than two arguments will generate a 128 **RETURN-CODE** value.

### 8.3.1.18. CALL “CBL\_CLOSE\_FILE” USING *file-handle*

The CBL\_CLOSE\_FILE subroutine closes a bytestream file previously opened by either the **CBL\_OPEN\_FILE** or **CBL\_CREATE\_FILE** subroutines.

If the file defined by the *file-handle* argument (a PIC X(4) USAGE COMP-X data item) was opened for output, an implicit **CBL\_FLUSH\_FILE** will be performed before the file is closed.

If the subroutine is successful, a value of 0 will be returned in **RETURN-CODE**. Failure will cause a **RETURN-CODE** value of -1 to be passed back.

### 8.3.1.19. CALL “CBL\_COPY\_FILE” USING *src-file-path*,*dest-file-path*

Use this subroutine to copy file *src-file-path* to *dest-file-path* as if it were done via the “CP” (Unix) or “COPY” (Windows) command.

Both file path arguments may be alphanumeric literals or identifiers.

If the attempt to copy the file fails (for example, it or the destination directory doesn't exist), **RETURN-CODE** will be set to 128; on successful completion it will be set to 0.

### 8.3.1.20. CALL “CBL\_CREATE\_DIR” USING *dir-path*

With this routine you may create a new directory – the name of which is supplied as the *dir-path* argument (an alphanumeric literal or identifier).

Only the lowest-level directory (last) in the specified path can be created – all others must already exist. This subroutine will NOT behave as a “mkdir –p” (Unix) or “mkdir /p” (Windows).

**RETURN-CODE** will be set to the return code of the operation; the value will be either 0=Success or 128=failure.

### 8.3.1.21. CALL “CBL\_CREATE\_FILE” USING *file-path*, 2, 0, 0,*file-handle*

The CBL\_CREATE\_FILE subroutine creates the new file specified using the *file-path* argument and opens it for output as a byte-stream file usable by **CBL\_WRITE\_FILE**.

---

<sup>49</sup> File size information may not be available in the particular GNU COBOL build / Operating System combination you are using and may therefore always be returned as zero.

Arguments 2, 3 and 4 should be coded as the constant values shown.<sup>50</sup>

A *file handle* (PIC X(4) USAGE COMP-X) will be returned, for any subsequent **CBL\_WRITE\_FILE** or **CBL\_CLOSE\_FILE** calls.

The success or failure of the subroutine will be reported back in the **RETURN-CODE** register, with a **RETURN-CODE** value of -1 indicating an invalid argument and a value of 0 indicating success.

### 8.3.1.22. CALL “CBL\_DELETE\_DIR” USING *dir-path*

Delete an empty directory via **CBL\_DELETE\_DIR**.

The only argument – *dir-path* (an alphanumeric literal or identifier) – is the name of the directory to be deleted.

Only the lowest-level directory (last) in the specified path will be deleted, and that directory must be empty to be deleted.

**RETURN-CODE** will be set to the return code of the operation; the value will be either 0=Success or 128=failure.

### 8.3.1.23. CALL “CBL\_DELETE\_FILE” USING *file-path*

This routine deletes the file specified by the file-path argument (an alphanumeric literal or identifier) just as if that were done using the “RM” (Unix) or “ERASE” (Windows) command.

If the attempt to delete the file fails (for example, it doesn't exist), **RETURN-CODE** will be set to 128; on successful completion it will be set to 0.

### 8.3.1.24. CALL “CBL\_ERROR\_PROC” USING *function, program-pointer*

This routine registers a general error-handling routine.

The *function* argument must be a numeric literal or a 32-bit binary **COMP-5** data item (**USAGE BINARY-LONG**, for example) with a value of 0 or 1. A value of 0 means that you will be registering (“installing”) an error procedure while a value of 1 indicates you're deregistering (“uninstalling”) a previously-installed error procedure.

The *program-pointer* must be a **USAGE PROGRAM-POINTER** data item containing the address of your error procedure. This item should be given a value using the **SET program-pointer** statement. If the error procedure is written in GNU COBOL, it must be a subroutine, not a user-defined function.

A success (0) or failure (non-0) result will be passed back in the **RETURN-CODE** register.

A custom error procedure, will trigger when a runtime error condition is encountered. An error procedure may be registered by a main program or a subprogram, but regardless of from where it was registered, it applies to the overall program compilation group and will trigger when a runtime error occurs anywhere in the executable program. If the error procedure was defined by a subprogram, that program must be loaded at the time the error procedure is executed.

The code within the handler will be executed and – once the handler issues a return (C) or an **EXIT PROGRAM** or **GOBACK** (GNU COBOL), the system-standard error handling routine will be executed.

Only one user-defined error procedure may be in effect at any time.

The following is a sample GNU COBOL program that registers an error procedure. The output of that program is shown as well - as you can see, the error handler's messages appear followed by the standard GNU COBOL message.

```

IDENTIFICATION DIVISION.
PROGRAM-ID. DemoERRPROC.
ENVIRONMENT DIVISION.
DATA DIVISION.
WORKING-STORAGE SECTION.
01 Err-Proc-Address          USAGE PROCEDURE-POINTER.
PROCEDURE DIVISION.

```

<sup>50</sup> **CBL\_CREATE\_FILE** is actually a special-case of the **CBL\_OPEN\_FILE** routine - see that routine for a description of the meanings of arguments 2, 3 and 4.

```

S1.
  DISPLAY 'Program is starting'
  SET Err-Proc-Address TO ENTRY 'ErrProc'
  CALL 'CBL_ERROR_PROC' USING 0, Err-Proc-Address
  CALL 'Tilt' *> THIS DOESN'T EXIST!!!!
  DISPLAY 'Program is stopping'
  STOP RUN
  .
END PROGRAM DemoERRPROC.

IDENTIFICATION DIVISION.
PROGRAM-ID. ErrProc.
PROCEDURE DIVISION.
000-Main.
  DISPLAY 'Error: ' EXCEPTION-LOCATION
  DISPLAY '      ' EXCEPTION-STATEMENT
  DISPLAY '      ' EXCEPTION-FILE
  DISPLAY '      ' EXCEPTION-STATUS
  DISPLAY '*** Returning to Standard Error Routine ***'
  EXIT PROGRAM
  .
END PROGRAM ErrProc.

```

When executed, this sample program generates the following console output:

```

>demoerrproc
Program is starting
Error: DemoERRPROC; S1; 13
  CALL
  00
    EC-PROGRAM-NOT-FOUND
*** Returning to Standard Error Routine ***
DEMOERRPROC.cbl: 28: libcob: Cannot find module 'Tilt'

```

### 8.3.1.25. CALL “CBL\_EXIT\_PROC” USING *function*, *program-pointer*

This routine registers a general exit-handling routine.

The *function* argument must be a numeric literal or a 32-bit binary COMP-5 data item (USAGE BINARY-LONG, for example) with a value of 0 or 1. A value of 0 means that you will be registering (“installing”) an exit procedure while a value of 1 indicates you’re deregistering (“uninstalling”) a previously-installed exit procedure.

The *program-pointer* must be a **USAGE PROGRAM-POINTER** data item containing the address of your exit procedure.

A success (0) or failure (non-0) result will be passed back in the **RETURN-CODE** register.

An exit procedure will trigger when a “**STOP RUN**” or its equivalent (i.e. “**GOBACK**” executed in a main program) is executed. The exit procedure code will be executed and – once it issues an **EXIT PROGRAM** or a **GOBACK**, the system-standard program termination routine will be executed.

Only one user-defined exit procedure may be in effect at any time.

An exit procedure may be defined by a main program or a subprogram, but regardless of from where it was registered, it applies to the overall program compilation group and will trigger when a **STOP RUN** is executed anywhere in the executable program. If the exit procedure was defined by a subprogram, that program must be loaded at the time the exit procedure is executed.

An exit procedure should terminate using **EXIT PROGRAM** or a **GOBACK**.

The following is a sample GNU COBOL program that registers an exit procedure. The output of that program is shown as well.

```

IDENTIFICATION DIVISION.
PROGRAM-ID. demoexitproc.

```

**Program output...**

```

Executing a STOP RUN...
*** STOP RUN has been executed ***
*** 2009/08/28 10:01:29 ***

```

```

ENVIRONMENT DIVISION.
DATA DIVISION.
WORKING-STORAGE SECTION.
78 Exit-Proc-Install      VALUE 0.
01 Current-Date          PIC X(8).
01 Current-Time           PIC X(8).
01 Exit-Proc-Address     USAGE PROCEDURE-POINTER.
01 Formatted-Date         PIC XXXX/XX/XX.
01 Formatted-Time          PIC XX/XX/XX.

PROCEDURE DIVISION.
000-Register-Exit-Proc.
    SET Exit-Proc-Address TO ENTRY "999-Exit"
    CALL "CBL_EXIT_PROC"
        USING Exit-Proc-Install, Exit-Proc-Address
    END-CALL
    IF RETURN-CODE NOT = 0
        DISPLAY 'Error: Could not register Exit Procedure'
    END-IF
    .
099-Now-Test-Exit-Proc.
    DISPLAY
        'Executing a STOP RUN...'
    END-DISPLAY
    GOBACK
    .
999-Exit-Proc.
    ENTRY "999-Exit"
    DISPLAY
        '*** STOP RUN has been executed ***'
    END-DISPLAY
    ACCEPT
        Current-Date FROM DATE YYYYMMDD
    END-ACCEPT
    ACCEPT
        Current-Time FROM TIME
    END-ACCEPT
    MOVE Current-Date TO Formatted-Date
    MOVE Current-Time TO Formatted-Time
    INSPECT Formatted-Time REPLACING ALL '/' BY ':'
    DISPLAY
        '***      ' Formatted-Date ' ' Formatted-Time ' ***'
    END-DISPLAY
    GOBACK
    .

```

### 8.3.1.26. CALL “CBL\_EQ” USING *item-1*, *item-2*, BY VALUE *byte-length*

This subroutine performs a bit-by-bit test for equality between the left-most  $8^*\text{byte-length}$  corresponding bits of *item-1* and *item-2*, storing the resulting bit string into *item-2*.

*Item-1* may be an alphanumeric literal or a data item. *Item-2* must be a data item. The length of both *item-1* and *item-2* must be at least  $8^*\text{byte-length}$ .

*Byte-length* may be a numeric literal or data item, and must be specified using .

The truth table shown to the right documents the “EQ” process.

Any bits in *item-2* after the  $8^*\text{byte-length}$  point will be unaffected.

A result of zero will be passed back in the **RETURN-CODE** register.

| Arg #1<br>bit | Arg #2<br>bit | New<br>Arg #2<br>bit |
|---------------|---------------|----------------------|
| 0             | 0             | 1                    |
| 0             | 1             | 0                    |
| 1             | 0             | 0                    |
| 1             | 1             | 1                    |

### 8.3.1.27. CALL “CBL\_FLUSH\_FILE” USING *file-handle*

In Micro Focus COBOL, **CALLing** this subroutine flushes any as-yet unwritten memory buffers for the (output) file whose *file-handle* is specified as the argument to disk.

This routine is non-functional in GNU COBOL. It exists only to provide compatibility for applications that may have been developed for Micro Focus COBOL.

### 8.3.1.28. CALL “CBL\_GET\_CURRENT\_DIR” USING BY VALUE 0, BY VALUE *length*, BY REFERENCE *buffer*

This retrieves the fully-qualified pathname of the current directory, saving up to *length* characters of that name into the specified *buffer*.

The first argument is unused, but must be specified. It must be specified .

The *length* argument must be specified .

The *buffer* argument must be specified .

The value specified for the *length* argument (a numeric literal or data item) should not exceed the actual length of the *buffer* argument.

If the value specified for the *length* argument is LESS THAN the actual length of the *buffer* argument, the current directory path will be left-justified and space filled within the first *length* bytes of *buffer* – any bytes in *buffer* after that point will be unchanged.

If the routine is successful, a value of 0 will be returned to the **RETURN-CODE** register. If the routine failed because of a problem with an argument (such as a negative or 0 *length*), a **RETURN-CODE** value of 128 will result. Finally, if the 1<sup>st</sup> argument value is anything but zero, the routine will fail with a 129 **RETURN-CODE**.

### 8.3.1.29. CALL “CBL\_GET\_CSR\_POS” USING *cursor-locn-buffer*

This subroutine will retrieve the current cursor location on the screen, returning a 2-byte value into the supplied *cursor-locn-buffer*. The first byte of *cursor-locn-buffer* will receive the current line (row) location while the second receives the current column location.

The returned location data will be in exact binary (i.e. USAGE COMPUTATIONAL) form, and will be based upon starting values of 0, meaning that if the cursor is located at line 15, column 12 at the time this routine is called, a value of (14,11) will be returned.

The following is a typical *cursor-locn-buffer* definition:

```
01 CURSOR-LOCN-BUFFER.
  05 CURSOR-LINE           USAGE BINARY-CHAR.
  05 CURSOR-COLUMN         USAGE BINARY-CHAR.
```

Values of 1 (Line) and 1 (column) will be returned if GNU COBOL was not generated to include screen I/O.

### 8.3.1.30. CALL “CBL\_GET\_SCR\_SIZE” USING *no-of-lines*, *no-of-cols*

Use this subroutine to retrieve the current console screen size. When the system is running in a windowed environment, this will be the sizing of the console window in which the program is executing. When the system is not running a windowing environment, the physical console screen attributes will be returned. In environments such as a Windows console window, where the logical size of the window may far exceed that of the physical console window, the size returned will be that of the physical console window. Two one-byte values will be returned – the first will be the current number of lines (rows) while the second will be the number of columns.

The returned size data will be in exact binary (i.e. USAGE COMPUTATIONAL) form.

The following are typical *no-of-lines* and *no-of-columns* Definitions

```
01 NO-OF-LINES           USAGE BINARY-CHAR.
```

01 NO-OF-COLUMNS

USAGE BINARY-CHAR.

GNU COBOL run-time screen management must have been initialized prior to **CALLing** this routine in order to receive meaningful values. This means that a screen-data DISPLAY and/or a screen-data ACCEPT must have been executed prior to the **CALL**.

Zero values will be returned if the screen has not been initialized and values of 24 (lines) and 80 (columns) will be returned if GNU COBOL was not generated to include screen I/O.. Compare this result with that of a screen-information ACCEPT.

**See Also...**The ACCEPT Statement (Screen Data) [6.4.1.4](#)The DISPLAY Statement (Screen Data) [6.4.12.4](#)The ACCEPT Statement (Screen Info): [6.4.1.6](#)**8.3.1.31. CALL “CBL\_IMP” USING *item-1*, *item-2*, BY VALUE *byte-length***

This subroutine performs a bit-by-bit “implies” test between the left-most *8\*byte-length* corresponding bits of *item-1* and *item-2*, storing the resulting bit string into *item-2*.

*Item-1* may be an alphanumeric literal or a data item. *Item-2* must be a data item. The length of both *item-1* and *item-2* must be at least *8\*byte-length*.

*Byte-length* may be a numeric literal or data item, and must be specified using .

The truth table shown to the right documents the “IMP” process.

Any bits in *item-2* after the *8\*byte-length* point will be unaffected.

A result of zero will be passed back in the **RETURN-CODE** register.

| Arg #1<br>bit | Arg #2<br>bit | New<br>Arg #2<br>bit |
|---------------|---------------|----------------------|
| 0             | 0             | 1                    |
| 0             | 1             | 1                    |
| 1             | 0             | 0                    |
| 1             | 1             | 1                    |

**8.3.1.32. CALL “CBL\_NIMP” USING *item-1*, *item-2*, BY VALUE *byte-length***

This subroutine performs the negation of a bit-by-bit “implies” test between the left-most *8\*byte-length* corresponding bits of *item-1* and *item-2*, storing the resulting bit string into *item-2*.

*Item-1* may be an alphanumeric literal or a data item. *Item-2* must be a data item. The length of both *item-1* and *item-2* must be at least *8\*byte-length*.

*Byte-length* may be a numeric literal or data item, and must be specified using .

The truth table shown to the right documents the “NIMP” process.

Any bits in *item-2* after the *8\*byte-length* point will be unaffected.

A result of zero will be passed back in the **RETURN-CODE** register.

| Arg #1<br>bit | Arg #2<br>bit | New<br>Arg #2<br>bit |
|---------------|---------------|----------------------|
| 0             | 0             | 0                    |
| 0             | 1             | 0                    |
| 1             | 0             | 1                    |
| 1             | 1             | 0                    |

**8.3.1.33. CALL “CBL\_NOR” USING *item-1*, *item-2*, BY VALUE *byte-length***

This subroutine performs the negation of a bit-by-bit “OR” test between the left-most *8\*byte-length* corresponding bits of *item-1* and *item-2*, storing the resulting bit string into *item-2*.

*Item-1* may be an alphanumeric literal or a data item. *Item-2* must be a data item. The length of both *item-1* and *item-2* must be at least *8\*byte-length*.

*Byte-length* may be a numeric literal or data item, and must be specified using .

The truth table shown to the right documents the “NOR” process.

| Arg #1 | Arg #2 | New |
|--------|--------|-----|
| 0      | 0      | 1   |
| 0      | 1      | 0   |
| 1      | 0      | 0   |
| 1      | 1      | 0   |

Any bits in *item-2* after the  $8^{\text{byte-length}}$  point will be unaffected.

A result of zero will be passed back in the **RETURN-CODE** register.

| bit | bit | <i>Arg #2</i><br>bit |
|-----|-----|----------------------|
| 0   | 0   | 1                    |
| 0   | 1   | 0                    |
| 1   | 0   | 0                    |
| 1   | 1   | 0                    |

### 8.3.1.34. CALL “CBL\_NOT” USING *item-1*, BY VALUE *byte-length*

This subroutine “flips” the left-most  $8^{\text{byte-length}}$  bits of *item-2*, storing the resulting bit string into *item-2*.

*Item-2* must be a data item. The length of *item-2* must be at least  $8^{\text{byte-length}}$ .

*Byte-length* may be a numeric literal or data item, and must be specified using .

The truth table shown to the right documents the “NOT” process.

Any bits in *item-2* after the  $8^{\text{byte-length}}$  point will be unaffected.

A result of zero will be passed back in the **RETURN-CODE** register.

| Old<br><i>Arg #2</i><br>bit | New<br><i>Arg #2</i><br>bit |
|-----------------------------|-----------------------------|
| 0                           | 1                           |
| 1                           | 0                           |

### 8.3.1.35. CALL “CBL\_OC\_NANOSLEEP” USING *nanoseconds-to-sleep*

CB\_OC\_NANOSLEEP puts the program to sleep for the specified number of nanoseconds.

The *nanoseconds-to-sleep* argument is a numeric literal or data item.

There are one BILLION nanoseconds in a second, so if you wanted to put the program to sleep for 1/4 second you'd use a *nanoseconds-to-sleep* value of 250000000.

### 8.3.1.36. CALL “CBL\_OPEN\_FILE” *file-path*, *access-mode*, 0, 0, *handle*

.This routine opens an existing file for use as a byte-stream file usable by **CBL\_WRITE\_FILE** or **CBL\_READ\_FILE**.

The *file-path* argument is an alphanumeric literal or data-item.

The *access-mode* argument is a numeric literal or data item with a PIC X USAGE COMP-X (or USAGE BINARY-CHAR) definition; it specifies how you wish to use the file, as follows:

1 = input (read-only)

2 = output (write-only)

3 = input and/or output

The third and fourth arguments would specify a locking mode and device specification, respectively, but they're not implemented in GNU COBOL (currently, at least) – just specify each as 0.

The final argument – *handle* - is a PIC X(4) USAGE COMP-X item that will receive the handle to the file. That handle is used on all other byte-stream functions to reference this specific file.

A **RETURN-CODE** value of -1 indicates an invalid argument, while a value of 0 indicates success. A value of 35 means the file does not exist.

### 8.3.1.37. CALL “CBL\_OR” USING *item-1*, *item-2*, BY VALUE *byte-length*

This subroutine performs a bit-by-bit “OR” test between the left-most  $8^{\text{byte-length}}$  corresponding bits of *item-1* and *item-2*, storing the resulting bit string into *item-2*.

*Item-1* may be an alphanumeric literal or a data item. *Item-2* must be a data item. The length of both *item-1* and *item-2* must be at least  $8^{\text{byte-length}}$ .

*Byte-length* may be a numeric literal or data item, and must be specified using .

The truth table shown below documents the “OR” process.

Any bits in *item-2* after the  $8 * \text{byte-length}$  point will be unaffected.

A result of zero will be passed back in the **RETURN-CODE** register.

| Arg #1<br>bit | Arg #2<br>bit | New<br>Arg #2<br>bit |
|---------------|---------------|----------------------|
| 0             | 0             | 0                    |
| 0             | 1             | 1                    |
| 1             | 0             | 1                    |
| 1             | 1             | 1                    |

### 8.3.1.38. CALL “CBL\_READ\_FILE” USING *handle, offset, nbytes, flag, buffer*

This routine reads *nbytes* of data starting at byte number *offset* from the byte-stream file defined by *handle* into the specified *buffer*.

The *handle* argument (PIC X(4) USAGE COMP-X) must have been populated by a prior call to CBL\_OPEN\_FILE.

The *offset* argument (PIC X(8) USAGE COMP-X) defines the location in the file of the first byte to be read. The first byte of a file is byte offset 0.

The *nbytes* argument (PIC X(4) USAGE COMP-X) specifies how many bytes (maximum) will be read.

If the *flags* argument is specified as 128, the size of the file (in bytes) will be returned into the file offset argument (argument 2) upon completion.<sup>51</sup> The only other valid value for *flags* is 0. This argument may be specified either as a numeric literal or as a PIC X USAGE COMP-X data item.

Upon completion, **RETURN-CODE** will be set to 0 if the read was successful or to 10 if an “end-of-file” condition occurred. If **RETURN-CODE** has a value of -1, a problem was identified with the subroutine arguments.

### 8.3.1.39. CALL “CBL\_RENAME\_FILE” USING *old-file-path, new-file-path*

You may use this subroutine to rename a file.

The file specified by *old-file-path* will be “renamed” to the name specified as *new-file-path*. Each argument may be an alphanumeric literal or data item.

Despite what the name of this routine might make you believe, this routine is more than just a simple “rename” – it will actually move the file supplied as the 1<sup>st</sup> argument to the file specified as the 2<sup>nd</sup> argument. Think of it as a two-step sequence, first copying the *old-file-path* to the *new-file-path* and then a second step where the *old-file-path* is deleted.

If the attempt to move the file fails (for example, it doesn't exist), **RETURN-CODE** will be set to 128; on successful completion it will be set to 0.

### 8.3.1.40. CALL “CBL\_TOLOWER” USING *data-item, BY VALUE convert-length*

This routine will converts *convert-length* (a numeric literal or data item) leading characters of *data-item* (an alphanumeric identifier) to lower-case.

The *convert-length* argument must be specified . It specifies how many (leading) characters in *data-item* will be converted – any characters after that will remain unchanged.

If *convert-length* is negative or zero, no conversion will be performed.

### 8.3.1.41. CALL “CBL\_TOUPPER” USING *data-item, BY VALUE convert-length*

<sup>51</sup> Not all operating system/GNU COBOL environments may be able to retrieve file sizes – in such cases, a value of zero will be returned.

Use C\$TOUPPER to change the *convert-length* (a numeric literal or data item) leading characters of *data-item* (an alphanumeric identifier) to upper-case.

The *convert-length* argument must be specified . It specifies how many (leading) characters in *data-item* will be converted – any characters after that will remain unchanged.

If *convert-length* is negative or zero, no conversion will be performed.

### 8.3.1.42. CALL “CBL\_WRITE\_FILE” USING *handle*, *offset*, *nbytes*, 0, *buffer*

This routine writes *nbytes* of data from the specified *buffer* to the byte-stream file defined by *handle* starting at byte number *offset*.

The *handle* argument (PIC X(4) USAGE COMP-X) must have been populated by a prior call to CBL\_OPEN\_FILE.

The *offset* argument (PIC X(8) USAGE COMP-X) defines the location in the file of the first byte to be written to. The first byte of a file is byte offset 0.

The *nbytes* argument (PIC X(4) USAGE COMP-X) specifies how many bytes (maximum) will be written.

The only allowable value or the *flags* argument is 0. This argument may be specified either as a numeric literal or as a PIC X USAGE COMP-X data item.

Upon completion, RETURN-CODE will be set to 0 if the write was successful or to 30 if an I/O error condition occurred. If RETURN-CODE has a value of -1, a problem was identified with the subroutine arguments.

### 8.3.1.43. CALL “CBL\_XOR” USING *item-1*, *item-2*, BY VALUE *byte-length*

This subroutine performs a bit-by-bit exclusive “OR” test between the left-most 8\**byte-length* corresponding bits of *item-1* and *item-2*, storing the resulting bit string into *item-2*.

*Item-1* may be an alphanumeric literal or a data item. *Item-2* must be a data item. The length of both *item-1* and *item-2* must be at least 8\**byte-length*.

*Byte-length* may be a numeric literal or data item, and must be specified using .

The truth table shown to the right documents the “XOR” process.

Any bits in *item-2* after the 8\**byte-length* point will be unaffected.

A result of zero will be passed back in the RETURN-CODE register.

| Arg #1<br>bit | Arg #2<br>bit | New<br>Arg #2<br>bit |
|---------------|---------------|----------------------|
| 0             | 0             | 0                    |
| 0             | 1             | 1                    |
| 1             | 0             | 1                    |
| 1             | 1             | 0                    |

### 8.3.1.44. CALL “SYSTEM” USING *command*

This subroutine submits the specified *command* (an alphanumeric literal or data item) to a command shell.

A shell will be opened subordinate to the GNU COBOL program issuing the CALL to SYSTEM.

Output from the command (if any) will appear in the command window in which the GNU COBOL program was executed.

On a Unix system, the shell environment will be established using the default shell program. This is also true when using a GNU COBOL build created with and for the Cygwin Unix emulator.

With native Windows Windows/MinGW builds, the shell environment will be the Windows console window command processor (usually “cmd.exe”) appropriate for the version of Windows you’re using.

To trap output from the executed command and process it within the GNU COBOL program, use a pipe (>) to send the command output to a temporary file which you then READ from within the program once control returns.

## 8.3.2. “Call by Number” Subroutines

Early versions of Micro Focus COBOL allowed programmers to access various runtime library routines by using a single two-digit hexadecimal number as the entry-point name. These were known as call-by-number routines. Over time, Micro Focus COBOL evolved, replacing most of the call-by-number routines with ones accessible using a more conventional call-by-name technique.

Most of the call-by-number routines have evolved into even more powerful call-by-name routines, many of which are supported by GNU COBOL and were already presented in section 8.3

Three of the original call-by-number routines never evolved call-by-name equivalents; GNU COBOL supports these routines.

### 8.3.2.1. CALL X"91" USING return-code, function-code, binary-variable-arg

The original Micro Focus version of this routine is capable of providing a wide variety of functions – GNU COBOL supports just three of those Functions

- ▶ Turning runtime switches (SWITCH-1, ..., SWITCH-8) on
- ▶ Turning runtime switches (SWITCH-1, ..., SWITCH-8) off
- ▶ Retrieving the number of arguments passed to a subroutine<sup>52</sup>

The *return-code* argument must be a binary numeric data item (USAGE BINARY-CHAR is recommended). It will receive a value of 0 if the operation was successful, 1 otherwise.

The *function code* argument must be either a numeric literal or a binary numeric data item (USAGE BINARY-CHAR is recommended).

The third argument – *variable-arg* – is defined differently depending upon the *function-code* value, as follows:

| <i>Value of<br/>function-code</i> | <i>Action To Be Performed</i>                                                                                                                                                  | <i>Definition and usage of variable-arg</i>                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11                                | Sets and/or clears <u>all eight</u> of the COBOL switches (SWITCH-1 through SWITCH-8) that are available for definition within SPECIAL-NAMES (see section 4.1.4) <sup>53</sup> | <p><i>Variable-arg</i> should be an OCCURS 8 TIMES array of USAGE BINARY-CHAR.</p> <p>Each occurrence that is set to a value of zero prior to the <b>CALL</b> will cause the corresponding switch to be cleared. Each occurrence set to 1 prior to the <b>CALL</b> will cause the corresponding switch to be set.</p> <p>Values other than 0 or 1 will be ignored.</p> |
| 12                                | Reads <u>all eight</u> of the COBOL switches (SWITCH-1 through SWITCH-8) that are available for definition within SPECIAL-NAMES (see section 4.1.4)                            | <p>This argument should be an OCCURS 8 TIMES array of USAGE BINARY-CHAR.</p> <p>Each of the 1<sup>st</sup> eight occurrences of the array will be set to either 0 or 1 – 1 if the corresponding switch is set, 0 otherwise.</p>                                                                                                                                        |
| 16                                | Retrieves the number of arguments passed to the program executing the <b>CALL X"91"</b>                                                                                        | <p>This argument should be a binary numeric data item (USAGE BINARY-CHAR is recommended).</p> <p>The number of arguments passed to the subroutine executing the <b>CALL X"91"</b> will be stored here.</p>                                                                                                                                                             |

### 8.3.2.2. CALL X"E4"

Use X"E4" to clear the screen. There are no arguments and no returned value.

### 8.3.2.3. CALL X"E5"

<sup>52</sup> GNU COBOL actually has two other ways to accomplish this task – the **C\$NARG** subroutine and the **NUMBER-OF-CALL-PARAMETERS** special register; I recommend you use one of these methods instead of the X"91" routine when coding new programs

<sup>53</sup> If you only wish to set and/or clear some of the switches, it is recommended that you first use function 12 to read the current values of the switches and then change the *variable-arg* occurrences for the switch(es) you wish to change before using function 11 to actually make the changes.

The X"E5" routine will sound the PC "bell". There are no arguments and no returned value.

### 8.3.2.4. CALL X"F4" USING *byte, table*

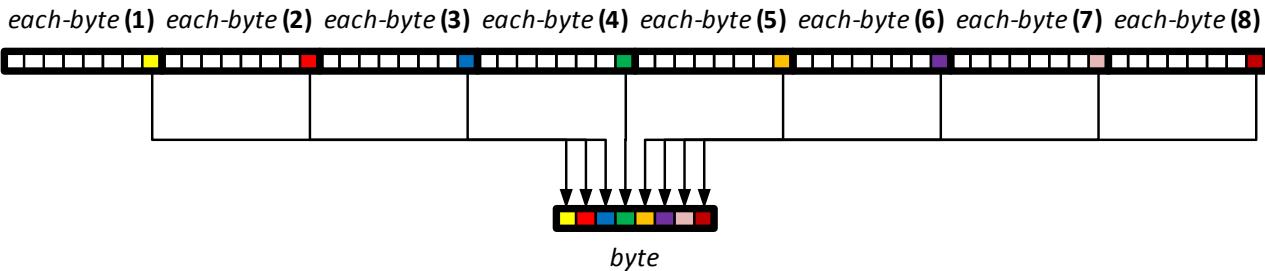
The Routine X"F4" packs an 8-byte area containing 8 1-byte binary values of 0 or 1 into the corresponding bit positions of a 1-byte data item.

The *byte* data item need be only a single byte in size. If it is longer, the excess will be unaffected by this subroutine.

*Table* must be a data item at least 8 bytes long. If it is longer, the excess will be ignored by this subroutine. Typically, *table* is defined similarly to the following:

```
01  table.
    05 each-byte OCCURS 8 TIMES USAGE BINARY-CHAR.
```

The following diagram illustrates how this subroutine works.



The colored squares represent the bits in the 1<sup>st</sup> 8 bytes of *array* that will be packed into *byte*. The white squares represent the bits in each *each-byte* that will be ignored.

### 8.3.2.5. CALL X"F5" USING *byte, table*

This routine unpacks each bit of a byte into an 8-byte area so they may be individually accessed and manipulated.

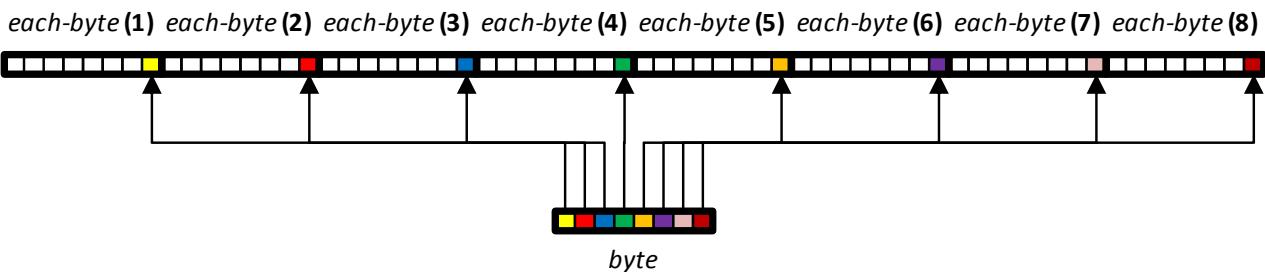
The *byte* data item need be only a single byte in size. If it is longer, the excess will be ignored by this subroutine.

*Table* must be a data item at least 8 bytes long. If it is longer, the excess will be unaffected by this subroutine.

Typically, *table* is defined similarly to the following:

```
01  table.
    05 each-byte OCCURS 8 TIMES USAGE BINARY-CHAR.
```

The following diagram illustrates how this subroutine works.



The colored squares represent each of the 8 bits in *byte*. The diagram shows how those bits will be "unpacked" into the rightmost bit of each of the 1<sup>st</sup> 8 consecutive bytes of *array*. The white squares represent the remaining bits in each of the 1<sup>st</sup> 8 *each-byte* occurrences – all of which will be set to 0.

## 8.4. Binary Truncation

By default, the GNU COBOL compiler will truncate binary data items to the precision indicated by their PICTURE clause. For example, the following data item will have 2 bytes of storage allocated for it:

```
01 Comp-5-Item PIC 9(3) COMP-5.
```

Because of truncation, even though this field has enough bits allocated (16) to store values from 0 to 65535, it will be limited to values of 0 to 999 because of its PICTURE.

Or is it?

Take a look at the small demo program shown here. This program will perform three different types of operations against a binary field, displaying the results of each.

Here are the results when the program is compiled (with truncation in-effect by default) and executed:

```
Bin-Item-1=760 Disp-Item-1=032760
Bin-Item-1=765 Disp-Item-1=032765
Bin-Item-1=767 Disp-Item-1=032767
```

You can see that truncation affected the DISPLAY statements but appears to have had no impact whatsoever on the MOVE and ADD statements. This is the hidden secret about truncation in GNU COBOL: it doesn't really truncate the internally-stored values – it just truncates the DISPLAY of them!

If that same program is recompiled without truncation (by adding the “-fnotrunc” switch to the ‘cobic’ command), the results are as follows:

```
Bin-Item-1=32760 Disp-Item-1=032760
Bin-Item-1=32765 Disp-Item-1=032765
Bin-Item-1=32767 Disp-Item-1=032767
```

against all types of numeric data items (even USAGE DISPLAY) are slowed down.

Before continuing, it's worth making the point that we're NOT talking about astronomical performance degradations here. Today's computers are FAST, and a user sitting at the keyboard, running a GNU COBOL program is unlikely to notice. BUT ... if you have a GNU COBOL program that has to process large amounts of data, performing some significant “number crunching” against that data as it goes, the impact of truncation could become noticeable.

The demo program shown in [Figure 8-4](#) compares the performance of performing arithmetic operations (in a totally non-scientific, non-rigorous way) against USAGE DISPLAY, COMP, COMP-5 and BINARY-xxx<sup>54</sup> numeric data. It was actually my intent when I first wrote the program to merely demonstrate the relative performance differences between the first three types of numeric data storage, and it certainly met that objective.

Imagine my surprise, however, when I discovered that the use of “-fnotrunc” also made a significant difference!

Figure 8-3 - A Binary Truncation Demo Program

```
IDENTIFICATION DIVISION.
PROGRAM-ID. DEMOTRUNC.
ENVIRONMENT DIVISION.
DATA DIVISION.
WORKING-STORAGE SECTION.
01 Bin-Item-1          PIC 9(3)
                           COMP-5
                           VALUE 32760 .
                           PIC 9(6).
01 Disp-Item-1
PROCEDURE DIVISION.
000-Main.
MOVE Bin-Item-1 TO Disp-Item-1
DISPLAY
  'Bin-Item-1=' Bin-Item-1
  ' Disp-Item-1=' Disp-Item-1
END-DISPLAY
ADD 5                  TO Bin-Item-1
MOVE Bin-Item-1 TO Disp-Item-1
DISPLAY
  'Bin-Item-1=' Bin-Item-1
  ' Disp-Item-1=' Disp-Item-1
END-DISPLAY
MOVE 32767             TO Bin-Item-1
MOVE Bin-Item-1 TO Disp-Item-1
DISPLAY
  'Bin-Item-1=' Bin-Item-1
  ' Disp-Item-1=' Disp-Item-1
END-DISPLAY
STOP RUN.
```

If this was all there was to the binary truncation issue it wouldn't be worth a section in this document. The fact is, however, that binary truncation has a significant effect on the performance of GNU COBOL programs. When binary truncation is in effect, arithmetic operations performed

<sup>54</sup> USAGE BINARY-xxx is supposed to store numeric data identically to USAGE COMP-5, but I felt it couldn't hurt to check.

Here's what the program does:

- ▶ There are four numeric data items in the program – one USAGE DISPLAY, one USAGE COMP, one USAGE COMP-5 and one USAGE BINARY-LONG. Since the program was run on a computer with an Intel-architecture processor (actually it's an AMD, but results are identical with Intel) I wanted to see just how much more efficient COMP-5 was over COMP.
- ▶ Each data item will have 7 added to it ten million times. You'll see why shortly.
- ▶ The time (to one-one-hundredth of a second) will be retrieved before and after each test and the difference between the two will be DISPLAYed. This is why the computations were done so many times – it was to make sure the timing was "measurable" with only a 1/100 second "stopwatch".

GNU COBOL is retrieving wall-clock time, not actual CPU-used time, so other activities taking place on the computer had to be kept to a minimum while the tests were running. I also ran the tests multiple times, just to make sure I had consistent results (I did). Like I mentioned earlier – this is not a rigorous, scientific benchmark of numeric performance; it's just a quick-and-dirty comparison.

[Figure 8-4](#) shows the program and the test results received when executing both with and without the “**-fnotrunc**” switch.

Here are the conclusions I drew from running these tests many times (30). The timings shown are average times from all Tests

With truncation ON:

- ▶ USAGE COMP has a significant performance advantage over USAGE DISPLAY
- ▶ USAGE COMP-5 has an even greater performance advantage over USAGE COMP, than COMP did over DISPLAY
- ▶ USAGE BINARY-LONG (and presumably the other BINARY-xxx USAGES as well) perform identically (within the measurement tolerances of the test) with COMP-5; this should be no surprise since COMP-5 and BINARY-xxx both allocate data the same way

With truncation OFF:

- ▶ There was a huge drop in both USAGE DISPLAY and USAGE COMP timings.
- ▶ The relative performance advantage of USAGE COMP over USAGE DISPLAY is even larger with truncation off than it was with it on.
- ▶ USAGE COMP-5 and USAGE BINARY-xxx appear to be virtually unaffected by the truncation on/off status, although there was a .01 second increase in average execution time of those tests without truncation over those with truncation. Given the number of times I ran the tests, it's obvious that something makes COMP-5/BINARY-xxx run slower without truncation than with it; that difference, however, is so minuscule that I discount it as being statistically irrelevant<sup>55</sup>.

My final observation is that I see absolutely no reason whatsoever why the “**-fnotrunc**” option shouldn't be used on all GNU COBOL compilations.

If you want to squeeze every last bit of performance out of your GNU COBOL programs, don't forget to investigate the various “**-O**” (optimization) switches. Actually run programs using various optimization switches (or not) and compare execution times, don't just compare the generated C code because sometimes the differences can't be “seen” at the C source-code level.

---

<sup>55</sup> Remember – that's a .01 second difference over TEN MILLION iterations!

Figure 8-4 - A Non-Scientific Comparison of Numeric Data Item USAGE Performance

```

IDENTIFICATION DIVISION.
PROGRAM-ID. DEMOMATH.
DATA DIVISION.
WORKING-STORAGE SECTION.
01 Begin-Time.
  05 BT-HH          PIC 9(2).
  05 BT-MM          PIC 9(2).
  05 BT-SS          PIC 9(2).
  05 BT-HU          PIC 9(2).
01 Binary-Item      BINARY-LONG SIGNED VALUE 0.
01 Comp-Item        COMP    PIC S9(9)  VALUE 0.
01 Comp-5-Item      COMP-5   PIC S9(9)  VALUE 0.
01 Display-Item     DISPLAY  PIC S9(9)  VALUE 0.
01 End-Time.
  05 ET-HH          PIC 9(2).
  05 ET-MM          PIC 9(2).
  05 ET-SS          PIC 9(2).
  05 ET-HU          PIC 9(2).
78 Repeat-Count     VALUE 10000000.
01 Time-Diff        PIC ZZ9.99.

PROCEDURE DIVISION.
010-Test-Usage-DISPLAY.
  ACCEPT Begin-Time FROM TIME END-ACCEPT
  PERFORM Repeat-Count TIMES ADD 7 TO Display-Item END-PERFORM
  PERFORM 100-Determine-Time-Diff
  DISPLAY 'USAGE DISPLAY: ' Time-Diff ' SECONDS' END-DISPLAY.

020-Test-Usage-COMP.
  ACCEPT Begin-Time FROM TIME END-ACCEPT
  PERFORM Repeat-Count TIMES ADD 7 TO Comp-Item END-PERFORM
  PERFORM 100-Determine-Time-Diff
  DISPLAY 'USAGE COMP:   ' Time-Diff ' SECONDS' END-DISPLAY.

030-Test-Usage-COMP-5.
  ACCEPT Begin-Time FROM TIME END-ACCEPT
  PERFORM Repeat-Count TIMES ADD 7 TO Comp-5-Item END-PERFORM
  PERFORM 100-Determine-Time-Diff
  DISPLAY 'USAGE COMP-5:  ' Time-Diff ' SECONDS' END-DISPLAY.

040-Test-Usage-BINARY.
  ACCEPT Begin-Time FROM TIME END-ACCEPT
  PERFORM Repeat-Count TIMES ADD 7 TO Binary-Item END-PERFORM
  PERFORM 100-Determine-Time-Diff
  DISPLAY 'USAGE BINARY:  ' Time-Diff ' SECONDS' END-DISPLAY.

099-Done.
  STOP RUN.

100-Determine-Time-Diff.
  ACCEPT End-Time FROM TIME END-ACCEPT
  COMPUTE Time-Diff =
    ( (ET-HH * 360000 + ET-MM * 6000 + ET-SS * 100 + ET-HU)
    - (BT-HH * 360000 + BT-MM * 6000 + BT-SS * 100 + BT-HU) )
    / 100.


```

Results with truncation turned on (the default)

|                |              |
|----------------|--------------|
| USAGE DISPLAY: | 6.49 SECONDS |
| USAGE COMP:    | 2.81 SECONDS |
| USAGE COMP-5:  | 0.04 SECONDS |
| USAGE BINARY:  | 0.04 SECONDS |

Results with truncation turned off ("fnotrunc" used on 'cdbc')

|                |              |
|----------------|--------------|
| USAGE DISPLAY: | 0.69 SECONDS |
| USAGE COMP:    | 0.06 SECONDS |
| USAGE COMP-5:  | 0.05 SECONDS |
| USAGE BINARY:  | 0.05 SECONDS |

## 9. So, You're a New COBOL Programmer?

This chapter deals with a variety of stylistic issues that may be of interest to someone who is just starting out learning and using COBOL. Much of this chapter makes stylistic recommendations and suggestions for how to write your own programs. The sample programs in chapter [10](#) ("Sample Programs") were coded using almost all of these recommendations.

There's no particular order of importance to the topics presented here.

### 9.1. Marking Changes in Programs

For quite a while now (back to the 1980s), the "sequence number area" of a COBOL statement (columns 1-6) has come to be used as a change indicator area. Programmers would place a code in columns 1-6 of every line they changed in a program. The author works in a COBOL shop where change indicators of the form "xxmmyy" are required on every altered line of a program – "xx" is the initials of the programmer while "mmyy" are the month and two-digit year of the date the change was made. This is frequently accompanied by a comment block at or near the top of a COBOL program providing general documentation of what changes were made and what change indicator was used to mark that change.

The GCic sample program source listing provides an excellent example of such documentation.

This technique of using columns 1-6 as a change indicator will ONLY work if fixed source-record format is in effect.

Marking changes becomes more of a challenge when free-format source code is in effect. Creating a top-of-program comment block to generically describe changes that have been made isn't difficult, even in free-form. What IS difficult, however, is coming up with a scheme for per-statement markup of changes that doesn't introduce a ridiculously excessive number of source lines to the program. I'm not sure there is a good answer to this problem (if a reader has one, please let me know). Generally, I've noticed that shops using free-format conventions for their COBOL source tend to stick with just the top-of-program comment block combined with minimal comment blocks sprinkled throughout the program noting areas that underwent major changes.

#### *See Also...*

|                          |                         |
|--------------------------|-------------------------|
| Fixed-Format Source Code | <a href="#">1.5.1.1</a> |
|--------------------------|-------------------------|

|                       |                      |
|-----------------------|----------------------|
| Sample Programs: GCic | <a href="#">10.4</a> |
|-----------------------|----------------------|

### 9.2. Data Item Coding and Naming Conventions

When programs get very large, it becomes more and more challenging to keep track of the data items that will be used in the program. Here are, in no particular order of importance, are a variety of conventions that can simplify that problem.

Remember that the points described here are intended to make things easier for you – the programmer. No COBOL compiler cares one way or another whether any of these suggestions are followed.

1. Avoid the use of level 77 data items in new programs. Once (1968 and before) there were valid reasons for creating level-77 data items, but since the 1974 ANSI standard of COBOL there really hasn't been any reason why an elementary level-01 data item couldn't have been used instead of a level-77 item.
2. Allocate level-01 data items in alphabetical sequence in the program source wherever practical. This will make it vastly easier to locate the definition of an 01-level item in the program source.
3. Consider prefixing data items with an indication of where in the program structure they were created. For example:
  - Everything defined in the **FILE SECTION** starts with "F-"
  - Everything defined in **WORKING-STORAGE** starts with "WS-"
  - Everything defined in **LOCAL-STORAGE** starts with "LS-"
  - Everything defined in the **LINKAGE SECTION** starts with "L-"
  - Everything defined in the **SCREEN SECTION** starts with "S-"

A convention such as this makes it simple, when you're reviewing code in the **PROCEDURE DIVISION**, to know what section of the **DATA DIVISION** to look in to locate the detailed description of a data item.

4. Consider including an acronym to be inserted into the name of any data item defined directly or indirectly subordinate to an 01-level item, typically to be specified after any section-level tag, if you're using them, as discussed in item #3 above. For example, consider the names used in the following structure:

```
01 WS-FILE-STATUS-MESSAGE.
  05 FILLER          PIC X(13) VALUE 'Status Code: '.
  05 WS-FSM-Status-CD  PIC 9(2).
  05 FILLER          PIC X(11) VALUE ', Meaning: '.
  05 WS-FSM-Msg-TXT   PIC X(25).
```

The “-FSM-” acronyms make it easier to locate – in the program source code - the description of the 01-item the status code and message text items belong to.

5. Consider including a trailing descriptor of the nature of all data items in their names. Two examples of this – “-CD” and “-TXT” were included in the above example. The following chart presents a variety of such descriptors the author has encountered and used through the years:

| Descriptor | Usage                                                                                                                                                                  |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -ADDR      | The data item contains all or a part of an Address (City-ADDR, State-ADDR, Street-ADDR, ...)                                                                           |
| -BOOL      | A level-88 data item (which only has the value TRUE or FALSE)                                                                                                          |
| -CD        | A CODE whose value denotes information content above and beyond that of the mere value itself. Some examples could be “Error-CD”, “Status-CD”, “Billing-CD”            |
| -CHR       | A data item containing a single character of data.                                                                                                                     |
| -CONST     | A constant, specified as a level-78 data item, a level-01 item with the CONST attribute                                                                                |
| -DT        | The data item contains a complete or partial date (Birth-DT, Birth-Month-DT, Birth-Year-DT, ...)                                                                       |
| -DTTM      | A data item containing both a date and a time                                                                                                                          |
| -FILE      | A file name. Note that these items would probably also have a “F-” prefix.                                                                                             |
| -IDX       | A data item used as a table index (see section <a href="#">9.3</a> )                                                                                                   |
| -NM        | All or a portion of a person's name. These could be extended to include business names, product names, etc.                                                            |
| -PTR       | A data item whose <b>USAGE</b> is <b>POINTER</b>                                                                                                                       |
| -NUM       | A generic numeric data item that doesn't fit into any of the other categories                                                                                          |
| -QTY       | A count of something                                                                                                                                                   |
| -REC       | An 01-level item defined in the <b>FILE SECTION</b> (constituting the layout of a record within a file). Note that these items would probably also have a “F-” prefix. |
| -SCR       | The data item contains a complete or partial screen description (appropriate for <b>SCREEN SECTION</b> 01-level data items).                                           |
| -SUB       | A numeric item used as a table subscript (see section <a href="#">9.3</a> )                                                                                            |
| -TEL       | All or part of a telephone number                                                                                                                                      |
| -TM        | The data item contains a complete or partial time value                                                                                                                |
| -TXT       | The data item contains generic alphanumeric text that doesn't fit into any of the other categories.                                                                    |

The above is by no means an exhaustive list, but good programmers will use as few of these descriptors as possible as having too many defeats any benefits of such classification/documentation efforts.

## 9.3. Table Subscripting versus Table Indexing

The elements of a table may be referenced either using a subscript or an index. Syntactically, this is coded using parenthesis, as per the following three examples, all of which store the letter “A” into the 17<sup>th</sup> occurrence of a data item named WSS- Output-Image-TXT:

1. **MOVE 'A' TO WSS-Output-Image-TXT (17)**
2. **MOVE 17 TO WSS-OI-SUB  
MOVE 'A' TO WSS-Output-Image-TXT (WSS-OI-SUB)**
3. **SET WSS-OI-IDX TO 17**

**MOVE 'A' TO WSS-Output-Image-TXT (WSS-OI-IDX)**

Examples 1 and 2 are referred to as subscripting while example 3 is known as indexing. The distinction is fairly simple – INDEXING is the process of referencing an element of a table utilizing a data item with an explicitly or implicitly defined USAGE of INDEX to select the desired occurrence, while SUBSCRIPTING is the process of referencing an element of a table utilizing either a numeric constant or an unedited numeric data item to select the desired occurrence.

Various implementations of COBOL generate object code that is quite different in each of these three situations, and GNU COBOL is no exception. In general, table references such as example #1 (constant subscript) generate the smallest, simplest and fastest object code while table references such as example #2 (numeric data item subscript) generate the largest, most-complicated and slowest object code. Table references such as example #3 (table indexing) generate object code that falls in the middle of the other two but is far closer in efficiency to example #1 than #2.

Some COBOL statements (SEARCH, SEARCH ALL and table-based SORT) require you to index the affected table and to utilize that index with those statements. With any other references to tables, the choice is left to the programmer as to which approach should be used. In general, follow these rules:

1. Use constant subscripts (example #1) wherever possible/practical.
2. If references to table elements are going to be performed many, many times (tens or hundreds of thousands of times or more) during program execution, you will probably see a noticeable improvement in program execution time if you use indexing versus subscripting.

Since it's impossible to perform any arithmetic operation against an index data item directly (other than a simple incrementation or decrementation operation), situations where any non-trivial computations are required to calculate the effective occurrence number for a table reference will require you to use a numeric data item to serve as the receiving field for the calculation. That calculated value would then need to be saved into the index data item via a SET statement.

If you only need to use the computed occurrence number once, you might as well just use the computed occurrence number data item as a subscript. If, however, you will need to use a computed “subscript” more than once, the run-time overhead of converting that occurrence value to an index (via SET) will be worth the coding effort.

Whew!

3. If references to table elements are not going to be performed many, many times it probably won't make much difference whether you use indexing or subscripting.

If you are comfortable with the “C” programming language, you might find the following simple GNU COBOL program useful in exploring the differences between subscripting and indexing:

```

IDENTIFICATION DIVISION.
PROGRAM-ID. SUBVSINDEX.
DATA DIVISION.
WORKING-STORAGE SECTION.
01 WS-TABLE-SUB          BINARY-LONG .
01 WS-TABLE.
   05 WS-TABLE-ENTRY      OCCURS 20 TIMES
                           INDEXED BY WS-TABLE-IDX
                           PIC X(1).

PROCEDURE DIVISION.
000-Main SECTION.
E1. MOVE 'A' TO WS-TABLE-ENTRY (17)
.
E2. MOVE 17 TO WS-TABLE-SUB
   MOVE 'A' TO WS-TABLE-ENTRY (WS-TABLE-SUB)
.
E3. SET WS-TABLE-IDX TO 17
   MOVE 'A' TO WS-TABLE-ENTRY (WS-TABLE-SUB)
.

```

Compile this program as follows (the assumption is made that you are executing the cobc command from the directory in which the above program source code (**subvsindex.cbl**) exists.

```
cobc -C -save-temp subvsindex.cbl
```

After this command is executed, the files “**subvsindex.c**” will contain the “PROCEDURE DIVISION” C code and “**subvsindex.c.1.h**” will contain the “WORKING-STORAGE” C code.

#### *See Also...*

|                                                                  |                                                          |
|------------------------------------------------------------------|----------------------------------------------------------|
| Giving a Data Item a Compile-Time VALUE <a href="#">5.2.1.12</a> | The SEARCH ALL Statement <a href="#">6.4.38.2</a>        |
| Referencing Table Entries <a href="#">6.1.1</a>                  | The SORT Statement (Table Sort) <a href="#">6.4.40.2</a> |
| The SEARCH Statement <a href="#">6.4.38.1</a>                    | The SET (Index) Statement <a href="#">6.2.39.4</a>       |
| The SET UP/DOWN Statement <a href="#">6.2.39.5</a>               |                                                          |

## 9.4. Copybook Naming Conventions and Usage

Since the intent of a copybook is to introduce COBOL code into a particular spot in a program via the COPY statement, it is always a good idea to prefix copybook names with a two-character sequence that identifies where in a program it's contents are intended to be COPYed.

For example:

- IDxxxxxxxx** copybooks containing code intended for the **IDENTIFICATION DIVISION**. These will be rare as you almost never encounter COPYed code in the **IDENTIFICATION DIVISION**.
- EDxxxxxxxx** copybooks containing code intended for use in the **ENVIRONMENT DIVISION**. These copybooks are generally used for predefined **SPECIAL-NAMES** or **FILE-CONTROL** syntax,
- DDxxxxxxxx** copybooks that contain data definitions.
- PDxxxxxxxx** copybooks that contain executable instructions.

## 9.5. PROCEDURE DIVISION Sections Versus Paragraphs

The issue of whether to use section and/or paragraph names (collectively referred to as *procedure names*) within the PROCEDURE DIVISION is one approaching religious significance with many COBOL programmers.

COBOL programming standards used by many organizations that use the language generally call for procedure names to:

1. Contain a leading numeric component
2. Be defined in the PROCEDURE DIVISION in non-decreasing sequence of that numeric component.

When you are looking at or editing any large COBOL program that has been created with programming standards that include these two rules, it is always a simple thing to know whether a reference to a procedure is being made to code that exists before or after your current location in the program!

Technically, GNU COBOL does not require ANY procedure names be defined unless:

1. You are using the **ALTER** statement (the use of which should be avoided at all costs)
2. You are using Format 1 of the **PERFORM** Statement
3. You are using a **GO TO** Statement
4. You are using a **SORT** or **MERGE** statement with either (or both) an INPUT PROCEDURE or OUTPUT PROCEDURE

Since it is difficult to write any non-trivial COBOL program that uses none of the above, lets assume you will be including at least one section or paragraph in your GNU COBOL programs.

I like to use PROCEDURE DIVISION paragraphs and sections as follows.

1. The very first procedure defined in the PROCEDURE DIVISION of my programs, assuming no DECLARATIVES are defined, will be a SECTION named “**000-Main**”. The declaration of this procedure will immediately follow the PROCEDURE DIVISION header (or **END DECLARATIVES** if DECLARATIVES are used).
2. Any procedures referenced by **MERGE**, **PERFORM**, or **SORT** statements will be defined as their own sections.
3. Any procedures referenced by **GO TO** statements will be defined as paragraphs, and those paragraphs will be defined in the same section as the **GO TO** statements that reference them. In other words, **GO TO** statements may not be used to transfer control to a point in a different section. This is NOT a GNU COBOL rule – this is my own personal rule intended to improve the readability of my programs.
4. I always include a numeric prefix to all procedure names I define, and those numbers are assigned in non-decreasing sequence of their value. Thus it is always possible, provided you know in what procedure the **GO TO**, **MERGE**, **PERFORM** or **SORT** statement you are looking at is located, to know whether you should look forward or backward in the program to find the procedure the statement is referencing.
5. I do not use **THRU** on any **MERGE**, **PERFORM** or **SORT** statement unless the programming standards of the shop in which I am working requires it.. My reasoning for this is that it is too easy to accidentally introduce a new procedure into the scope of a **PERFORM**.

*See Also...*

|                                                                        |                                                                        |
|------------------------------------------------------------------------|------------------------------------------------------------------------|
| The <b>USE</b> Statement and <b>DECLARATIVES</b> <a href="#">6.1.4</a> | The <b>GO TO</b> Statement <a href="#">6.2.20</a>                      |
| The <b>ALTER</b> Statement <a href="#">6.2.4</a>                       | The <b>MERGE</b> Statement <a href="#">6.2.25</a>                      |
| <b>PERFORM</b> Format 1 - Procedural <a href="#">6.2.30.1</a>          | <b>SORT</b> Format 1 – File-based <b>SORT</b> <a href="#">6.2.40.1</a> |

## 9.6. COMPUTE Versus ADD, SUBTRACT, MULTIPLY and DIVIDE

Over the years, there has been much debate over the effectiveness, appropriateness and arithmetic accuracy of using the **COMPUTE** statement rather than the four basic arithmetic operation statements (**ADD**, **SUBTRACT**, **MULTIPLY**, **DIVIDE**).

Here are the facts. Draw your own conclusions as to which approach is more appropriate under which circumstances.

1. The **COMPUTE** statement supports exponentiation (via the “\*\*” operator) – there is no equivalent basic arithmetic statement. Although you could simulate integral exponentiation (raising a value to the third power, for example) using **MULTIPLY** statements, and you may use the **SQRT** built-in intrinsic function to find a square root, there’s just no (easy) way to find the  $\sqrt[4]{}$  root of a value without using **COMPUTE**.
2. For non-trivial computations, **COMPUTE** statements “read” better. Take this, for example:

**COMPUTE R = (A + B \* C) / D**

As compared to:

```
MULTIPLY B BY C GIVING TEMP
ADD A TO TEMP
DIVIDE TEMP BY D GIVING R
```

3. For non-trivial computations, **COMPUTE** statements may execute faster than the equivalent chain of basic arithmetic statements. For example, the **COMPUTE** statement shown in #2 above executes about 25% faster on than does the **MULTIPLY-ADD-DIVIDE** sequence.
4. For trivial computations, on the other hand, I prefer the inherent readability of a statement such as this:

**ADD 1 TO WSS-Input-Trans-QTY**

to this:

**COMPUTE WSS-Input-Trans-QTY = WSS-Input-Trans-QTY + 1**

*See Also...*

|                                                    |                                                      |
|----------------------------------------------------|------------------------------------------------------|
| The <b>ADD</b> Statement <a href="#">6.2.2</a>     | The <b>MULTIPLY</b> Statement <a href="#">6.2.27</a> |
| The <b>COMPUTE</b> Statement <a href="#">6.2.9</a> | The <b>SUBTRACT</b> Statement <a href="#">6.2.44</a> |

The **DIVIDE** Statement [6.2.13](#)

## 10. Sample Programs

This chapter contains some sample GNU COBOL programs, subroutines, functions and copybooks. All code shown here is included in release-appropriate form within the “samples” directory of GNU COBOL distributions that I prepare. They are also available upon request using the email address on the cover.

All program listings were created by the **GCic GNU COBOL Interactive Compiler** (itself a sample program listed in section [10.4](#)).

### 10.1. FileStat-Msgs.cpy – File Status Values

The **FileStat-Msgs.cpy** copybook contains an **EVALUATE** statement to translate the two-digit file status codes that may be generated by file I/O statements.

The copybook assumes that the file status data item name is “**STATUS**” and the error message data item is named “**MSG**”. By using the **COPY** statement’s **REPLACING** clause, however, you may use the data names you wish, as follows:

```
COPY FileStat-Msgs
  REPLACING STATUS BY file-status-data-item-name
    MSG BY error-message-data-item-name
```

Here's the **FileStat-Msgs.cpy** copybook:

```

EVALUATE STATUS
  WHEN 00 MOVE 'SUCCESS'          ' TO MSG
  WHEN 02 MOVE 'SUCCESS DUPLICATE' ' TO MSG
  WHEN 04 MOVE 'SUCCESS INCOMPLETE' ' TO MSG
  WHEN 05 MOVE 'SUCCESS OPTIONAL' ' TO MSG
  WHEN 07 MOVE 'SUCCESS NO UNIT' ' TO MSG
  WHEN 10 MOVE 'END OF FILE'      ' TO MSG
  WHEN 14 MOVE 'OUT OF KEY RANGE' ' TO MSG
  WHEN 21 MOVE 'KEY INVALID'     ' TO MSG
  WHEN 22 MOVE 'KEY EXISTS'      ' TO MSG
  WHEN 23 MOVE 'KEY NOT EXISTS'   ' TO MSG
  WHEN 30 MOVE 'PERMANENT ERROR'  ' TO MSG
  WHEN 31 MOVE 'INCONSISTENT FILENAME' ' TO MSG
  WHEN 34 MOVE 'BOUNDARY VIOLATION' ' TO MSG
  WHEN 35 MOVE 'FILE NOT FOUND'   ' TO MSG
  WHEN 37 MOVE 'PERMISSION DENIED' ' TO MSG
  WHEN 38 MOVE 'CLOSED WITH LOCK'  ' TO MSG
  WHEN 39 MOVE 'CONFLICT ATTRIBUTE' ' TO MSG
  WHEN 41 MOVE 'ALREADY OPEN'     ' TO MSG
  WHEN 42 MOVE 'NOT OPEN'        ' TO MSG
  WHEN 43 MOVE 'READ NOT DONE'   ' TO MSG
  WHEN 44 MOVE 'RECORD OVERFLOW'  ' TO MSG
  WHEN 46 MOVE 'READ ERROR'      ' TO MSG
  WHEN 47 MOVE 'INPUT DENIED'    ' TO MSG
  WHEN 48 MOVE 'OUTPUT DENIED'   ' TO MSG
  WHEN 49 MOVE 'I/O DENIED'      ' TO MSG
  WHEN 50 MOVE 'RECORD LOCKED'   ' TO MSG
  WHEN 52 MOVE 'END-OF-PAGE'      ' TO MSG
  WHEN 57 MOVE 'I/O LINAGE'      ' TO MSG
  WHEN 61 MOVE 'FILE SHARING FAILURE' ' TO MSG
  WHEN 91 MOVE 'FILE NOT AVAILABLE' ' TO MSG
END-EVALUATE.
```

## 10.2. COBDUMP – A Hex/ASCII Data Dump Subroutine

COBDUMP is a useful little utility subroutine to produce a formatted hexadecimal and character dump of the data area passed to it.

If you follow the GNU COBOL forums, you've undoubtedly heard about the CBL\_OC\_DUMP subroutine that was the winning entry in a GNU COBOL programming contest. It's a great tool for producing data dumps, and it's now included in the official GNU COBOL distributions.

For now though, I'll keep using my good ol' "COBDUMP" routine. It's been my travelling companion from COBOL job to COBOL job since 1971. Here it is, all tuned up for GNU COBOL, with new tires and a fresh coat of paint.

GNU COBOL V2.0 11FEB2012 Source Listing - GCic for Windows/MinGW Copyright (C) 2009 - 2013, Gary L. Cutler, GPL 2013/11/21  
 E:/GNU-COBOL/samples/COBDUMP.cbl  
 Page: 1

| Line | Statement                                                         |
|------|-------------------------------------------------------------------|
| 1    | >>SOURCE FORMAT IS FIXED                                          |
| 2    | IDENTIFICATION DIVISION.                                          |
| 3    | PROGRAM-ID. COBDUMP.                                              |
| 4    | *>*****                                                           |
| 5    | *> This is an OpenCOBOL subroutine that will generate a **        |
| 6    | *> formatted Hex/Char dump of a storage area. To use this **      |
| 7    | *> subroutine, simply CALL it as follows: **                      |
| 8    | *> **                                                             |
| 9    | *> CALL "COBDUMP" USING <data-item> **                            |
| 10   | *> [ <length> ] **                                                |
| 11   | *> **                                                             |
| 12   | *> If specified, the <length> argument specifies how many **      |
| 13   | *> bytes of <data-item> are to be dumped. If absent, all of **    |
| 14   | *> <data-item> will be dumped (i.e. LENGTH(<data-item>) will **   |
| 15   | *> be assumed for <length>). **                                   |
| 16   | *> **                                                             |
| 17   | *> >> Note that the subroutine name MUST be specified in <<< **   |
| 18   | *> >> UPPERCASE <<< **                                            |
| 19   | *> **                                                             |
| 20   | *> The dump is generated to STDERR, so you may pipe it to a **    |
| 21   | *> file when you execute your program using "2> file". **         |
| 22   | *> **                                                             |
| 23   | *> AUTHOR: GARY L. CUTLER **                                      |
| 24   | *> CutlerGL@gmail.com **                                          |
| 25   | *> **                                                             |
| 26   | *> NOTE: The author has a sentimental attachment to **            |
| 27   | *> this subroutine - it's been around since 1971 **               |
| 28   | *> and it's been converted to and run on 10 dif- **               |
| 29   | *> ferent operating system/compiler environments **               |
| 30   | *> **                                                             |
| 31   | *> DATE-WRITTEN: October 14, 1971 **                              |
| 32   | *> **                                                             |
| 33   | *>*****                                                           |
| 34   | *> DATE CHANGE DESCRIPTION **                                     |
| 35   | *> ====== **                                                      |
| 36   | *> GC1071 Initial coding - Univac Dept. of Defense COBOL '68 **   |
| 37   | *> GC0577 Converted to Univac ASCII COBOL (ACOB) - COBOL '74 **   |
| 38   | *> GC1182 Converted to Univac UTS4000 COBOL - COBOL '74 w/ **     |
| 39   | *> SCREEN SECTION enhancements **                                 |
| 40   | *> GC0883 Converted to Honeywell/Bull COBOL - COBOL '74 **        |
| 41   | *> GC0983 Converted to IBM VS COBOL - COBOL '74 **                |
| 42   | *> GC0887 Converted to IBM VS COBOL II - COBOL '85 **             |
| 43   | *> GC1294 Converted to Micro Focus COBOL V3.0 - COBOL '85 w/ **   |
| 44   | *> extensions **                                                  |
| 45   | *> GC0703 Converted to Unisys Universal Compiling System (UCS) ** |
| 46   | *> COBOL (UCOB) - COBOL '85 **                                    |
| 47   | *> GC1204 Converted to Unisys Object COBOL (OCOB) - COBOL 2002 ** |
| 48   | *> GC0609 Converted to OpenCOBOL 1.1 - COBOL '85 w/ some COBOL ** |
| 49   | *> 2002 features **                                               |

```
50      *> GC0410 Enhanced to make 2nd argument (buffer length)      **
51      *>          optional                                **
52      *> GC0211 Ported to IBM Enterprise COBOL          **
53      *> GC0612 Updated for OpenCOBOL 2.0              **
54      *>*****
```

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Line Statement

```
===== =====
55      ENVIRONMENT DIVISION.
56      CONFIGURATION SECTION.
57      REPOSITORY.
58          FUNCTION ALL INTRINSIC.
59      DATA DIVISION.
60          WORKING-STORAGE SECTION.
61              01 WS-Addr-PTR           USAGE POINTER.
62              01 WS-Addr-NUM REDEFINES WS-Addr-PTR
63                                USAGE BINARY-LONG.
64
65              01 WS-Addr-SUB           USAGE BINARY-CHAR.
66
67              01 WS-Addr-Value-NUM     USAGE BINARY-LONG.
68
69              01 WS-Buffer-Byte-CHR.
70                  05 WS-Buffer-Byte-NUM   USAGE BINARY-CHAR.
71
72              01 WS-Buffer-Length-NUM  USAGE BINARY-LONG.
73
74              01 WS-Buffer-SUB         PIC 9(4) COMP-5.
75
76              01 WS-Hex-Digit-TXT VALUE '0123456789ABCDEF'.
77                  05 WS-Hex-Digit-CHR    OCCURS 16 TIMES
78                                PIC X(1).
79
80              01 WS-Nibble-SUB         PIC 9(1) COMP-5.
81
82              01 WS-Nibble-Left-SUB   PIC 9(1) COMP-5.
83
84              01 WS-Nibble-Right-SUB  PIC 9(1) COMP-5.
85
86              01 WS-Output-Detail-TXT.
87                  05 WS-OD-Addr-TXT.
88                      10 WS-OD-Addr-Hex-CHR  OCCURS 8 TIMES PIC X.
89                      05 FILLER             PIC X(1).
90                      05 WS-OD-Relative-Byte-NUM PIC Z(3)9.
91                      05 FILLER             PIC X(1).
92                      05 WS-OD-Hex-TXT       OCCURS 16 TIMES.
93                          10 WS-OD-Hex-1-CHR   PIC X.
94                          10 WS-OD-Hex-2-CHR   PIC X.
95                          10 FILLER             PIC X.
96                  05 WS-OD-ASCII-Data-TXT.
97                      10 WS-OD-ASCII-CHR   OCCURS 16 TIMES
98                                PIC X.
99
100             01 WS-Output-SUB        PIC 9(2) COMP-5.
101
102             >>SOURCE FORMAT IS FREE
103             01 WS-Output-Header-1-TXT.
```

```
104      05 VALUE '<-Addr-> Byte <----- Hexadecimal ''-----> <--- Char --->' PIC X(80).
105
106 01 WS-Output-Header-2-TXT.
107      05 VALUE '===== ===== ===== =====' PIC X(80).
108 >>SOURCE FORMAT IS FIXED
```

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Line Statement

```
109
110      LINKAGE SECTION.
111      01  L-Buffer-TXT          PIC X ANY LENGTH.
112
113      01  L-Buffer-Length-NUM   USAGE BINARY-LONG.
114
115      PROCEDURE DIVISION USING L-Buffer-TXT,
116                      OPTIONAL L-Buffer-Length-NUM.
117
118      000-Main SECTION.
119          IF NUMBER-OF-CALL-PARAMETERS = 1
120              MOVE LENGTH(L-Buffer-TXT) TO WS-Buffer-Length-NUM
121          ELSE
122              MOVE L-Buffer-Length-NUM TO WS-Buffer-Length-NUM
123          END-IF
124          MOVE SPACES TO WS-Output-Detail-TXT
125          SET WS-Addr-PTR TO ADDRESS OF L-Buffer-TXT
126          PERFORM 100-Generate-Address
127          MOVE 0 TO WS-Output-SUB
128          DISPLAY WS-Output-Header-1-TXT UPON SYSERR
129          DISPLAY WS-Output-Header-2-TXT UPON SYSERR
130          PERFORM VARYING WS-Buffer-SUB FROM 1 BY 1
131              UNTIL WS-Buffer-SUB > WS-Buffer-Length-NUM
132          ADD 1 TO WS-Output-SUB
133          IF WS-Output-SUB = 1
134              MOVE WS-Buffer-SUB TO WS-OD-Relative-Byte-NUM
135          END-IF
136          MOVE L-Buffer-TXT (WS-Buffer-SUB : 1)
137              TO WS-OD-ASCII-CHR (WS-Output-SUB)
138                  WS-Buffer-Byte-CHR
139          DIVIDE WS-Buffer-Byte-NUM BY 16
140              GIVING WS-Nibble-Left-SUB
141                  REMAINDER WS-Nibble-Right-SUB
142          ADD 1 TO WS-Nibble-Left-SUB
143              WS-Nibble-Right-SUB
144          MOVE WS-Hex-Digit-CHR (WS-Nibble-Left-SUB)
145              TO WS-OD-Hex-1-CHR (WS-Output-SUB)
146          MOVE WS-Hex-Digit-CHR (WS-Nibble-Right-SUB)
147              TO WS-OD-Hex-2-CHR (WS-Output-SUB)
148          IF WS-Output-SUB = 16
149              CALL "C$PRINTABLE" USING WS-OD-ASCII-Data-TXT
150              DISPLAY WS-Output-Detail-TXT UPON SYSERR
151              MOVE SPACES TO WS-Output-Detail-TXT
152              MOVE 0 TO WS-Output-SUB
153              SET WS-Addr-PTR UP BY 16
154              PERFORM 100-Generate-Address
155          END-IF
156      END-PERFORM
157      IF WS-Output-SUB > 0
158          CALL "C$PRINTABLE" USING WS-OD-ASCII-Data-TXT
```

```
158      DISPLAY WS-Output-Detail-TXT UPON SYSERR
159      END-IF
160      EXIT PROGRAM
161      .
162 100-Generate-Address SECTION.
```

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```
163      MOVE 8 TO WS-Addr-SUB
164      MOVE WS-Addr-NUM TO WS-Addr-Value-NUM
165      MOVE ALL '0' TO WS-OD-Addr-TXT
166      PERFORM WITH TEST BEFORE UNTIL WS-Addr-Value-NUM = 0
167          DIVIDE WS-Addr-Value-NUM BY 16
168              GIVING WS-Addr-Value-NUM
169              REMAINDER WS-Nibble-SUB
170          ADD 1 TO WS-Nibble-SUB
171          MOVE WS-Hex-Digit-CHR (WS-Nibble-SUB)
172              TO WS-OD-Addr-Hex-CHR (WS-Addr-SUB)
173          SUBTRACT 1 FROM WS-Addr-SUB
174      END-PERFORM
175  .
```

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|---------------------|---------------|--------------------------|--------------------------|
| PROGRAM-ID                                                                                                                                                              | Identifier/Register/Function | Defn                | Where Defined | References (* = Updated) | Page: 5                  |
| COBDUMP                                                                                                                                                                 | 000-Main                     | 117 PROCEDURE       |               |                          |                          |
| COBDUMP                                                                                                                                                                 | 100-Generate-Address         | 162 PROCEDURE       | 125           | 153                      |                          |
| COBDUMP                                                                                                                                                                 | L-Buffer-Length-NUM          | 113 LINKAGE         | 116           | 121                      |                          |
| COBDUMP                                                                                                                                                                 | L-Buffer-TXT                 | 111 LINKAGE         | 115           | 119                      | 124 135                  |
| COBDUMP                                                                                                                                                                 | LENGTH                       | PROCEDURE           | 119           |                          |                          |
| COBDUMP                                                                                                                                                                 | NUMBER-OF-CALL-PARAMETERS    | PROCEDURE           | 118           |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-Addr-NUM                  | 62 WORKING-STORAGE  | 164           |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-Addr-PTR                  | 61 WORKING-STORAGE  | 62            | 124*                     | 152*                     |
| COBDUMP                                                                                                                                                                 | WS-Addr-SUB                  | 65 WORKING-STORAGE  | 163*          | 172                      | 173                      |
| COBDUMP                                                                                                                                                                 | WS-Addr-Value-NUM            | 67 WORKING-STORAGE  | 164*          | 166                      | 167 168*                 |
| COBDUMP                                                                                                                                                                 | WS-Buffer-Byte-CHR           | 69 WORKING-STORAGE  | 137           |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-Buffer-Byte-NUM           | 70 WORKING-STORAGE  | 138           |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-Buffer-Length-NUM         | 72 WORKING-STORAGE  | 119*          | 121*                     | 130                      |
| COBDUMP                                                                                                                                                                 | WS-Buffer-SUB                | 74 WORKING-STORAGE  | 129*          | 130                      | 133 135                  |
| COBDUMP                                                                                                                                                                 | WS-Hex-Digit-CHR             | 77 WORKING-STORAGE  | 143           | 145                      | 171                      |
| COBDUMP                                                                                                                                                                 | WS-Hex-Digit-TXT             | 76 WORKING-STORAGE  |               |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-Nibble-Left-SUB           | 82 WORKING-STORAGE  | 139*          | 141*                     | 143                      |
| COBDUMP                                                                                                                                                                 | WS-Nibble-Right-SUB          | 84 WORKING-STORAGE  | 140*          | 142*                     | 145                      |
| COBDUMP                                                                                                                                                                 | WS-Nibble-SUB                | 80 WORKING-STORAGE  | 169*          | 170*                     | 171                      |
| COBDUMP                                                                                                                                                                 | WS-OD-Addr-Hex-CHR           | 88 WORKING-STORAGE  | 172*          |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-OD-Addr-TXT               | 87 WORKING-STORAGE  | 165*          |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-OD-ASCII-CHR              | 97 WORKING-STORAGE  | 136*          |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-OD-ASCII-Data-TXT         | 96 WORKING-STORAGE  | 148*          | 157*                     |                          |
| COBDUMP                                                                                                                                                                 | WS-OD-Hex-1-CHR              | 93 WORKING-STORAGE  | 144*          |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-OD-Hex-2-CHR              | 94 WORKING-STORAGE  | 146*          |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-OD-Hex-TXT                | 92 WORKING-STORAGE  |               |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-OD-Relative-Byte-NUM      | 90 WORKING-STORAGE  | 133*          |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-Output-Detail-TXT         | 86 WORKING-STORAGE  | 123*          | 149                      | 150* 158                 |
| COBDUMP                                                                                                                                                                 | WS-Output-Header-1-TXT       | 103 WORKING-STORAGE | 127           |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-Output-Header-2-TXT       | 106 WORKING-STORAGE | 128           |                          |                          |
| COBDUMP                                                                                                                                                                 | WS-Output-SUB                | 100 WORKING-STORAGE | 126*          | 131*                     | 132 136 144 146 147 151* |
|                                                                                                                                                                         |                              |                     | 156           |                          |                          |

## 10.3. DAY-FROM-DATE – A Function to Determine Day of Week From a Date

DAY-FROM-DATE is a user-defined function that accepts a single argument – either a 7-digit Julian date in the form “yyyyddd” or an 8-digit Gregorian date in the form “yyyymmdd”. This argument may be supplied either as a PIC 9(n) USAGE DISPLAY data item (n=7 or 8) or as a 7- or 8-digit numeric literal.

The subroutine will determine if the supplied date is a valid date in the year range 0000 thru 9999 and what day of the week that date fell on.

The value returned will be zero if the date argument was invalid or an integer in the range 1-7, representing Sunday thru Saturday.

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Line Statement

```

=====
1  >>SOURCE FORMAT IS FIXED
2  IDENTIFICATION DIVISION.
3  FUNCTION-ID. DAY-FROM-DATE.
4  *>***** *****
5  *> This GNU COBOL user-defined function converts a Gregorian or **
6  *> Julian date into a numeric day of the week. **
7  *>*****
8  *> Arguments: **
9  *>
10 *> Calendar-Date A PIC 9 data item or numeric literal which **
11 *> will be treated as a calendar date as fol- **
12 *> lows: **
13 *>
14 *> 7-digit value: Interpreted as a Julian date **
15 *>           in the form yyyyddd **
16 *> 8-digit value: Interpreted as a Gregorian **
17 *>           date in the form yyyyymmdd **
18 *>
19 *> The result returned will be one of the following: **
20 *>
21 *> 0: The supplied date is invalid **
22 *> 1: The supplied date is a Sunday **
23 *> 2: The supplied date is a Monday **
24 *> .
25 *> .
26 *> .
27 *> 7: The supplied date is a Saturday **
28 *>*****
29 ENVIRONMENT DIVISION.
30 CONFIGURATION SECTION.
31 REPOSITORY.
32   FUNCTION ALL INTRINSIC.
33 DATA DIVISION.
34 WORKING-STORAGE SECTION.
35 01 WS-Input-Date-DT.
36    05 WS-ID-YYYY-NUM          PIC 9(4).
37    05 WS-ID-MM-NUM          PIC 9(2).
38    05 WS-ID-DD-NUM          PIC 9(2).
39 01 WS-Y-NUM                BINARY-LONG.
40 01 WS-M-NUM                BINARY-LONG.
41 01 WS-Temp-NUM             BINARY-LONG.
42 LINKAGE SECTION.
43 01 L-Input-Date-DT         PIC 9 ANY LENGTH.
44 01 L-Output-Day-NUM        USAGE BINARY-LONG
45                           SIGNED.
46 PROCEDURE DIVISION USING L-Input-Date-DT
47           RETURNING L-Output-Day-NUM.
48 000-Main SECTION.
49   CALL "C$PARAMSIZE" USING 1
50   EVALUATE RETURN-CODE
51   WHEN 7
52     IF TEST-DAY-YYYYDDD(L-Input-Date-DT) > 0
53       MOVE 0 TO L-Output-Day-NUM
54       GOBACK

```

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| Line | Statement                                                           |
|------|---------------------------------------------------------------------|
| 55   | END-IF                                                              |
| 56   | MOVE DATE-OF-INTEGER(INTEGER-OF-DAY(L-Input-Date-DT))               |
| 57   | TO WS-Input-Date-DT                                                 |
| 58   | WHEN 8                                                              |
| 59   | IF TEST-DATE-YYYYMMDD(L-Input-Date-DT) > 0                          |
| 60   | MOVE 0 TO L-Output-Day-NUM                                          |
| 61   | GOBACK                                                              |
| 62   | END-IF                                                              |
| 63   | MOVE L-Input-Date-DT TO WS-Input-Date-DT                            |
| 64   | WHEN OTHER                                                          |
| 65   | MOVE 0 TO L-Output-Day-NUM                                          |
| 66   | GOBACK                                                              |
| 67   | END-EVALUATE                                                        |
| 68   | **> IF january OR february                                          |
| 69   | **>   y = year - 1                                                  |
| 70   | **>   m = month + 10                                                |
| 71   | **> ELSE                                                            |
| 72   | **>   y = year                                                      |
| 73   | **>   m = month - 2                                                 |
| 74   | **> END-IF                                                          |
| 75   | **> For Gregorian calendar:                                         |
| 76   | **>   result = (day + y + y/4 - y/100 + y/400 + (31*m)/12) mod 7    |
| 77   | **> (All divisions are integer divisions, discarding any remainder) |
| 78   | IF WS-ID-MM-NUM = 1 OR 2                                            |
| 79   | SUBTRACT 1 FROM WS-ID-YYYY-NUM GIVING WS-Y-NUM                      |
| 80   | ADD WS-ID-MM-NUM, 10 GIVING WS-M-NUM                                |
| 81   | ELSE                                                                |
| 82   | MOVE WS-ID-YYYY-NUM TO WS-Y-NUM                                     |
| 83   | SUBTRACT 2 FROM WS-ID-MM-NUM GIVING WS-M-NUM                        |
| 84   | END-IF                                                              |
| 85   | COMPUTE L-Output-Day-NUM =                                          |
| 86   | WS-ID-DD-NUM                                                        |
| 87   | + WS-Y-NUM                                                          |
| 88   | + INTEGER(WS-Y-NUM/4)                                               |
| 89   | - INTEGER(WS-Y-NUM/100)                                             |
| 90   | + INTEGER(WS-Y-NUM/400)                                             |
| 91   | + INTEGER((31*WS-M-NUM)/12)                                         |
| 92   | DIVIDE L-Output-Day-NUM BY 7                                        |
| 93   | GIVING WS-Temp-NUM                                                  |
| 94   | REMAINDER L-Output-Day-NUM                                          |
| 95   | ADD 1 TO L-Output-Day-NUM                                           |
| 96   | GOBACK                                                              |
| 97   | .                                                                   |
| 98   |                                                                     |

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------|-----------------|--------------------------|-----|-----|---------|
| PROGRAM-ID                                                                                                                                                                    | Identifier/Register/Function | Defn | Where Defined   | References (* = Updated) |     |     | Page: 3 |
| DAY-FROM-DATE                                                                                                                                                                 | 000-Main                     | 48   | PROCEDURE       |                          |     |     |         |
| DAY-FROM-DATE                                                                                                                                                                 | DATE-OF-INTEGER              |      | PROCEDURE       | 56                       |     |     |         |
| DAY-FROM-DATE                                                                                                                                                                 | INTEGER                      |      | PROCEDURE       | 88                       | 89  | 90  | 91      |
| DAY-FROM-DATE                                                                                                                                                                 | INTEGER-OF-DAY               |      | PROCEDURE       | 56                       |     |     |         |
| DAY-FROM-DATE                                                                                                                                                                 | L-Input-Date-DT              | 43   | LINKAGE         | 46                       | 52  | 56  | 59      |
| DAY-FROM-DATE                                                                                                                                                                 | L-Output-Day-NUM             | 44   | LINKAGE         | 47                       | 53* | 60* | 65*     |
| DAY-FROM-DATE                                                                                                                                                                 | RETURN-CODE                  |      | PROCEDURE       | 50                       |     |     |         |
| DAY-FROM-DATE                                                                                                                                                                 | TEST-DATE-YYYYMMDD           |      | PROCEDURE       | 59                       |     |     |         |
| DAY-FROM-DATE                                                                                                                                                                 | TEST-DAY-YYYYDDD             |      | PROCEDURE       | 52                       |     |     |         |
| DAY-FROM-DATE                                                                                                                                                                 | WS-ID-DD-NUM                 | 38   | WORKING-STORAGE | 86                       |     |     |         |
| DAY-FROM-DATE                                                                                                                                                                 | WS-ID-MM-NUM                 | 37   | WORKING-STORAGE | 78                       | 80  | 83  |         |
| DAY-FROM-DATE                                                                                                                                                                 | WS-ID-YYYY-NUM               | 36   | WORKING-STORAGE | 79                       | 82  |     |         |
| DAY-FROM-DATE                                                                                                                                                                 | WS-Input-Date-DT             | 35   | WORKING-STORAGE | 57*                      | 63* |     |         |
| DAY-FROM-DATE                                                                                                                                                                 | WS-M-NUM                     | 40   | WORKING-STORAGE | 80*                      | 83* | 91  |         |
| DAY-FROM-DATE                                                                                                                                                                 | WS-Temp-NUM                  | 41   | WORKING-STORAGE | 93*                      |     |     |         |
| DAY-FROM-DATE                                                                                                                                                                 | WS-Y-NUM                     | 39   | WORKING-STORAGE | 79*                      | 82* | 87  | 88      |
|                                                                                                                                                                               |                              |      |                 |                          |     | 89  | 90      |

## 10.4. GCic – an Interactive GNU COBOL Full-Screen Compiler Front-End

This is MUCH more than a mere demonstration program – it's also a very practical utility! The “GCic” (GNU COBOL Interactive Compiler) is a TUI (Textual User Interface) program that may be used as a full-screen interface to the “cobic” compiler. In addition, GCic can produce neat, concise and useful cross-reference listings of GNU COBOL programs, showing not only where user-defined names and built-in registers and intrinsic functions are referenced, but also where user-defined data items ARE MODIFIED by program code! The program is well documented (IMHO) and you should find it fairly easy to follow. The GCic.cbl program was written to work with a native Windows or Windows/MinGW build of GNU COBOL as well as a Windows/Cygwin, UNIX or OS X build.

Source listings generated by GCic will show the original source code of your programs, with all indentation and comments preserved. Additionally, any COPYed code will be included in the listing immediately (in compressed form) following the COPY statement that triggered its inclusion into your program.

Cross-reference listings will show all user-defined data items and procedures as well as intrinsic function and special register references. In addition to showing the line numbers at which items were defined and referenced, those references that MODIFY the contents of the data item will have an asterisk appended to them.

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| Line | Statement                                                                                                                                                                                                                                                          |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | >>SOURCE FORMAT IS FIXED                                                                                                                                                                                                                                           |
| 2    | *> CONFIGURATION SETTINGS: Set these switches before compiling:                                                                                                                                                                                                    |
| 3    | *>                                                                                                                                                                                                                                                                 |
| 4    | *> LINEDRAW Set to:                                                                                                                                                                                                                                                |
| 5    | *> 0 To use spaces (no lines)                                                                                                                                                                                                                                      |
| 6    | *> 1 To use the line-drawing characterset (PC codepage 437)                                                                                                                                                                                                        |
| 7    | *> 2 To use conventional ASCII characters (+, -,  )                                                                                                                                                                                                                |
| 8    | *>                                                                                                                                                                                                                                                                 |
| 9    | *> OSX USERS - To use the linedrawing characterset,<br>10 *> set your 'terminal' font to 'Lucida Console'                                                                                                                                                          |
| 11   | *>                                                                                                                                                                                                                                                                 |
| 12   | *> OS Set to one of the following:<br>13 *> 'CYGWIN' For a Windows/Cygwin version<br>14 *> 'MINGW' For a Windows/MinGW version<br>15 *> 'OSX' For a Macintosh OSX version<br>16 *> 'UNIX' For a Unix/Linux version<br>17 *> 'WINDOWS' For a Native Windows version |
| 18   | *>                                                                                                                                                                                                                                                                 |
| 19   | *> SELCHAR Set to the desired single character to be used as the red<br>20 *> 'feature selected' character on the screen.                                                                                                                                          |
| 21   | *> SUGGESTIONS: '>', '*', '=', '+'                                                                                                                                                                                                                                 |
| 22   | *>                                                                                                                                                                                                                                                                 |
| 23   | GC0712 >>DEFINE CONSTANT LINEDRAW AS 1                                                                                                                                                                                                                             |
| 24   | GC0712 >>DEFINE CONSTANT OS AS 'MINGW'                                                                                                                                                                                                                             |
| 25   | GC0712 >>DEFINE CONSTANT SELCHAR AS '>'                                                                                                                                                                                                                            |
| 26   | *> -----                                                                                                                                                                                                                                                           |
| 27   | *> Now set these switches to establish initial (default) settings<br>28 *> for the various on-screen options. Set them to a value of<br>29 *> 0 if they are to be 'OFF' and 1 if they are to be 'ON'                                                               |
| 30   | *>                                                                                                                                                                                                                                                                 |
| 31   | GC0712 >>DEFINE CONSTANT F1 AS 0 *> Assume WITH DEBUGGING MODE                                                                                                                                                                                                     |
| 32   | GC0712 >>DEFINE CONSTANT F2 AS 0 *> Procedure+Statement Trace                                                                                                                                                                                                      |
| 33   | GC0712 >>DEFINE CONSTANT F3 AS 0 *> Make A Library (DLL)                                                                                                                                                                                                           |
| 34   | GC0712 >>DEFINE CONSTANT F4 AS 0 *> Execute If Compilation OK                                                                                                                                                                                                      |
| 35   | GC0712 >>DEFINE CONSTANT F5 AS 0 *> Generate Listings                                                                                                                                                                                                              |
| 36   | GC0712 >>DEFINE CONSTANT F6 AS 1 *> "FUNCTION" Is Optional                                                                                                                                                                                                         |
| 37   | GC0712 >>DEFINE CONSTANT F7 AS 1 *> Enable All Warnings                                                                                                                                                                                                            |
| 38   | GC0712 >>DEFINE CONSTANT F8 AS 0 *> Source Is Free-Format                                                                                                                                                                                                          |
| 39   | GC0712 >>DEFINE CONSTANT F9 AS 1 *> No COMP/BINARY Truncation                                                                                                                                                                                                      |
| 40   | GC0712 >>DEFINE CONSTANT F12 AS 4 *> Default config file (1-7):                                                                                                                                                                                                    |
| 41   | *> 1 = BS2000                                                                                                                                                                                                                                                      |
| 42   | *> 2 = COBOL85                                                                                                                                                                                                                                                     |
| 43   | *> 3 = COBOL2002                                                                                                                                                                                                                                                   |
| 44   | *> 4 = DEFAULT                                                                                                                                                                                                                                                     |
| 45   | *> 5 = IBM                                                                                                                                                                                                                                                         |
| 46   | *> 6 = MF (i.e. Microfocus)                                                                                                                                                                                                                                        |
| 47   | *> 7 = MVS                                                                                                                                                                                                                                                         |
| 48   | *>                                                                                                                                                                                                                                                                 |
| 49   | *> END CONFIGURATION SETTINGS                                                                                                                                                                                                                                      |

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| Line | Statement                                                         |
|------|-------------------------------------------------------------------|
| 50   | /                                                                 |
| 51   | IDENTIFICATION DIVISION.                                          |
| 52   | PROGRAM-ID. GCic.                                                 |
| 53   | *>*****                                                           |
| 54   | *> >NOTE< >NOTE< >NOTE< >NOTE< >NOTE< **                          |
| 55   | *>                                                                |
| 56   | *> If this program is compiled with '-fdebugging-line', you **    |
| 57   | *> will need to pipe SYSERR to a text file when executing GCic ** |
| 58   | *> (by adding the text '2> filename' to the end of the GCic **    |
| 59   | *> command). You may also need to press the ENTER key when **     |
| 60   | *> GCic is finished. **                                           |
| 61   | *>*****                                                           |
| 62   | *> This program provides a Textual User Interface (TUI) to the ** |
| 63   | *> process of compiling and (optionally) executing a GNU COBOL ** |
| 64   | *> program. **                                                    |
| 65   | *>                                                                |
| 66   | *> This programs execution syntax is as follows: **               |
| 67   | *>                                                                |
| 68   | *> GCic <program-path-and-filename> [ <switch>... ] **            |
| 69   | *>                                                                |
| 70   | *> Once executed, a display screen will be presented showing **   |
| 71   | *> the compilation options that will be used. The user will **    |
| 72   | *> have the opportunity to change options, specify new ones **    |
| 73   | *> and specify any program execution arguments to be used if **   |
| 74   | *> you select the 'Execute' option. When you press the Enter **   |
| 75   | *> key the program will be compiled. **                           |
| 76   | *>                                                                |
| 77   | *> The SCREEN SECTION contains an image of the screen. **         |
| 78   | *>                                                                |
| 79   | *> The '010-Parse-Args' section in the PROCEDURE DIVISION has **  |
| 80   | *> documentation on switches and their function. **               |
| 81   | *>*****                                                           |
| 82   | *>                                                                |
| 83   | *> AUTHOR: GARY L. CUTLER **                                      |
| 84   | *> CutlerGL@gmail.com **                                          |
| 85   | *> Copyright (C) 2009-2013, Gary L. Cutler, GPL **                |
| 86   | *>                                                                |
| 87   | *> DATE-WRITTEN: June 14, 2009 **                                 |
| 88   | *>                                                                |
| 89   | *>*****                                                           |
| 90   | *> DATE CHANGE DESCRIPTION **                                     |
| 91   | *> ====== **                                                      |
| 92   | *> GC0609 Don't display compiler messages file if compilation **  |
| 93   | *> Is successful. Also don't display messages if the **           |
| 94   | *> output file is busy (just put a message on the **              |
| 95   | *> screen, leave the OC screen up & let the user fix **           |
| 96   | *> the problem & resubmit. **                                     |
| 97   | *> GC0709 When 'EXECUTE' is selected, a 'FILE BUSY' error will ** |
| 98   | *> still cause the (old) executable to be launched. **            |
| 99   | *> Also, the 'EXTRA SWITCHES' field is being ignored. **          |
| 100  | *> Changed the title bar to lowlighted reverse video & **         |
| 101  | *> the message area to highlighted reverse-video. **              |
| 102  | *> GC0809 Add a SPACE in front of command-line args when **       |
| 103  | *> executing users program. Add a SPACE after the **              |

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| Line | Statement                                                                                              |
|------|--------------------------------------------------------------------------------------------------------|
| 104  | *> -ftraceall switch when building cobc command. **                                                    |
| 105  | *> GC0909 Convert to work on Cygwin/Linux as well as MinGW **                                          |
| 106  | *> GC0310 Virtualized the key codes for S-F1 thru S-F7 as they **                                      |
| 107  | *> differ depending upon whether PDCurses or NCurses is **                                             |
| 108  | *> being used. **                                                                                      |
| 109  | *> GC0410 Introduced the cross-reference and source listing **                                         |
| 110  | *> features. Also fixed a bug in @EXTRA switch proces- **                                              |
| 111  | *> sing where garbage will result if more than the **                                                  |
| 112  | *> @EXTRA switch is specified. **                                                                      |
| 113  | *> GC1010 Corrected several problems reported by Vince Coen: **                                        |
| 114  | 1) Listing/Xref wouldn't work if '-I' additional **                                                    |
| 115  | *> cobc switch specified. **                                                                           |
| 116  | *> 2) Programs coded with lowercase reserved words did **                                              |
| 117  | *> not get parsed properly when generating listing **                                                  |
| 118  | *> and/or xref reports. **                                                                             |
| 119  | *> 3) Reliance on a TEMP environment variable caused **                                                |
| 120  | *> non-recoverable errors when generating listing **                                                   |
| 121  | *> and/or xref reports in a session that lacks a **                                                    |
| 122  | *> TEMP variable. **                                                                                   |
| 123  | *> As a result of this change, GCic no longer runs a **                                                |
| 124  | *> second 'cobc' when generating listing and/or xref **                                                |
| 125  | *> reports. A '-save-temp' (without '=dir') specified **                                               |
| 126  | *> in the @EXTRA options field will be ignored. A **                                                   |
| 127  | *> '-save-temp=dir' specified in the @EXTRA options **                                                 |
| 128  | *> field will negate both the @XREF and @SOURCE opts, **                                               |
| 129  | *> if specified. **                                                                                    |
| 130  | *> GC0711 Tailored for 29APR2011 version of GNU COBOL 2.0 **                                           |
| 131  | *> GC0712 Replaced all switches with configuration settings; **                                        |
| 132  | *> Tailored for 11FEB2012 version of GNU COBOL 2.0; **                                                 |
| 133  | *> Reformatted screen layout to fit a 24x80 screen **                                                  |
| 134  | *> rather than a 25x81 screen and to accommodate shell **                                              |
| 135  | *> environments having only F1-F12 (like 'terminal' in **                                              |
| 136  | *> OSX); Fully tested under OSX (required a few altera- **                                             |
| 137  | *> tions); Expanded both extra-options and runtime- **                                                 |
| 138  | *> arguments areas to TWO lines (152 chars total) each; **                                             |
| 139  | *> Added support for MF/IBM/BS2000 listing-control **                                                  |
| 140  | *> directives EJECT,SKIP1,SKIP2,SKIP3 (any of these in **                                              |
| 141  | *> copybooks will be ignored) **                                                                       |
| 142  | *> GC0313 Expand the source code record from 80 chars to 256 **                                        |
| 143  | *> to facilitate looking for "LINKAGE SECTION" in a **                                                 |
| 144  | *> free-format file. **                                                                                |
| 145  | *> GC1113 Edited to support the change of "OpenCOBOL" to "GNU" **                                      |
| 146  | *> COBOL" **                                                                                           |
| 147  | *>*****                                                                                                |
| 148  | ENVIRONMENT DIVISION.                                                                                  |
| 149  | CONFIGURATION SECTION.                                                                                 |
| 150  | REPOSITORY.                                                                                            |
| 151  | FUNCTION ALL INTRINSIC.                                                                                |
| 152  | INPUT-OUTPUT SECTION.                                                                                  |
| 153  | FILE-CONTROL.                                                                                          |
| 154  | GC1010 SELECT F-Cobc-Output-FILE ASSIGN TO WS-Listing-Filename-TXT<br>ORGANIZATION IS LINE SEQUENTIAL. |
| 155  |                                                                                                        |
| 156  |                                                                                                        |
| 157  | SELECT F-Source-Code-FILE ASSIGN TO WS-File-Name-TXT                                                   |

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| Line | Statement                        |
|------|----------------------------------|
| 158  | ORGANIZATION IS LINE SEQUENTIAL  |
| 159  | FILE STATUS IS WS-FSM-Status-CD. |

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Line Statement

```
=====
```

160 /  
161 DATA DIVISION.  
162 FILE SECTION.  
163 FD F-Cobc-Output-FILE.  
164 01 F-Cobc-Output-REC PIC X(256).  
165  
166 FD F-Source-Code-FILE.  
167 GC0313 01 F-Source-Code-REC PIC X(256).  
168  
169 WORKING-STORAGE SECTION.  
170 COPY screenio.  
78 COB-COLOR-BLACK VALUE 0.  
78 COB-COLOR-BLUE VALUE 1.  
78 COB-COLOR-GREEN VALUE 2.  
78 COB-COLOR-CYAN VALUE 3.  
78 COB-COLOR-RED VALUE 4.  
78 COB-COLOR-MAGENTA VALUE 5.  
78 COB-COLOR-YELLOW VALUE 6.  
78 COB-COLOR-WHITE VALUE 7.  
78 COB-SCR-OK VALUE 0.  
78 COB-SCR-F1 VALUE 1001.  
78 COB-SCR-F2 VALUE 1002.  
78 COB-SCR-F3 VALUE 1003.  
78 COB-SCR-F4 VALUE 1004.  
78 COB-SCR-F5 VALUE 1005.  
78 COB-SCR-F6 VALUE 1006.  
78 COB-SCR-F7 VALUE 1007.  
78 COB-SCR-F8 VALUE 1008.  
78 COB-SCR-F9 VALUE 1009.  
78 COB-SCR-F10 VALUE 1010.  
78 COB-SCR-F11 VALUE 1011.  
78 COB-SCR-F12 VALUE 1012.  
78 COB-SCR-F13 VALUE 1013.  
78 COB-SCR-F14 VALUE 1014.  
78 COB-SCR-F15 VALUE 1015.  
78 COB-SCR-F16 VALUE 1016.  
78 COB-SCR-F17 VALUE 1017.  
78 COB-SCR-F18 VALUE 1018.  
78 COB-SCR-F19 VALUE 1019.  
78 COB-SCR-F20 VALUE 1020.  
78 COB-SCR-F21 VALUE 1021.  
78 COB-SCR-F22 VALUE 1022.  
78 COB-SCR-F23 VALUE 1023.  
78 COB-SCR-F24 VALUE 1024.  
78 COB-SCR-F25 VALUE 1025.  
78 COB-SCR-F26 VALUE 1026.  
78 COB-SCR-F27 VALUE 1027.  
78 COB-SCR-F28 VALUE 1028.  
78 COB-SCR-F29 VALUE 1029.  
78 COB-SCR-F30 VALUE 1030.  
78 COB-SCR-F31 VALUE 1031.  
78 COB-SCR-F32 VALUE 1032.  
78 COB-SCR-F33 VALUE 1033.  
78 COB-SCR-F34 VALUE 1034.

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| Line | Statement                                                          |
|------|--------------------------------------------------------------------|
| 78   | COB-SCR-F35 VALUE 1035.                                            |
| 78   | COB-SCR-F36 VALUE 1036.                                            |
| 78   | COB-SCR-F37 VALUE 1037.                                            |
| 78   | COB-SCR-F38 VALUE 1038.                                            |
| 78   | COB-SCR-F39 VALUE 1039.                                            |
| 78   | COB-SCR-F40 VALUE 1040.                                            |
| 78   | COB-SCR-F41 VALUE 1041.                                            |
| 78   | COB-SCR-F42 VALUE 1042.                                            |
| 78   | COB-SCR-F43 VALUE 1043.                                            |
| 78   | COB-SCR-F44 VALUE 1044.                                            |
| 78   | COB-SCR-F45 VALUE 1045.                                            |
| 78   | COB-SCR-F46 VALUE 1046.                                            |
| 78   | COB-SCR-F47 VALUE 1047.                                            |
| 78   | COB-SCR-F48 VALUE 1048.                                            |
| 78   | COB-SCR-F49 VALUE 1049.                                            |
| 78   | COB-SCR-F50 VALUE 1050.                                            |
| 78   | COB-SCR-F51 VALUE 1051.                                            |
| 78   | COB-SCR-F52 VALUE 1052.                                            |
| 78   | COB-SCR-F53 VALUE 1053.                                            |
| 78   | COB-SCR-F54 VALUE 1054.                                            |
| 78   | COB-SCR-F55 VALUE 1055.                                            |
| 78   | COB-SCR-F56 VALUE 1056.                                            |
| 78   | COB-SCR-F57 VALUE 1057.                                            |
| 78   | COB-SCR-F58 VALUE 1058.                                            |
| 78   | COB-SCR-F59 VALUE 1059.                                            |
| 78   | COB-SCR-F60 VALUE 1060.                                            |
| 78   | COB-SCR-F61 VALUE 1061.                                            |
| 78   | COB-SCR-F62 VALUE 1062.                                            |
| 78   | COB-SCR-F63 VALUE 1063.                                            |
| 78   | COB-SCR-F64 VALUE 1064.                                            |
| 78   | COB-SCR-PAGE_UP VALUE 2001.                                        |
| 78   | COB-SCR-PAGE_DOWN VALUE 2002.                                      |
| 78   | COB-SCR-KEY_UP VALUE 2003.                                         |
| 78   | COB-SCR-KEY_DOWN VALUE 2004.                                       |
| 78   | COB-SCR-ESC VALUE 2005.                                            |
| 78   | COB-SCR-PRINT VALUE 2006.                                          |
| 78   | COB-SCR-NO-FIELD VALUE 8000.                                       |
| 78   | COB-SCR-TIME-OUT VALUE 8001.                                       |
| 78   | COB-SCR-FATAL VALUE 9000.                                          |
| 78   | COB-SCR-MAX-FIELD VALUE 9001.                                      |
| 171  |                                                                    |
| 172  | GC0712 01 WS-Compilation-Switches-TXT.                             |
| 173  | GC0712 05 WS-CS-Args-TXT VALUE SPACES.                             |
| 174  | GC0712 10 WS-CS-Arg-H1-TXT PIC X(76).                              |
| 175  | GC0712 10 WS-CS-Arg-H2-TXT PIC X(76).                              |
| 176  | GC0712 05 WS-CS-Filenames-TXT.                                     |
| 177  | GC0712 10 VALUE 'BS2000' PIC X(9).                                 |
| 178  | GC0712 10 VALUE 'COBOL85' PIC X(9).                                |
| 179  | GC0712 10 VALUE 'COBOL2002' PIC X(9).                              |
| 180  | GC0712 10 VALUE 'DEFAULT' PIC X(9).                                |
| 181  | GC0712 10 VALUE 'IBM' PIC X(9).                                    |
| 182  | GC0712 10 VALUE 'MF' PIC X(9).                                     |
| 183  | GC0712 10 VALUE 'MVS' PIC X(9).                                    |
| 184  | GC0712 05 WS-CS-Filenames-Table-TXT REDEFINES WS-CS-Filenames-TXT. |

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| Line | Statement                                                             |
|------|-----------------------------------------------------------------------|
| 185  | GC0712 10 WS-CS-Filename-TXT OCCURS 7 TIMES                           |
| 186  | GC0712 PIC X(9).                                                      |
| 187  | GC0712 >>IF F12 < 1                                                   |
| 188  | 05 WS-CS-Config-NUM VALUE 4 PIC 9(1).                                 |
| 189  | GC0712 >>ELIF F12 > 7                                                 |
| 190  | 05 WS-CS-Config-NUM VALUE 4 PIC 9(1).                                 |
| 191  | GC0712 >>ELSE                                                         |
| 192  | 05 WS-CS-Config-NUM VALUE F12 PIC 9(1).                               |
| 193  | GC0712 >>ENDIF                                                        |
| 194  | 05 WS-CS-Extra-TXT VALUE SPACES.                                      |
| 195  | GC0712 10 WS-CS-Extra-H1-TXT PIC X(76).                               |
| 196  | GC0712 10 WS-CS-Extra-H2-TXT PIC X(76).                               |
| 197  | GC0712 05 WS-CS-Switch-Defaults-TXT.                                  |
| 198  | 10 VALUE F1 PIC 9(1). *> WS-CS-DEBUG-CHR                              |
| 199  | GC0712 10 VALUE F4 PIC 9(1). *> WS-CS-EXECUTE-CHR                     |
| 200  | GC0712 10 VALUE F8 PIC 9(1). *> WS-CS-FREE-CHR                        |
| 201  | GC0712 10 VALUE F3 PIC 9(1). *> WS-CS-LIBRARY-CHR                     |
| 202  | GC0712 10 VALUE F5 PIC 9(1). *> WS-CS-LISTING-CHR                     |
| 203  | GC0712 10 VALUE F6 PIC 9(1). *> WS-CS-NOFUNC-CHR                      |
| 204  | GC0712 10 VALUE F9 PIC 9(1). *> WS-CS-NOTRUNC-CHR                     |
| 205  | GC0712 10 VALUE F2 PIC 9(1). *> WS-CS-TRACEALL-CHR                    |
| 206  | GC0712 10 VALUE F7 PIC 9(1). *> WS-CS-WARNALL-CHR                     |
| 207  | GC0712 05 WS-CS-All-Switches-TXT REDEFINES WS-CS-Switch-Defaults-TXT. |
| 208  | GC0712 10 WS-CS-DEBUG-CHR PIC X(1).                                   |
| 209  | GC0712 10 WS-CS-EXECUTE-CHR PIC X(1).                                 |
| 210  | GC0712 10 WS-CS-FREE-CHR PIC X(1).                                    |
| 211  | GC0712 10 WS-CS-LIBRARY-CHR PIC X(1).                                 |
| 212  | GC0712 10 WS-CS-LISTING-CHR PIC X(1).                                 |
| 213  | GC0712 10 WS-CS-NOFUNC-CHR PIC X(1).                                  |
| 214  | GC0712 10 WS-CS-NOTRUNC-CHR PIC X(1).                                 |
| 215  | GC0712 10 WS-CS-TRACEALL-CHR PIC X(1).                                |
| 216  | GC0712 10 WS-CS-WARNALL-CHR PIC X(1).                                 |
| 217  | GC0712 10 WS-CS-WARNALL-CHR PIC X(1).                                 |
| 218  |                                                                       |
| 219  | GC0909 01 WS-Cmd-TXT PIC X(512).                                      |
| 220  |                                                                       |
| 221  | GC0712 01 WS-Cmd-Args-TXT PIC X(256).                                 |
| 222  |                                                                       |
| 223  | GC0712 01 WS-Cmd-End-Quote-CHR PIC X(1).                              |
| 224  |                                                                       |
| 225  | GC0712 01 WS-Cmd-SUB USAGE BINARY-LONG.                               |
| 226  |                                                                       |
| 227  | 01 WS-Cobc-Cmd-TXT PIC X(256).                                        |
| 228  |                                                                       |
| 229  | 01 WS-Config-Fn-TXT PIC X(12).                                        |
| 230  |                                                                       |
| 231  | GC1113 01 WS-Delete-Fn-TXT PIC X(256).                                |
| 232  |                                                                       |
| 233  | 01 WS-File-Name-TXT.                                                  |
| 234  | 05 WS-FN-CHR OCCURS 256 TIMES                                         |
| 235  | PIC X(1).                                                             |
| 236  |                                                                       |
| 237  | 01 WS-File-Status-Message-TXT.                                        |
| 238  | 05 VALUE 'Status Code: ' PIC X(13).                                   |

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| Line | Statement                                      |
|------|------------------------------------------------|
| 239  | 05 WS-FSM-Status-CD PIC 9(2).                  |
| 240  | 05 VALUE ', Meaning: ' PIC X(11).              |
| 241  | 05 WS-FSM-Msg-TXT PIC X(25).                   |
| 242  |                                                |
| 243  | GC0909 01 WS-Horizontal-Line-TXT PIC X(80).    |
| 244  | GC0909 01 WS-I-SUB USAGE BINARY-LONG.          |
| 245  | 01 WS-J-SUB USAGE BINARY-LONG.                 |
| 246  |                                                |
| 247  |                                                |
| 248  |                                                |
| 249  | GC0712 01 WS-Listing-Filename-TXT PIC X(256).  |
| 250  |                                                |
| 251  | 01 WS-OC-Compile-DT PIC XXXX/XX/XXBXX/XX.      |
| 252  |                                                |
| 253  | GC0712 >>IF OS = 'CYGWIN'                      |
| 254  | GC0712 01 WS-OS-Dir-CHR VALUE '/' PIC X(1).    |
| 255  | GC0712 78 WS-OS-Exe-Ext-CONST VALUE '.exe'.    |
| 256  | GC0712 78 WS-OS-Lib-Ext-CONST VALUE '.dll'.    |
| 257  | GC0712 78 WS-OS-Lib-Type-CONST VALUE 'DLL)'.   |
| 258  | GC0712 01 WS-OS-Type-CD VALUE 2 PIC 9(1).      |
| 259  | GC0712 >>ELIF OS = 'MINGW'                     |
| 260  | GC0712 01 WS-OS-Dir-CHR VALUE '\\' PIC X(1).   |
| 261  | GC0712 78 WS-OS-Exe-Ext-CONST VALUE '.exe'.    |
| 262  | GC0712 78 WS-OS-Lib-Ext-CONST VALUE '.dll'.    |
| 263  | GC0712 78 WS-OS-Lib-Type-CONST VALUE 'DLL)'.   |
| 264  | GC0712 01 WS-OS-Type-CD VALUE 5 PIC 9(1).      |
| 265  | GC0712 >>ELIF OS = 'OSX'                       |
| 266  | GC0712 01 WS-OS-Dir-CHR VALUE '/' PIC X(1).    |
| 267  | GC0712 78 WS-OS-Exe-Ext-CONST VALUE '.'.       |
| 268  | GC0712 78 WS-OS-Lib-Ext-CONST VALUE '.dylib'.  |
| 269  | GC0712 78 WS-OS-Lib-Type-CONST VALUE 'DYLIB)'. |
| 270  | GC0712 01 WS-OS-Type-CD VALUE 4 PIC 9(1).      |
| 271  | GC0712 >>ELIF OS = 'UNIX'                      |
| 272  | GC0712 01 WS-OS-Dir-CHR VALUE '/' PIC X(1).    |
| 273  | GC0712 78 WS-OS-Exe-Ext-CONST VALUE '.'.       |
| 274  | GC0712 78 WS-OS-Lib-Ext-CONST VALUE '.so'.     |
| 275  | GC0712 78 WS-OS-Lib-Type-CONST VALUE 'SO)'.    |
| 276  | GC0712 01 WS-OS-Type-CD VALUE 3 PIC 9(1).      |
| 277  | GC0712 >>ELIF OS = 'WINDOWS'                   |
| 278  | GC0712 01 WS-OS-Dir-CHR VALUE '\\' PIC X(1).   |
| 279  | GC0712 78 WS-OS-Exe-Ext-CONST VALUE '.exe'.    |
| 280  | GC0712 78 WS-OS-Lib-Ext-CONST VALUE '.dll'.    |
| 281  | GC0712 78 WS-OS-Lib-Type-CONST VALUE 'DLL)'.   |
| 282  | GC0712 01 WS-OS-Type-CD VALUE 1 PIC 9(1).      |
| 283  | GC0712 >>END-IF                                |
| 284  | GC0909 88 WS-OS-Windows-BOOL VALUE 1, 5.       |
| 285  | GC0909 88 WS-OS-Cygwin-BOOL VALUE 2.           |
| 286  | GC0712 88 WS-OS-UNIX-BOOL VALUE 3, 4.          |
| 287  | GC0712 88 WS-OS-OSX-BOOL VALUE 4.              |
| 288  |                                                |
| 289  | 01 WS-OS-Type-FILLER-TXT.                      |
| 290  | 05 VALUE 'Windows' PIC X(14).                  |
| 291  | 05 VALUE 'Windows/Cygwin' PIC X(14).           |
| 292  | 05 VALUE 'UNIX/Linux' PIC X(14).               |

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| Line | Statement                                                   |
|------|-------------------------------------------------------------|
| 293  | 05 VALUE 'OSX' PIC X(14).                                   |
| 294  | 05 VALUE 'Windows/MinGW' PIC X(14).                         |
| 295  | 01 WS-OS-Types-TXT REDEFINES WS-OS-Type-FILLER-TXT.         |
| 296  | 05 WS-OS-Type-TXT OCCURS 5 TIMES                            |
| 297  | PIC X(14).                                                  |
| 298  |                                                             |
| 299  | 01 WS-Output-Msg-TXT PIC X(80).                             |
| 300  |                                                             |
| 301  | 01 WS-Path-Delimiter-CHR PIC X(1).                          |
| 302  |                                                             |
| 303  | 01 WS-Prog-Extension-TXT PIC X(256).                        |
| 304  |                                                             |
| 305  | 01 WS-Prog-Folder-TXT PIC X(256).                           |
| 306  |                                                             |
| 307  | GC0712 01 WS-Prog-File-Name-TXT.                            |
| 308  | GC0712 05 WS-PFN-CHR OCCURS 256 TIMES                       |
| 309  | GC0712 PIC X(1).                                            |
| 310  |                                                             |
| 311  | GC0712 01 WS-Pgm-Nm-TXT PIC X(31).                          |
| 312  |                                                             |
| 313  | 01 WS-Runtime-Switches-TXT.                                 |
| 314  | 05 WS-RS-Compile-OK-CHR PIC X(1).                           |
| 315  | 88 WS-RS-Compile-OK-BOOL VALUE 'Y'.                         |
| 316  | GC0909 88 WS-RS-Compile-OK-Warn-BOOL VALUE 'W'.             |
| 317  | 88 WS-RS-Compile-Failed-BOOL VALUE 'N'.                     |
| 318  | GC0609 05 WS-RS-Complete-CHR PIC X(1).                      |
| 319  | GC0609 88 WS-RS-Complete-BOOL VALUE 'Y'.                    |
| 320  | GC0609 88 WS-RS-Not-Complete-BOOL VALUE 'N'.                |
| 321  | GC0712 05 WS-RS-Quote-CHR PIC X(1).                         |
| 322  | GC0712 88 WS-RS-Double-Quote-Used-BOOL VALUE 'Y' FALSE 'N'. |
| 323  | GC0809 05 WS-RS-IDENT-DIV-CHR PIC X(1).                     |
| 324  | GC0809 88 WS-RS-1st-Prog-Complete-BOOL VALUE 'Y'.           |
| 325  | GC0809 88 WS-RS-More-To-1st-Prog-BOOL VALUE 'N'.            |
| 326  | 05 WS-RS-No-Switch-Chgs-CHR PIC X(1).                       |
| 327  | 88 WS-RS-No-Switch-Changes-BOOL VALUE 'Y'.                  |
| 328  | 88 WS-RS-Switch-Changes-BOOL VALUE 'N'.                     |
| 329  | GC0709 05 WS-RS-Output-File-Busy-CHR PIC X(1).              |
| 330  | GC0709 88 WS-RS-Output-File-Busy-BOOL VALUE 'Y'.            |
| 331  | GC0709 88 WS-RS-Output-File-Avail-BOOL VALUE 'N'.           |
| 332  | GC0809 05 WS-RS-Source-Record-Type-CHR PIC X(1).            |
| 333  | GC0809 88 WS-RS-Source-Rec-Linkage-BOOL VALUE 'L'.          |
| 334  | GC0809 88 WS-RS-Source-Rec-Ident-BOOL VALUE 'I'.            |
| 335  | GC0712 88 WS-RS-Source-Rec-Ignored-BOOL VALUE ''.           |
| 336  | 05 WS-RS-Switch-Error-CHR PIC X(1).                         |
| 337  | 88 WS-RS-Switch-Is-Bad-BOOL VALUE 'Y'.                      |
| 338  | 88 WS-RS-Switch-Is-Good-BOOL VALUE 'N'.                     |
| 339  |                                                             |
| 340  | 01 WS-Tally-QTY USAGE BINARY-LONG.                          |

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| Line | Statement                                                                                      | =====         |
|------|------------------------------------------------------------------------------------------------|---------------|
| 341  | /                                                                                              |               |
| 342  | SCREEN SECTION.                                                                                |               |
| 343  | * >                                                                                            |               |
| 344  | * > Here is the layout of the GCic screen.                                                     |               |
| 345  | * >                                                                                            |               |
| 346  | * > The sample screen below shows how the screen would look if the LINEDRAW                    |               |
| 347  | * > configuration setting is set to a value of 2                                               |               |
| 348  | * >                                                                                            |               |
| 349  | * > The following sample screen layout shows how the screen looks with line-drawing            |               |
| 350  | * > characters disabled.                                                                       |               |
| 351  | * >                                                                                            |               |
| 352  | * >      1           2           3           4           5           6           7           8 |               |
| 353  | * >1234567890123456789012345678901234567890123456789012345678901234567890                      |               |
| 354  | * >=====                                                                                       |               |
| 355  | GC0712* > GCic (2011/07/11 08:52) - GNU COBOL V2.0 11FEB2012 Interactive Compilation           | 01            |
| 356  | GC0712* >+                                                                                     | 02            |
| 357  | GC0712* >  Folder: E:\GNU COBOL\Samples                                                        | 03            |
| 358  | GC0712* >  Filename: GCic.cbl                                                                  | 04            |
| 359  | GC0712* >+                                                                                     | 05            |
| 360  | GC0712* > Set/Clr Switches Via F1-F9; Set Config Via F12; ENTER Key Compiles; ESC Quits        | 06            |
| 361  | GC0712* >+                                                                                     | 07            |
| 362  | GC0712* >  F1 Assume WITH DEBUGGING MODE   F6 "FUNCTION" Is Optional                           | 08            |
| 363  | GC0712* >  F2 Procedure+Statement Trace   F7 Enable All Warnings                               | 09            |
| 364  | GC0712* >  F3 Make A Library (DLL)   F8 Source Is Free-Format                                  | @@@0000000000 |
| 365  | GC0712* >  F4 Execute If Compilation OK   F9 No COMP/BINARY Truncation                         | 10            |
| 366  | GC0712* >  F5 >Produce Full Listing                                                            | 11            |
| 367  | GC0712* >+                                                                                     | 12            |
| 368  | GC0712* > Extra "cobic" Switches, If Any ("--save-temp=xxx" Prevents Listings):                | 13            |
| 369  | GC0712* >+                                                                                     | 14            |
| 370  | GC0712* >                                                                                      | 15            |
| 371  | GC0712* >                                                                                      | 16            |
| 372  | GC0712* >+                                                                                     | 17            |
| 373  | GC0712* > Program Execution Arguments, If Any:                                                 | 18            |
| 374  | GC0712* >+                                                                                     | 19            |
| 375  | GC0712* >                                                                                      | 20            |
| 376  | GC0712* >                                                                                      | 21            |
| 377  | GC0712* >+                                                                                     | 22            |
| 378  | GC0712* > GCic Copyright (C) 2009 - 2013, Gary L. Cutler, GPL                                  | 23            |
| 379  | * >=====                                                                                       | 24            |
| 380  | * >123456789012345678901234567890123456789012345678901234567890                                |               |
| 381  | * >      1           2           3           4           5           6           7           8 |               |
| 382  | * >                                                                                            |               |
| 383  | * > If this program is run on Windows, it must run with codepage 437 activated to              |               |
| 384  | * > display the line-drawing characters. With a native Windows build or a                      |               |
| 385  | * > Windows/MinGW build, one could use the command 'chcp 437' to set that codepage             |               |
| 386  | * > for display within a Windows console window (that should be the default, though).          |               |
| 387  | * > With a Windows/Cygwin build, set the environment variable CYGWIN to a value of             |               |
| 388  | * > 'codepage:oem' (this cannot be done from within the program though - you will              |               |
| 389  | * > have to use the 'Computer/Advanced System Settings/Environment Variables' (Vista or        |               |
| 390  | * > Windows 7) function to define the variable. XP Users: use 'My Computer/Properties/         |               |
| 391  | * > Advanced/Environment Variables'.                                                           |               |
| 392  | * >                                                                                            |               |
| 393  | * > OSX users may use line drawing characters in this and any GNU COBOL program simply         |               |
| 394  | * > by setting their 'terminal' application's font to "Lucida Console".                        |               |

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| Line | Statement                                                                     |
|------|-------------------------------------------------------------------------------|
| 395  | *>                                                                            |
| 396  | >>IF LINEDRAW IS EQUAL TO 0                                                   |
| 397  | 78 LD-UL-Corner                   VALUE ' '.                                  |
| 398  | 78 LD-LL-Corner                   VALUE ' '.                                  |
| 399  | 78 LD-UR-Corner                   VALUE ' '.                                  |
| 400  | 78 LD-LR-Corner                   VALUE ' '.                                  |
| 401  | 78 LD-Upper-T                     VALUE ' '.                                  |
| 402  | 78 LD-Lower-T                     VALUE ' '.                                  |
| 403  | 78 LD-Horiz-Line                 VALUE ' '.                                   |
| 404  | 78 LD-Vert-Line                 VALUE ' '.                                    |
| 405  | >>ELIF LINEDRAW IS EQUAL TO 1                                                 |
| 406  | 78 LD-UL-Corner                 VALUE X'DA'.                                  |
| 407  | 78 LD-LL-Corner                 VALUE X'C0'.                                  |
| 408  | 78 LD-UR-Corner                 VALUE X'BF'.                                  |
| 409  | 78 LD-LR-Corner                 VALUE X'D9'.                                  |
| 410  | 78 LD-Upper-T                 VALUE X'C2'.                                    |
| 411  | 78 LD-Lower-T                 VALUE X'C1'.                                    |
| 412  | 78 LD-Horiz-Line                 VALUE X'C4'.                                 |
| 413  | 78 LD-Vert-Line                 VALUE X'B3'.                                  |
| 414  | >>ELSE                                                                        |
| 415  | 78 LD-UL-Corner                 VALUE '+'.                                    |
| 416  | 78 LD-LL-Corner                 VALUE '+'.                                    |
| 417  | 78 LD-UR-Corner                 VALUE '+'.                                    |
| 418  | 78 LD-LR-Corner                 VALUE '+'.                                    |
| 419  | 78 LD-Upper-T                 VALUE '+'.                                      |
| 420  | 78 LD-Lower-T                 VALUE '+'.                                      |
| 421  | 78 LD-Horiz-Line                 VALUE '-'.                                   |
| 422  | 78 LD-Vert-Line                 VALUE ' '.                                    |
| 423  | >>END-IF                                                                      |
| 424  |                                                                               |
| 425  | 01 S-Blank-SCR LINE 1 COLUMN 1 BLANK SCREEN.                                  |
| 426  |                                                                               |
| 427  | 01 S-Switches-SCR BACKGROUND-COLOR COB-COLOR-BLACK                            |
| 428  | FOREGROUND-COLOR COB-COLOR-WHITE AUTO.                                        |
| 429  | *>                                                                            |
| 430  | >> GENERAL SCREEN FRAMEWORK                                                   |
| 431  | *>                                                                            |
| 432  | 03 BACKGROUND-COLOR COB-COLOR-BLACK                                           |
| 433  | FOREGROUND-COLOR COB-COLOR-GREEN HIGHLIGHT.                                   |
| 434  | 05 LINE 02 COL 01             VALUE LD-UL-Corner.                             |
| 435  | 05                             COL 02 PIC X(78) FROM WS-Horizontal-Line-TXT.  |
| 436  | 05                             COL 80                     VALUE LD-UR-Corner. |
| 437  |                                                                               |
| 438  | 05 LINE 03 COL 01             VALUE LD-Vert-Line.                             |
| 439  | 05                             COL 80                     VALUE LD-Vert-Line. |
| 440  |                                                                               |
| 441  | 05 LINE 04 COL 01             VALUE LD-Vert-Line.                             |
| 442  | 05                             COL 80                     VALUE LD-Vert-Line. |
| 443  |                                                                               |
| 444  | 05 LINE 05 COL 01             VALUE LD-LL-Corner.                             |
| 445  | 05                             COL 02 PIC X(78) FROM WS-Horizontal-Line-TXT.  |
| 446  | 05                             COL 80                     VALUE LD-LR-Corner. |
| 447  |                                                                               |
| 448  | 05 LINE 07 COL 01             VALUE LD-UL-Corner.                             |

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| Line | Statement                                               |
|------|---------------------------------------------------------|
| 449  | GC0712 05 COL 02 PIC X(65) FROM WS-Horizontal-Line-TXT. |
| 450  | GC0712 05 COL 67 VALUE LD-Upper-T.                      |
| 451  | GC0712 05 COL 68 PIC X(12) FROM WS-Horizontal-Line-TXT. |
| 452  | 05 COL 80 VALUE LD-UR-Corner.                           |
| 453  |                                                         |
| 454  | GC0712 05 LINE 08 COL 01 VALUE LD-Vert-Line.            |
| 455  | GC0712 05 COL 67 VALUE LD-Vert-Line.                    |
| 456  | 05 COL 80 VALUE LD-Vert-Line.                           |
| 457  |                                                         |
| 458  | GC0712 05 LINE 09 COL 01 VALUE LD-Vert-Line.            |
| 459  | GC0712 05 COL 67 VALUE LD-Vert-Line.                    |
| 460  | 05 COL 80 VALUE LD-Vert-Line.                           |
| 461  |                                                         |
| 462  | GC0712 05 LINE 10 COL 01 VALUE LD-Vert-Line.            |
| 463  | GC0712 05 COL 67 VALUE LD-Vert-Line.                    |
| 464  | 05 COL 80 VALUE LD-Vert-Line.                           |
| 465  |                                                         |
| 466  | GC0712 05 LINE 11 COL 01 VALUE LD-Vert-Line.            |
| 467  | GC0712 05 COL 67 VALUE LD-Vert-Line.                    |
| 468  | 05 COL 80 VALUE LD-Vert-Line.                           |
| 469  |                                                         |
| 470  | GC0712 05 LINE 12 COL 01 VALUE LD-Vert-Line.            |
| 471  | GC0712 05 COL 67 VALUE LD-Vert-Line.                    |
| 472  | 05 COL 80 VALUE LD-Vert-Line.                           |
| 473  |                                                         |
| 474  | GC0712 05 LINE 13 COL 01 VALUE LD-LL-Corner.            |
| 475  | GC0712 05 COL 02 PIC X(65) FROM WS-Horizontal-Line-TXT. |
| 476  | GC0712 05 COL 67 VALUE LD-Lower-T.                      |
| 477  | GC0712 05 COL 68 PIC X(12) FROM WS-Horizontal-Line-TXT. |
| 478  | 05 COL 80 VALUE LD-LR-Corner.                           |
| 479  |                                                         |
| 480  | GC0712 05 LINE 15 COL 01 VALUE LD-UL-Corner.            |
| 481  | GC0712 05 COL 02 PIC X(78) FROM WS-Horizontal-Line-TXT. |
| 482  | 05 COL 80 VALUE LD-UR-Corner.                           |
| 483  |                                                         |
| 484  | GC0712 05 LINE 16 COL 01 VALUE LD-Vert-Line.            |
| 485  | 05 COL 80 VALUE LD-Vert-Line.                           |
| 486  |                                                         |
| 487  | GC0712 05 LINE 17 COL 01 VALUE LD-Vert-Line.            |
| 488  | 05 COL 80 VALUE LD-Vert-Line.                           |
| 489  |                                                         |
| 490  | GC0712 05 LINE 18 COL 01 VALUE LD-LL-Corner.            |
| 491  | GC0712 05 COL 02 PIC X(78) FROM WS-Horizontal-Line-TXT. |
| 492  | 05 COL 80 VALUE LD-LR-Corner.                           |
| 493  |                                                         |
| 494  | GC0712 05 LINE 20 COL 01 VALUE LD-UL-Corner.            |
| 495  | GC0712 05 COL 02 PIC X(78) FROM WS-Horizontal-Line-TXT. |
| 496  | 05 COL 80 VALUE LD-UR-Corner.                           |
| 497  |                                                         |
| 498  | GC0712 05 LINE 21 COL 01 VALUE LD-Vert-Line.            |
| 499  | 05 COL 80 VALUE LD-Vert-Line.                           |
| 500  |                                                         |
| 501  | GC0712 05 LINE 22 COL 01 VALUE LD-Vert-Line.            |
| 502  | 05 COL 80 VALUE LD-Vert-Line.                           |

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```

Line Statement
=====
503
504 GC0712      05 LINE 23 COL 01          VALUE LD-LL-Corner.
505 GC0712      05     COL 02 PIC X(78) FROM WS-Horizontal-Line-TXT.
506      05     COL 80          VALUE LD-LR-Corner.
507      *>
508      *> TOP AND BOTTOM LINES
509      *>
510 GC0712      03 BACKGROUND-COLOR COB-COLOR-BLUE
511           FOREGROUND-COLOR COB-COLOR-WHITE HIGHLIGHT.
512 GC0410      05 LINE 01 COL 01 VALUE ' GCic ('.
513 GC0410      05     COL 08 PIC X(16) FROM WS-OC-Compile-DT.
514 GC0711      05     COL 24 VALUE ') GNU COBOL 2.0 11FEB2012 ' &
515 GC0410           'Interactive Compilation '.
516 GC0712      03 BACKGROUND-COLOR COB-COLOR-RED BLINK
517 GC0712           FOREGROUND-COLOR COB-COLOR-WHITE HIGHLIGHT.
518 GC0712      05 LINE 24 COL 01 PIC X(80) FROM WS-Output-Msg-TXT.
519      *>
520      *> LABELS
521      *>
522      03 BACKGROUND-COLOR COB-COLOR-BLACK
523           FOREGROUND-COLOR COB-COLOR-CYAN HIGHLIGHT.
524 GC0712      05 LINE 06 COL 02 VALUE 'Set/Clr Switches Via F1-F9; ' &
525 GC0712           'Set Config Via F12; Enter Key ' &
526 GC0712           'Compiles; Esc Quits'.
527 GC0712      05 LINE 14 COL 02 VALUE 'Extra "cdbc" Switches, If Any ' &
528 GC0712           '(-save-temp=xxx" Prevents ' &
529 GC0712           'Listings)'.
530 GC0712      05 LINE 19 COL 02 VALUE 'Program Execution Arguments, ' &
531 GC0712           'If Any:'.
532 GC0712      03 BACKGROUND-COLOR COB-COLOR-BLACK
533 GC0712           FOREGROUND-COLOR COB-COLOR-WHITE HIGHLIGHT.
534 GC0712      05 LINE 06 COL 23 VALUE 'F1'.
535 GC0712      05     COL 26 VALUE 'F9'.
536 GC0712      05     COL 45 VALUE 'F12'.
537 GC0712      05     COL 50 VALUE 'ENTER'.
538 GC0712      05     COL 70 VALUE 'ESC'.
539      *>
540      *> TOP SECTION BACKGROUND
541      *>
542      03 BACKGROUND-COLOR COB-COLOR-BLACK
543           FOREGROUND-COLOR COB-COLOR-WHITE HIGHLIGHT.
544 GC0712      05 LINE 03 COL 62 VALUE 'Enter'.
545 GC0712      05 LINE 04 COL 62 VALUE 'Esc'.
546
547      03 BACKGROUND-COLOR COB-COLOR-BLACK
548           FOREGROUND-COLOR COB-COLOR-GREEN HIGHLIGHT.
549 GC0712      05 LINE 04 COL 03 VALUE 'Folder: '.
550 GC0712      05 LINE 03 COL 03 VALUE 'Filename: '.
551
552 GC0712      05 LINE 03 COL 67 VALUE ': Compile '.
553 GC0712      05 LINE 04 COL 65 VALUE ': Quit '.
554      *>
555      *> TOP SECTION PROGRAM INFO
556      *>

```

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Line Statement

```

=====
557      03 BACKGROUND-COLOR COB-COLOR-BLACK
558      FOREGROUND-COLOR COB-COLOR-WHITE HIGHLIGHT.
559 GC0712      05 LINE 03 COL 13 PIC X(66) FROM WS-Prog-File-Name-TXT.
560 GC0712      05 LINE 04 COL 13 PIC X(66) FROM WS-Prog-Folder-TXT.
561      *gt;
562      *> MIDDLE LEFT SECTION F-KEYS
563      *gt;
564      03 BACKGROUND-COLOR COB-COLOR-BLACK
565      FOREGROUND-COLOR COB-COLOR-WHITE HIGHLIGHT.
566 GC0712      05 LINE 08 COL 03 VALUE 'F1'.
567 GC0712      05 LINE 09 COL 03 VALUE 'F2'.
568 GC0712      05 LINE 10 COL 03 VALUE 'F3'.
569 GC0712      05 LINE 11 COL 03 VALUE 'F4'.
570 GC0712      05 LINE 12 COL 03 VALUE 'F5'.
571
572 GC0712      05 LINE 08 COL 35 VALUE 'F6'.
573 GC0712      05 LINE 09 COL 35 VALUE 'F7'.
574 GC0712      05 LINE 10 COL 35 VALUE 'F8'.
575 GC0712      05 LINE 11 COL 35 VALUE 'F9'.
576      *gt;
577      *> MIDDLE LEFT SECTION SWITCHES
578      *gt;
579      03 BACKGROUND-COLOR COB-COLOR-BLACK
580      FOREGROUND-COLOR COB-COLOR-RED HIGHLIGHT.
581 GC0712      05 LINE 08 COL 06 PIC X(1) FROM WS-CS-DEBUG-CHR.
582 GC0712      05 LINE 09 COL 06 PIC X(1) FROM WS-CS-TRACEALL-CHR.
583 GC0712      05 LINE 10 COL 06 PIC X(1) FROM WS-CS-LIBRARY-CHR.
584 GC0712      05 LINE 11 COL 06 PIC X(1) FROM WS-CS-EXECUTE-CHR.
585 GC0712      05 LINE 12 COL 06 PIC X(1) FROM WS-CS-LISTING-CHR.
586
587 GC0712      05 LINE 08 COL 38 PIC X(1) FROM WS-CS-NOFUNC-CHR.
588 GC0712      05 LINE 09 COL 38 PIC X(1) FROM WS-CS-WARNALL-CHR.
589 GC0712      05 LINE 10 COL 38 PIC X(1) FROM WS-CS-FREE-CHR.
590 GC0712      05 LINE 11 COL 38 PIC X(1) FROM WS-CS-NOTRUNC-CHR.
591      *gt;
592      *> MIDDLE LEFT SECTION BACKGROUND
593      *gt;
594      03 BACKGROUND-COLOR COB-COLOR-BLACK
595      FOREGROUND-COLOR COB-COLOR-GREEN HIGHLIGHT.
596 GC0712      05 LINE 08 COL 07 VALUE 'Assume WITH DEBUGGING MODE'.
597 GC0712      05 LINE 09 COL 07 VALUE 'Procedure+Statement Trace '.
598 GC0712      05 LINE 10 COL 07 VALUE 'Make a Library ('.
599 GC0712      05 COL 23 VALUE WS-OS-Lib-Type-CONST.
600 GC0712      05 LINE 11 COL 07 VALUE 'Execute If Compilation OK '.
601 GC0712      05 LINE 12 COL 07 VALUE 'Produce Full Listing '.
602
603 GC0712      05 LINE 08 COL 39 VALUE '"FUNCTION" Is Optional '.
604 GC0712      05 LINE 09 COL 39 VALUE 'Enable All Warnings '.
605 GC0712      05 LINE 10 COL 39 VALUE 'Source Is Free-Format '.
606 GC0712      05 LINE 11 COL 39 VALUE 'No COMP/BINARY Truncation '.
607      *gt;
608      *> MIDDLE RIGHT SECTION Text
609      *gt;
610      03 BACKGROUND-COLOR COB-COLOR-BLACK
  
```

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Line Statement

```
=====
```

611 FOREGROUND-COLOR COB-COLOR-GREEN HIGHLIGHT.  
612 GC0712 05 LINE 08 COL 69 VALUE 'Current'.  
613 GC0712 05 LINE 09 COL 69 VALUE 'Config:'.  
614 \*>  
615 \*> MIDDLE RIGHT SECTION CONFIG FILE  
616 \*>  
617 03 BACKGROUND-COLOR COB-COLOR-BLACK  
618 FOREGROUND-COLOR COB-COLOR-WHITE HIGHLIGHT.  
619 GC0712 05 LINE 10 COL 69 PIC X(10)  
620 GC0712 FROM WS-CS-Filename-TXT (WS-CS-Config-NUM).  
621 \*>  
622 \*> FREE-FORM OPTIONS FIELDS  
623 \*>  
624 03 BACKGROUND-COLOR COB-COLOR-BLACK  
625 FOREGROUND-COLOR COB-COLOR-WHITE HIGHLIGHT.  
626 GC0712 05 LINE 16 COL 03 PIC X(76) USING WS-CS-Extra-H1-TXT.  
627 GC0712 05 LINE 17 COL 03 PIC X(76) USING WS-CS-Extra-H2-TXT.  
628 GC0712 05 LINE 21 COL 03 PIC X(76) USING WS-CS-Arg-H1-TXT.  
629 GC0712 05 LINE 22 COL 03 PIC X(76) USING WS-CS-Arg-H2-TXT.

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Line Statement

```

=====
630      /
631      PROCEDURE DIVISION.
632      *>***** Legend to procedure names: *****
633      *> Legend to procedure names:          **
634      *>
635      *> 00x-xxx   All MAIN driver procedures    **
636      *> 0xx-xxx   All GLOBAL UTILITY procedures    **
637      *> 1xx-xxx   All INITIALIZATION procedures    **
638      *> 2xx-xxx   All CORE PROCESSING procedures    **
639      *> 9xx-xxx   All TERMINATION procedures    **
640      *>*****
641      DECLARATIVES.
642      000-File-Error SECTION.
643      USE AFTER STANDARD ERROR PROCEDURE ON F-Source-Code-FILE.
644      COPY FileStat-Msgs
645          REPLACING STATUS BY WS-FSM-Status-CD
646              MSG BY WS-FSM-Msg-TXT.

EVALUATE WS-FSM-Status-CD
WHEN 00 MOVE 'SUCCESS'           TO WS-FSM-Msg-TXT
WHEN 02 MOVE 'SUCCESS DUPLICATE' TO WS-FSM-Msg-TXT
WHEN 04 MOVE 'SUCCESS INCOMPLETE' TO WS-FSM-Msg-TXT
WHEN 05 MOVE 'SUCCESS OPTIONAL'  TO WS-FSM-Msg-TXT
WHEN 07 MOVE 'SUCCESS NO UNIT'   TO WS-FSM-Msg-TXT
WHEN 10 MOVE 'END OF FILE'       TO WS-FSM-Msg-TXT
WHEN 14 MOVE 'OUT OF KEY RANGE' TO WS-FSM-Msg-TXT
WHEN 21 MOVE 'KEY INVALID'      TO WS-FSM-Msg-TXT
WHEN 22 MOVE 'KEY EXISTS'       TO WS-FSM-Msg-TXT
WHEN 23 MOVE 'KEY NOT EXISTS'   TO WS-FSM-Msg-TXT
WHEN 30 MOVE 'PERMANENT ERROR'  TO WS-FSM-Msg-TXT
WHEN 31 MOVE 'INCONSISTENT FILENAME' TO WS-FSM-Msg-TXT
WHEN 34 MOVE 'BOUNDARY VIOLATION' TO WS-FSM-Msg-TXT
WHEN 35 MOVE 'FILE NOT FOUND'   TO WS-FSM-Msg-TXT
WHEN 37 MOVE 'PERMISSION DENIED' TO WS-FSM-Msg-TXT
WHEN 38 MOVE 'CLOSED WITH LOCK'  TO WS-FSM-Msg-TXT
WHEN 39 MOVE 'CONFLICT ATTRIBUTE' TO WS-FSM-Msg-TXT
WHEN 41 MOVE 'ALREADY OPEN'     TO WS-FSM-Msg-TXT
WHEN 42 MOVE 'NOT OPEN'         TO WS-FSM-Msg-TXT
WHEN 43 MOVE 'READ NOT DONE'   TO WS-FSM-Msg-TXT
WHEN 44 MOVE 'RECORD OVERFLOW'  TO WS-FSM-Msg-TXT
WHEN 46 MOVE 'READ ERROR'       TO WS-FSM-Msg-TXT
WHEN 47 MOVE 'INPUT DENIED'     TO WS-FSM-Msg-TXT
WHEN 48 MOVE 'OUTPUT DENIED'    TO WS-FSM-Msg-TXT
WHEN 49 MOVE 'I/O DENIED'       TO WS-FSM-Msg-TXT
WHEN 51 MOVE 'RECORD LOCKED'    TO WS-FSM-Msg-TXT
WHEN 52 MOVE 'END-OF-PAGE'      TO WS-FSM-Msg-TXT
WHEN 57 MOVE 'I/O LINAGE'       TO WS-FSM-Msg-TXT
WHEN 61 MOVE 'FILE SHARING FAILURE' TO WS-FSM-Msg-TXT
WHEN 91 MOVE 'FILE NOT AVAILABLE' TO WS-FSM-Msg-TXT
END-EVALUATE.

647      MOVE SPACES TO WS-Output-Msg-TXT
648      IF WS-FSM-Status-CD = 35
649          DISPLAY
650              'File not found: "''
651              TRIM(WS-File-Name-TXT,.TRAILING)

```

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```
=====  
652      ''''  
653      ELSE  
654          DISPLAY  
655              'Error accessing file: ''  
656              TRIM(WS-File-Name-TXT,TRAILING)  
657          ''''  
658      END-IF  
659      GOBACK  
660      .  
661      END DECLARATIVES.  
662  
663      000-Main SECTION.  
664          PERFORM 100-Initialization  
665 GC0609      SET WS-RS-Not-Complete-BOOL TO TRUE  
666 GC0609      PERFORM UNTIL WS-RS-Complete-BOOL  
667 GC0609          PERFORM 200-Let-User-Set-Switches  
668 GC0609          PERFORM 210-Run-Compiler  
669 GC0410          IF (WS-RS-Compile-OK-BOOL OR WS-RS-Compile-OK-Warn-BOOL)  
670 GC0712          AND (WS-CS-LISTING-CHR > SPACE)  
671 GC0712          DISPLAY S-Blank-SCR  
672 GC0410          PERFORM 220-Make-Listing  
673 GC0410          END-IF  
674 GC0709          IF (WS-CS-EXECUTE-CHR NOT = SPACES)  
675 GC0709          AND (WS-RS-Output-File-Avail-BOOL)  
676 GC0609          PERFORM 230-Run-Program  
677 GC0609          END-IF  
678 GC0712          PERFORM 250-Autoload-Listing  
679 GC0609      END-PERFORM  
680          PERFORM 900-Terminate  
681      * -- Control will NOT return  
682      * -- .  
683      * -- Control will NOT return
```

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```

Line Statement
=====
684      /
685      *>***** ****
686      *> Perform all program-wide initialization operations      **
687      *>***** ****
688      100-Initialization SECTION.
689      *>***** ****
690      *> Make sure full screen-handling is in effect      **
691      *>***** ****
692          SET ENVIRONMENT 'COB_SCREEN_EXCEPTIONS' TO 'Y'
693          SET ENVIRONMENT 'COB_SCREEN_ESC'           TO 'Y'
694      *>***** ****
695      *> Get GCic Compilation Date/Time      **
696      *>***** ****
697          MOVE WHEN-COMPILED (1:12) TO WS-OC-Compile-DT
698          INSPECT WS-OC-Compile-DT
699              REPLACING ALL '/' BY ':'
700              AFTER INITIAL SPACE
701      *>***** ****
702      *> Convert WS-CS-All-Switches-TXT to Needed Alphanumeric Values      **
703      *>***** ****
704          INSPECT WS-CS-All-Switches-TXT
705              REPLACING ALL '0' BY SPACE
706                  ALL '1' BY SELCHAR
707      *>***** ****
708      *> Process filename (the only command-line argument)      **
709      *>***** ****
710 GC0712    ACCEPT WS-Cmd-Args-TXT FROM COMMAND-LINE
711 GC0712    MOVE 1 TO WS-Cmd-SUB
712 GC0712    IF WS-Cmd-Args-TXT(WS-Cmd-SUB:1) = ''' OR """
713 GC0712        MOVE WS-Cmd-Args-TXT(WS-Cmd-SUB:1)
714 GC0712            TO WS-Cmd-End-Quote-CHR
715 GC0712        ADD 1 TO WS-Cmd-SUB
716 GC0712        UNSTRING WS-Cmd-Args-TXT
717 GC0712            DELIMITED BY WS-Cmd-End-Quote-CHR
718 GC0712            INTO WS-File-Name-TXT
719 GC0712            WITH POINTER WS-Cmd-SUB
720 GC0712        ELSE
721 GC0712            UNSTRING WS-Cmd-Args-TXT
722 GC0712                DELIMITED BY ALL SPACES
723 GC0712                INTO WS-File-Name-TXT
724 GC0712                WITH POINTER WS-Cmd-SUB
725 GC0712        END-IF
726        IF WS-File-Name-TXT = SPACES
727 GC0712            DISPLAY 'No program filename was specified'
728        PERFORM 900-Terminate
729        * ----- Control will NOT return
730        END-IF
731      *>***** ****
732      *> Determine if 'Make A Library' feature should be forced 'ON' **
733      *>***** ****
734          PERFORM 240-Find-LINKAGE-SECTION
735      *>***** ****
736      *> Split 'WS-File-Name-TXT' into 'WS-Prog-Folder-TXT' and      **
737          'WS-Prog-File-Name-TXT'      **

```

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Line Statement

```

=====
738      *>*****
739 GC0909  IF WS-OS-Cygwin-BOOL AND WS-File-Name-TXT (2:1) = ':'
740 GC0712  MOVE '\' TO WS-OS-Dir-CHR
741 GC0909  END-IF
742 GC0712  MOVE LENGTH(WS-File-Name-TXT) TO WS-I-SUB
743 GC0712  PERFORM UNTIL WS-I-SUB = 0
744 GC0712  OR WS-FN-CHR (WS-I-SUB) = WS-OS-Dir-CHR
745          SUBTRACT 1 FROM WS-I-SUB
746          END-PERFORM
747          IF WS-I-SUB = 0
748              MOVE SPACES    TO WS-Prog-Folder-TXT
749              MOVE WS-File-Name-TXT TO WS-Prog-File-Name-TXT
750          ELSE
751              MOVE '*' TO WS-FN-CHR (WS-I-SUB)
752              UNSTRING WS-File-Name-TXT DELIMITED BY '*'
753                  INTO WS-Prog-Folder-TXT
754                  WS-Prog-File-Name-TXT
755 GC0712  MOVE WS-OS-Dir-CHR TO WS-FN-CHR (WS-I-SUB)
756          END-IF
757          IF WS-Prog-Folder-TXT = SPACES
758              ACCEPT WS-Prog-Folder-TXT FROM ENVIRONMENT 'CD'
759 GC0909  ELSE
760 GC0909  CALL 'CBL_CHANGE_DIR'
761 GC0909  USING TRIM(WS-Prog-Folder-TXT,TRAILING)
762          END-IF
763 GC0909  IF WS-OS-Cygwin-BOOL AND WS-File-Name-TXT (2:1) = ':'
764 GC0712  MOVE '/' TO WS-OS-Dir-CHR
765 GC0909  END-IF
766      *>*****
767      *> Split 'WS-Prog-File-Name-TXT' into 'WS-Pgm-Nm-TXT' &      **
768      *> 'WS-Prog-Extension-TXT'                                **
769      *>*****
770 GC0712  MOVE LENGTH(WS-Prog-File-Name-TXT) TO WS-I-SUB
771 GC0712  PERFORM UNTIL WS-I-SUB = 0
772 GC0712  OR WS-PFN-CHR (WS-I-SUB) = '.'
773 GC0712  SUBTRACT 1 FROM WS-I-SUB
774 GC0712  END-PERFORM
775 GC0712  IF WS-I-SUB = 0
776 GC0712  MOVE WS-Prog-File-Name-TXT TO WS-Pgm-Nm-TXT
777 GC0712  MOVE SPACES    TO WS-Prog-Extension-TXT
778 GC0712  ELSE
779 GC0712  MOVE '*' TO WS-PFN-CHR (WS-I-SUB)
780 GC0712  UNSTRING WS-Prog-File-Name-TXT DELIMITED BY '*'
781 GC0712  INTO WS-Pgm-Nm-TXT
782 GC0712  WS-Prog-Extension-TXT
783 GC0712  MOVE '.' TO WS-PFN-CHR (WS-I-SUB)
784 GC0712  END-IF
785      *>*****
786      *> Build initial Line 24 Message                      **
787      *>*****
788 GC0909  MOVE ALL LD-Horiz-Line TO WS-Horizontal-Line-TXT.
789 GC0410  MOVE CONCATENATE(' GCic for '
790 GC0410  TRIM(WS-OS-Type-TXT(WS-OS-Type-CD),Trailing)
791 GC0712  ' Copyright (C) 2009 - 2013, Gary L. '

```

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Line Statement

```
=====
```

792 GC0410 'Cutler, GPL')  
793 GC0410 TO WS-Output-Msg-TXT.  
794 GC0909 .

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| Line | Statement                                                         |
|------|-------------------------------------------------------------------|
| 795  | /                                                                 |
| 796  | *>*****                                                           |
| 797  | *> Show the user the current switch settings and allow them to ** |
| 798  | *> be changed.                                                    |
| 799  | *>*****                                                           |
| 800  | 200-Let-User-Set-Switches SECTION.                                |
| 801  | SET WS-RS-Switch-Changes-BOOL TO TRUE                             |
| 802  | PERFORM UNTIL WS-RS-No-Switch-Changes-BOOL                        |
| 803  | ACCEPT S-Switches-SCR                                             |
| 804  | IF COB-CRT-STATUS > 0                                             |
| 805  | EVALUATE COB-CRT-STATUS                                           |
| 806  | WHEN COB-SCR-F1                                                   |
| 807  | IF WS-CS-DEBUG-CHR = SPACE                                        |
| 808  | MOVE SELCHAR TO WS-CS-DEBUG-CHR                                   |
| 809  | ELSE                                                              |
| 810  | MOVE '' TO WS-CS-DEBUG-CHR                                        |
| 811  | END-IF                                                            |
| 812  | WHEN COB-SCR-F2                                                   |
| 813  | IF WS-CS-TRACEALL-CHR = SPACE                                     |
| 814  | MOVE SELCHAR TO WS-CS-TRACEALL-CHR                                |
| 815  | ELSE                                                              |
| 816  | MOVE '' TO WS-CS-TRACEALL-CHR                                     |
| 817  | END-IF                                                            |
| 818  | WHEN COB-SCR-F3                                                   |
| 819  | IF WS-CS-LIBRARY-CHR = SPACE                                      |
| 820  | MOVE SELCHAR TO WS-CS-LIBRARY-CHR                                 |
| 821  | ELSE                                                              |
| 822  | MOVE '' TO WS-CS-LIBRARY-CHR                                      |
| 823  | END-IF                                                            |
| 824  | WHEN COB-SCR-F4                                                   |
| 825  | IF WS-CS-EXECUTE-CHR = SPACE                                      |
| 826  | MOVE SELCHAR TO WS-CS-EXECUTE-CHR                                 |
| 827  | ELSE                                                              |
| 828  | MOVE '' TO WS-CS-EXECUTE-CHR                                      |
| 829  | END-IF                                                            |
| 830  | WHEN COB-SCR-F5                                                   |
| 831  | IF WS-CS-LISTING-CHR = SPACE                                      |
| 832  | MOVE SELCHAR TO WS-CS-LISTING-CHR                                 |
| 833  | ELSE                                                              |
| 834  | MOVE '' TO WS-CS-LISTING-CHR                                      |
| 835  | END-IF                                                            |
| 836  | WHEN COB-SCR-F6                                                   |
| 837  | IF WS-CS-NOFUNC-CHR = SPACE                                       |
| 838  | MOVE SELCHAR TO WS-CS-NOFUNC-CHR                                  |
| 839  | ELSE                                                              |
| 840  | MOVE '' TO WS-CS-NOFUNC-CHR                                       |
| 841  | END-IF                                                            |
| 842  | WHEN COB-SCR-F7                                                   |
| 843  | IF WS-CS-WARNALL-CHR = SPACE                                      |
| 844  | MOVE SELCHAR TO WS-CS-WARNALL-CHR                                 |
| 845  | ELSE                                                              |
| 846  | MOVE '' TO WS-CS-WARNALL-CHR                                      |
| 847  | END-IF                                                            |
| 848  | WHEN COB-SCR-F8                                                   |

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```
=====
849 GC0712           IF WS-CS-FREE-CHR = SPACE
850 GC0712             MOVE SELCHAR TO WS-CS-FREE-CHR
851 GC0712           ELSE
852 GC0712             MOVE ' ' TO WS-CS-FREE-CHR
853 GC0712           END-IF
854 GC0712           WHEN COB-SCR-F9
855 GC0712             IF WS-CS-NOTRUNC-CHR = SPACE
856 GC0712               MOVE SELCHAR TO WS-CS-NOTRUNC-CHR
857 GC0712             ELSE
858 GC0712               MOVE ' ' TO WS-CS-NOTRUNC-CHR
859 GC0712             END-IF
860                   WHEN COB-SCR-ESC
861                     PERFORM 900-Terminate
862 * ----- Control will NOT return
863 GC0712           WHEN COB-SCR-F12
864 GC0712             ADD 1 TO WS-CS-Config-NUM
865 GC0712             IF WS-CS-Config-NUM > 7
866 GC0712               MOVE 1 TO WS-CS-Config-NUM
867 GC0712             END-IF
868           WHEN OTHER
869             MOVE 'An unsupported key was pressed'
870               TO WS-Output-Msg-TXT
871             END-EVALUATE
872           ELSE
873             SET WS-RS-No-Switch-Changes-BOOL TO TRUE
874           END-IF
875         END-PERFORM
876   .
```

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| Line | Statement                                                        |
|------|------------------------------------------------------------------|
| 877  | /                                                                |
| 878  | *>*****                                                          |
| 879  | *> Run the compiler using the switch settings we've prepared. ** |
| 880  | *>*****                                                          |
| 881  | 210-Run-Compiler SECTION.                                        |
| 882  | MOVE SPACES TO WS-Cmd-TXT                                        |
| 883  | WS-Cobc-Cmd-TXT                                                  |
| 884  | WS-Output-Msg-TXT                                                |
| 885  | DISPLAY S-Switches-SCR                                           |
| 886  | MOVE 1 TO WS-I-SUB                                               |
| 887  | GC0712 MOVE LOWER-CASE(WS-CS-Filename-TXT (WS-CS-Config-NUM))    |
| 888  | GC0712   TO WS-Config-Fn-TXT                                     |
| 889  | *>*****                                                          |
| 890  | *> Build the 'cobc' command                       **             |
| 891  | *>*****                                                          |
| 892  | GC0909 MOVE SPACES TO WS-Cobc-Cmd-TXT                            |
| 893  | GC0909 STRING 'cobc -v -std='                                    |
| 894  | GC0909      TRIM(WS-Config-Fn-TXT,TRAILING)                      |
| 895  | GC0909                                                           |
| 896  | GC0909      INTO WS-Cobc-Cmd-TXT                                 |
| 897  | GC0909      WITH POINTER WS-I-SUB                                |
| 898  | IF WS-CS-LIBRARY-CHR NOT = ' '                                   |
| 899  | STRING '-m'                                                      |
| 900  | DELIMITED SIZE INTO WS-Cobc-Cmd-TXT                              |
| 901  | WITH POINTER WS-I-SUB                                            |
| 902  | ELSE                                                             |
| 903  | STRING '-x'                                                      |
| 904  | DELIMITED SIZE INTO WS-Cobc-Cmd-TXT                              |
| 905  | WITH POINTER WS-I-SUB                                            |
| 906  | END-IF                                                           |
| 907  | IF WS-CS-DEBUG-CHR NOT = ' '                                     |
| 908  | STRING '-fdebugging-line'                                        |
| 909  | DELIMITED SIZE INTO WS-Cobc-Cmd-TXT                              |
| 910  | WITH POINTER WS-I-SUB                                            |
| 911  | END-IF                                                           |
| 912  | IF WS-CS-NOTRUNC-CHR NOT = ' '                                   |
| 913  | STRING '-fnotrunc'                                               |
| 914  | DELIMITED SIZE INTO WS-Cobc-Cmd-TXT                              |
| 915  | WITH POINTER WS-I-SUB                                            |
| 916  | END-IF                                                           |
| 917  | IF WS-CS-TRACEALL-CHR NOT = ' '                                  |
| 918  | GC0809    STRING '-ftraceall'                                    |
| 919  | DELIMITED SIZE INTO WS-Cobc-Cmd-TXT                              |
| 920  | WITH POINTER WS-I-SUB                                            |
| 921  | END-IF                                                           |
| 922  | IF WS-CS-NOFUNC-CHR NOT = ' '                                    |
| 923  | GC0712    STRING '-fintrinsic=all'                               |
| 924  | GC0712      DELIMITED SIZE INTO WS-Cobc-Cmd-TXT                  |
| 925  | GC0712      WITH POINTER WS-I-SUB                                |
| 926  | GC0712 END-IF                                                    |
| 927  | GC0712 IF WS-CS-WARNALL-CHR NOT = ' '                            |
| 928  | GC0712    STRING '-Wall'                                         |
| 929  | GC0712      DELIMITED SIZE INTO WS-Cobc-Cmd-TXT                  |
| 930  | GC0712      WITH POINTER WS-I-SUB                                |

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```

=====
931 GC0712      END-IF
932 GC0712      IF WS-CS-FREE-CHR NOT = ' '
933 GC0712          STRING '-free'
934 GC0712          DELIMITED SIZE INTO WS-Cobc-Cmd-TXT
935 GC0712          WITH POINTER WS-I-SUB
936 GC0712      ELSE
937 GC0712          STRING '-fixed'
938 GC0712          DELIMITED SIZE INTO WS-Cobc-Cmd-TXT
939 GC0712          WITH POINTER WS-I-SUB
940 GC0712      END-IF
941
942 GC0712      MOVE 0 TO WS-Tally-QTY
943 GC0712      INSPECT WS-CS-Extra-TXT
944 GC0712          TALLYING WS-Tally-QTY FOR ALL '-save-temp'
945 GC0712          IF WS-CS-LISTING-CHR > SPACE
946 GC0712          AND WS-Tally-QTY > 0
947 GC0712          MOVE SPACE TO WS-CS-LISTING-CHR *> Can't generate listing if -save-temp used
948 GC0712      END-IF
949 GC0712      IF WS-CS-LISTING-CHR > SPACE
950 GC1010          STRING '-save-temp'
951 GC1010          DELIMITED SIZE INTO WS-Cobc-Cmd-TXT
952 GC1010          WITH POINTER WS-I-SUB
953 GC1010      END-IF
954
955 GC0709      IF WS-CS-Extra-TXT > SPACES
956 GC0709          STRING ''
957 GC0709          TRIM(WS-CS-Extra-TXT,TRAILING)
958 GC0709
959 GC0709          DELIMITED SIZE INTO WS-Cobc-Cmd-TXT
960 GC0709          WITH POINTER WS-I-SUB
961 GC0709      END-IF
962 GC0909      STRING TRIM(WS-Prog-File-Name-TXT,TRAILING)
963 GC0909      DELIMITED SIZE INTO WS-Cobc-Cmd-TXT
964 GC0909      WITH POINTER WS-I-SUB
965 *->*****
966 *-> Prepare the compilation listing file      **
967 *->*****
968 GC1113      MOVE CONCATENATE(TRIM(WS-Pgm-Nm-TXT,Trailing),'.gclst')
969 GC0712      TO WS-Listing-Filename-TXT
970 GC0712      CALL 'CBL_DELETE_FILE' USING WS-Listing-Filename-TXT
971 *->*****
972 *-> Now execute the 'cobc' command      **
973 *->*****
974 GC0410      MOVE ' Compiling...' TO WS-Output-Msg-TXT
975 GC0410      DISPLAY S-Switches-SCR
976 GC0609      SET WS-RS-Output-File-Avail-BOOL TO TRUE
977 MOVE SPACES TO WS-Cmd-TXT
978 STRING TRIM(WS-Cobc-Cmd-TXT,TRAILING)
979 GC0712          ' > WS-Listing-Filename-TXT
980 GC0712          ' 2>&1'
981          DELIMITED SIZE
982          INTO WS-Cmd-TXT
983 DEBUG D      DISPLAY WS-Cmd-TXT UPON SYSERR
984          CALL 'SYSTEM' USING TRIM(WS-Cmd-TXT,TRAILING)

```

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Line Statement

```
=====
985 GC0712      OPEN EXTEND F-Cobc-Output-FILE
986 GC0712      WRITE F-Cobc-Output-REC FROM SPACES
987 GC0712      IF RETURN-CODE = 0
988 GC0712          SET WS-RS-Compile-OK-BOOL TO TRUE
989 GC0712          MOVE ' Compilation Was Successful' TO WS-Output-Msg-TXT
990 GC0712          MOVE CONCATENATE('GNU COBOL',WS-Output-Msg-TXT)
991 GC0712              TO F-Cobc-Output-REC
992 GC0712          WRITE F-Cobc-Output-REC
993 GC0712          SET WS-RS-Complete-BOOL TO TRUE
994 GC0712      ELSE
995 GC0712          SET WS-RS-Compile-Failed-BOOL TO TRUE
996 GC0712          MOVE CONCATENATE(' Compilation Failed - See ',
997 GC0712              TRIM(WS-Listing-Filename-TXT,Trailing))
998 GC0712          TO WS-Output-Msg-TXT
999 GC0712          MOVE 'GNU COBOL Compilation HAS FAILED - See Above'
1000 GC0712              TO F-Cobc-Output-REC
1001 GC0712          WRITE F-Cobc-Output-REC
1002 GC0712      END-IF
1003 GC0712      CLOSE F-Cobc-Output-FILE
1004 GC0712      DISPLAY S-Switches-SCR
1005 GC0712      CALL 'C$SLEEP' USING 2
1006 GC0712      MOVE SPACES TO WS-Output-Msg-TXT
1007 GC0712      IF WS-RS-Compile-Failed-BOOL
1008 GC0712          PERFORM 250-Autoload-Listing
1009 GC0712          PERFORM 900-Terminate
1010 GC0712      *-> ----- Control will not return
1011 GC0712      END-IF
1012 GC0712      .
=====
```

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Line Statement

```
=====
1013      /
1014      *>*****Generate a source + xref listing using 'LISTING' subroutine ***
1015      *> Generate a source + xref listing using 'LISTING' subroutine **
1016      *>*****Generate a source + xref listing using 'LISTING' subroutine ***
1017 GC0410 220-Make-Listing SECTION.
1018 GC0410    MOVE ' Generating listing...' TO WS-Output-Msg-TXT
1019 GC0410    DISPLAY S-Switches-SCR
1020 GC0410    MOVE 0 TO RETURN-CODE
1021      *>*****Generate a source + xref listing using 'LISTING' subroutine ***
1022      *> Create the listing
1023      *>*****Generate a source + xref listing using 'LISTING' subroutine ***
1024 GC0410    MOVE SPACES TO WS-Output-Msg-TXT
1025 GC0410    CALL 'LISTING' USING WS-Listing-Filename-TXT
1026 GC0712        WS-File-Name-TXT
1027 GC0712        WS-OS-Type-CD
1028 GC0410    ON EXCEPTION
1029 GC0410        MOVE ' LISTING module is not available'
1030 GC0410        TO WS-Output-Msg-TXT
1031 GC0410        MOVE 1 TO RETURN-CODE
1032 GC0410    END-CALL
1033 GC0410    IF RETURN-CODE = 0
1034 GC0712        MOVE ' Source+Xref listing generated '
1035 GC0712        TO WS-Output-Msg-TXT
1036 GC0410    END-IF
1037 GC0712    DISPLAY S-Switches-SCR
1038 GC0712    CALL 'C$SLEEP' USING 2
1039 GC0712    PERFORM 250-Autoload-Listing
1040 GC0410    .
=====
```

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| Line | Statement                                                      |
|------|----------------------------------------------------------------|
| 1041 | /                                                              |
| 1042 | *>*****                                                        |
| 1043 | *> Run the compiled program                                    |
| 1044 | *>*****                                                        |
| 1045 | 230-Run-Program SECTION.                                       |
| 1046 | GC0909 MOVE SPACES TO WS-Cmd-TXT                               |
| 1047 | GC0909 MOVE 1 TO WS-I-SUB                                      |
| 1048 | *>*****                                                        |
| 1049 | *> If necessary, start with 'cobcrun' command                  |
| 1050 | *>*****                                                        |
| 1051 | GC0712 IF WS-CS-LIBRARY-CHR NOT = ' '                          |
| 1052 | STRING 'cobcrun' DELIMITED SIZE                                |
| 1053 | INTO WS-Cmd-TXT                                                |
| 1054 | WITH POINTER WS-I-SUB                                          |
| 1055 | END-IF                                                         |
| 1056 | *>*****                                                        |
| 1057 | *> Add any necessary path prefix                               |
| 1058 | *>*****                                                        |
| 1059 | GC0712 SET WS-RS-Double-Quote-Used-BOOL TO FALSE               |
| 1060 | IF WS-Prog-Folder-TXT NOT = SPACES                             |
| 1061 | GC0909 IF WS-OS-Cygwin-BOOL AND WS-Prog-Folder-TXT (2:1) = ':' |
| 1062 | GC0909 STRING '/cygdrive/'                                     |
| 1063 | GC0909 INTO WS-Cmd-TXT                                         |
| 1064 | GC0909 WITH POINTER WS-I-SUB                                   |
| 1065 | GC0909 STRING LOWER-CASE(WS-Prog-Folder-TXT (1:1))             |
| 1066 | GC0909 INTO WS-Cmd-TXT                                         |
| 1067 | GC0909 WITH POINTER WS-I-SUB                                   |
| 1068 | GC0909 PERFORM                                                 |
| 1069 | GC0909 VARYING WS-J-SUB FROM 3 BY 1                            |
| 1070 | GC0909 UNTIL WS-J-SUB > LENGTH(TRIM(WS-Prog-Folder-TXT))       |
| 1071 | GC0909 IF WS-Prog-Folder-TXT (WS-J-SUB:1) = '\'                |
| 1072 | GC0909 STRING '/'                                              |
| 1073 | GC0909 INTO WS-Cmd-TXT                                         |
| 1074 | GC0909 WITH POINTER WS-I-SUB                                   |
| 1075 | GC0909 ELSE                                                    |
| 1076 | GC0909 STRING WS-Prog-Folder-TXT (WS-J-SUB:1)                  |
| 1077 | GC0909 INTO WS-Cmd-TXT                                         |
| 1078 | GC0909 WITH POINTER WS-I-SUB                                   |
| 1079 | GC0909 END-IF                                                  |
| 1080 | GC0909 END-PERFORM                                             |
| 1081 | GC0909 ELSE                                                    |
| 1082 | GC0410 STRING '''' TRIM(WS-Prog-Folder-TXT,TRAILING)           |
| 1083 | GC0909 INTO WS-Cmd-TXT                                         |
| 1084 | GC0909 WITH POINTER WS-I-SUB                                   |
| 1085 | GC0712 SET WS-RS-Double-Quote-Used-BOOL TO TRUE                |
| 1086 | GC0909 END-IF                                                  |
| 1087 | GC0712 STRING WS-OS-Dir-CHR                                    |
| 1088 | GC0909 INTO WS-Cmd-TXT                                         |
| 1089 | GC0909 WITH POINTER WS-I-SUB                                   |
| 1090 | GC0909 ELSE                                                    |
| 1091 | GC0909 IF WS-OS-Cygwin-BOOL OR WS-OS-UNIX-BOOL                 |
| 1092 | GC0909 STRING './'                                             |
| 1093 | GC0909 INTO WS-Cmd-TXT                                         |
| 1094 | GC0909 WITH POINTER WS-I-SUB                                   |

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```

Line Statement
=====
1095 GC0909      END-IF
1096      END-IF
1097      *>***** Insert program filename *****
1098      *> Insert program filename          **
1099      *>*****
1100 GC0909      STRING TRIM(WS-Pgm-Nm-TXT,TRAILING)
1101 GC0909      INTO WS-Cmd-TXT
1102 GC0909      WITH POINTER WS-I-SUB
1103      *>*****
1104      *> Insert proper extension          **
1105      *>*****
1106 GC0712      IF WS-CS-LIBRARY-CHR = ' '
1107 GC0712      IF WS-OS-Exe-Ext-CONST > ' '
1108 GC0712      STRING WS-OS-Exe-Ext-CONST DELIMITED SPACE
1109 GC0712      INTO WS-Cmd-TXT
1110 GC0712      WITH POINTER WS-I-SUB
1111 GC0712      END-IF
1112 GC0712      ELSE
1113 GC0712      IF WS-OS-Lib-Ext-CONST > ' '
1114 GC0712      STRING WS-OS-Lib-Ext-CONST DELIMITED SPACE
1115 GC0712      INTO WS-Cmd-TXT
1116 GC0712      WITH POINTER WS-I-SUB
1117 GC0712      END-IF
1118 GC0712      END-IF
1119 GC0712      IF WS-RS-Double-Quote-Used-BOOL
1120 GC0712      STRING ''' DELIMITED SIZE
1121 GC0712      INTO WS-Cmd-TXT
1122 GC0712      WITH POINTER WS-I-SUB
1123 GC0712      END-IF
1124 IF WS-CS-Args-TXT NOT = SPACES
1125 GC0809      STRING '' TRIM(WS-CS-Args-TXT,TRAILING)
1126      INTO WS-Cmd-TXT
1127      WITH POINTER WS-I-SUB
1128      END-IF
1129 IF WS-OS-Windows-BOOL
1130 GC0712      STRING '&&pause'
1131      INTO WS-Cmd-TXT
1132      WITH POINTER WS-I-SUB
1133      ELSE
1134 GC0712      STRING ';echo "Press ENTER to close...";read'
1135      INTO WS-Cmd-TXT
1136      WITH POINTER WS-I-SUB
1137      END-IF
1138 DEBUG D      DISPLAY WS-Cmd-TXT UPON SYSERR
1139      *>*****
1140      *> Run the program          **
1141      *>*****
1142 GC0909      DISPLAY S-Blank-SCR
1143      CALL 'SYSTEM' USING TRIM(WS-Cmd-TXT,TRAILING)
1144 GC0712      MOVE SPACES TO WS-Output-Msg-TXT
1145      PERFORM 900-Terminate
1146      * -- Control will NOT return
1147      .

```

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Line Statement

```
=====
1148      /
1149      *>*****Determine if the program being compiled is a MAIN program ****
1150      *> Determine if the program being compiled is a MAIN program   **
1151      *>*****
1152      240-Find-LINKAGE-SECTION SECTION.
1153      OPEN INPUT F-Source-Code-FILE
1154 GC0712      MOVE ' ' TO WS-CS-LIBRARY-CHR
1155      SET WS-RS-More-To-1st-Prog-BOOL  TO TRUE
1156      PERFORM UNTIL WS-RS-1st-Prog-Complete-BOOL
1157          READ F-Source-Code-FILE AT END
1158          CLOSE F-Source-Code-FILE
1159          EXIT SECTION
1160      END-READ
1161 GC0712      CALL 'CHECKSRC'
1162 GC0712      USING BY CONTENT  F-Source-Code-REC
1163 GC0712      BY REFERENCE WS-RS-Source-Record-Type-CHR
1164      IF WS-RS-Source-Rec-Ident-BOOL
1165          SET WS-RS-1st-Prog-Complete-BOOL TO TRUE
1166      END-IF
1167      END-PERFORM
1168 GC0712      SET WS-RS-Source-Rec-Ignored-BOOL TO TRUE
1169      PERFORM UNTIL WS-RS-Source-Rec-Linkage-BOOL
1170          OR WS-RS-Source-Rec-Ident-BOOL
1171          READ F-Source-Code-FILE AT END
1172          CLOSE F-Source-Code-FILE
1173          EXIT SECTION
1174      END-READ
1175 GC0712      CALL 'CHECKSRC'
1176 GC0712      USING BY CONTENT  F-Source-Code-REC
1177 GC0712      BY REFERENCE WS-RS-Source-Record-Type-CHR
1178      END-PERFORM
1179      CLOSE F-Source-Code-FILE
1180      IF WS-RS-Source-Rec-Linkage-BOOL
1181 GC0712      MOVE SELCHAR TO WS-CS-LIBRARY-CHR
1182      END-IF
1183  .
```

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```

Line Statement
=====
1184   /
1185 GC0712*>***** ****
1186 GC0712*> Attempt to open the listing file as a command. This will - **
1187 GC1113*> if the user has associated filetype/extension 'gclst' with **
1188 GC0712*> an application - invoke the appropriate application to **
1189 GC0712*> allow the user to view the listing. **
1190 GC0712*>***** ****
1191 GC0712 250-Autoload-Listing SECTION.
1192 GC0712    EVALUATE TRUE
1193 GC0712      WHEN WS-OS-Windows-BOOL OR WS-OS-Cygwin-BOOL
1194 GC0712        MOVE SPACES TO WS-Cmd-TXT
1195 GC0712        STRING
1196 GC0712          'cmd /c '
1197 GC0712          TRIM(WS-Listing-Filename-TXT,TRAILING)
1198 GC0712          DELIMITED SIZE INTO WS-Cmd-TXT
1199 GC0712          CALL 'SYSTEM' USING TRIM(WS-Cmd-TXT,TRAILING)
1200 GC0712      WHEN WS-OS OSX-BOOL
1201 GC0712        MOVE SPACES TO WS-Cmd-TXT
1202 GC0712        STRING
1203 GC0712          'open -t '
1204 GC0712          TRIM(WS-Listing-Filename-TXT,TRAILING)
1205 GC0712          DELIMITED SIZE INTO WS-Cmd-TXT
1206 GC0712          CALL 'SYSTEM' USING TRIM(WS-Cmd-TXT,TRAILING)
1207 GC0712 END-EVALUATE
1208 GC0712*>*****
1209 GC0712*> ** Since we had to do our own '-save-temp' when we **
1210 GC0712*> ** compiled (in order to generate the cross-reference **
1211 GC0712*> ** listing) we now need to clean up after ourselves. **
1212 GC0712*>*****
1213 GC1112 DISPLAY S-Blank-SCR
1214 GC0712 IF WS-OS-Windows-BOOL
1215 GC0712   MOVE CONCATENATE('del ',TRIM(WS-Pgm-Nm-TXT,TRAILING))
1216 GC0712     TO WS-Cmd-TXT
1217 GC0712 ELSE
1218 GC0712   MOVE CONCATENATE('rm ',TRIM(WS-Pgm-Nm-TXT,TRAILING))
1219 GC0712     TO WS-Cmd-TXT
1220 GC0712 END-IF
1221 GC0712 CALL 'SYSTEM'
1222 GC0712   USING CONCATENATE(TRIM(WS-Cmd-TXT,TRAILING),'.c')
1223 GC0712 CALL 'SYSTEM'
1224 GC0712   USING CONCATENATE(TRIM(WS-Cmd-TXT,TRAILING),'.c.h')
1225 GC0712 CALL 'SYSTEM'
1226 GC0712   USING CONCATENATE(TRIM(WS-Cmd-TXT,TRAILING),'.c.l*.h')
1227 GC0712 CALL 'SYSTEM'
1228 GC0712   USING CONCATENATE(TRIM(WS-Cmd-TXT,TRAILING),'.i')
1229 GC0712 CALL 'SYSTEM'
1230 GC0712   USING CONCATENATE(TRIM(WS-Cmd-TXT,TRAILING),'.o')
1231
1232 GC0712 .

```

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Line Statement

```
=====
```

1233 /  
1234 \*>\*\*\*\*\*  
1235 \*> Display a message and halt the program \*\*  
1236 \*>\*\*\*\*\*  
1237 900-Terminate SECTION.  
1238 GC0909 IF WS-Output-Msg-TXT > SPACES  
1239 GC0909 DISPLAY S-Switches-SCR  
1240 GC0909 CALL 'C\$SLEEP' USING 2  
1241 GC0909 END-IF  
1242 DISPLAY S-Blank-SCR  
1243 STOP RUN  
1244 .  
1245  
1246 END PROGRAM GCic.

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Line Statement

```
=====
1247      /
1248      IDENTIFICATION DIVISION.
1249      PROGRAM-ID. CHECKSRC.
1250      *>***** ****
1251      *> This subprogram will scan a line of source code it is given **
1252      *> looking for 'LINKAGE SECTION' or 'IDENTIFICATION DIVISION'. **
1253      *>
1254      **  ****NOTE****  ****NOTE****  ****NOTE****  ****NOTE***  **
1255      *>
1256      *> These two strings must be found IN THEIR ENTIRETY within  **
1257      *> the 1st 80 columns of program source records, and cannot  **
1258      *> follow either a '>' sequence OR a '*' in col 7.  **
1259      *>***** ****
1260      *> DATE CHANGE DESCRIPTION  **
1261      *> =====  ==
1262      *> GC0809 Initial coding.  **
1263      *>***** ****
1264      ENVIRONMENT DIVISION.
1265      CONFIGURATION SECTION.
1266      REPOSITORY.
1267          FUNCTION ALL INTRINSIC.
1268      DATA DIVISION.
1269      WORKING-STORAGE SECTION.
1270      01 WS-Compressed-Src-TXT.
1271          05 WS-CS-CHR          OCCURS 80 TIMES
1272                      PIC X(1).
1273
1274      01 WS-Runtime-Switches-TXT.
1275          05 WS-RS-Found-SPACE-CHR    PIC X(1).
1276              88 WS-RS-Skipping-SPACE-BOOL  VALUE 'Y'.
1277              88 WS-RS-Not-Skipping-SPACE-BOOL  VALUE 'N'.
1278
1279      01 WS-I-SUB           USAGE BINARY-CHAR.
1280
1281      01 WS-J-SUB           USAGE BINARY-CHAR.
1282      LINKAGE SECTION.
1283      01 L-Argument-1-TXT.
1284          02 L-A1-CHR          OCCURS 80 TIMES
1285                      PIC X(1).
1286
1287      01 L-Argument-2-CHR      PIC X(1).
1288          88 L-A2-LINKAGE-SECTION-BOOL  VALUE 'L'.
1289          88 L-A2-IDENT-DIVISION-BOOL  VALUE 'I'.
1290          88 L-A2-Nothing-Special-BOOL  VALUE ' '.
```

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```

Line Statement
=====
1291   /
1292 GC0712 PROCEDURE DIVISION USING BY VALUE      L-Argument-1-TXT
1293 GC0712           BY REFERENCE L-Argument-2-CHR.
1294   000-Main SECTION.
1295     SET L-A2-Nothing-Special-BOOL TO TRUE
1296     IF L-A1-CHR (7) = '*'
1297       GOBACK
1298     END-IF
1299   .
1300   *>
1301   *> Compress multiple consecutive spaces
1302   *>
1303     SET WS-RS-Not-Skipping-SPACE-BOOL TO TRUE
1304     MOVE 0 TO WS-J-SUB
1305     MOVE SPACES TO WS-Compressed-Src-TXT
1306     PERFORM VARYING WS-I-SUB FROM 1 BY 1
1307       UNTIL WS-I-SUB > 80
1308     IF L-A1-CHR (WS-I-SUB) = SPACE
1309       IF WS-RS-Not-Skipping-SPACE-BOOL
1310         ADD 1 TO WS-J-SUB
1311         MOVE UPPER-CASE(L-A1-CHR (WS-I-SUB))
1312           TO WS-CS-CHR (WS-J-SUB)
1313         SET WS-RS-Skipping-SPACE-BOOL TO TRUE
1314       END-IF
1315     ELSE
1316       SET WS-RS-Not-Skipping-SPACE-BOOL TO TRUE
1317       ADD 1 TO WS-J-SUB
1318       MOVE L-A1-CHR (WS-I-SUB) TO WS-CS-CHR (WS-J-SUB)
1319     END-IF
1320   END-PERFORM
1321   *>
1322   *> Scan the compressed source line
1323   *>
1324     PERFORM VARYING WS-I-SUB FROM 1 BY 1
1325       UNTIL WS-I-SUB > 66
1326     EVALUATE TRUE
1327       WHEN WS-CS-CHR (WS-I-SUB) = '*'
1328         IF WS-Compressed-Src-TXT (WS-I-SUB : 2) = '*>'
1329           GOBACK
1330         END-IF
1331       WHEN (WS-CS-CHR (WS-I-SUB) = 'L') AND (WS-I-SUB < 66)
1332         IF WS-Compressed-Src-TXT (WS-I-SUB : 15)
1333           = 'LINKAGE SECTION'
1334           SET L-A2-LINKAGE-SECTION-BOOL TO TRUE
1335           GOBACK
1336         END-IF
1337       WHEN (WS-CS-CHR (WS-I-SUB) = 'I') AND (WS-I-SUB < 58)
1338         IF WS-Compressed-Src-TXT (WS-I-SUB : 23)
1339           = 'IDENTIFICATION DIVISION'
1340           SET L-A2-IDENT-DIVISION-BOOL TO TRUE
1341           GOBACK
1342         END-IF
1343     END-EVALUATE
1344   END-PERFORM

```

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Line Statement

```

=====
1345      */
1346      *> If we get to here, we never found anything!
1347      */
1348 +     GOBACK
1349 .
1350     END PROGRAM CHECKSRC.

1351
1352     IDENTIFICATION DIVISION.
1353     PROGRAM-ID. LISTING.
1354 *>*****
1355 *> This subprogram generates a cross-reference listing of an   **
1356 *> GNU COBOL program.   **
1357 *>*****
1358 *>
1359 *> AUTHOR:      GARY L. CUTLER          **
1360 *>             CutlerGL@gmail.com       **
1361 *>             Copyright (C) 2010, Gary L. Cutler, GPL    **
1362 *>
1363 *> DATE-WRITTEN: April 1, 2010           **
1364 *>
1365 *>*****
1366 *> DATE CHANGE DESCRIPTION            **
1367 *> ====== ====== ====== ====== ====== **
1368 *> GC0410 Initial coding              **
1369 *> GC0711 Updates to accommodate the 12MAR2010 version of OC  **
1370 *> GC0710 Handle duplicate data names (i.e. 'CORRESPONDING' or  **
1371 *> qualified items) better; ignore 'END PROGRAM' recs        **
1372 *> so program name doesn't appear in listing.                **
1373 *> GC0313 Fix problem where the first procedure name defined  **
1374 *> in the PROCEDURE DIVISION lacks a "Defined" line        **
1375 *> number.   **
1376 *>*****
1377 ENVIRONMENT DIVISION.
1378 CONFIGURATION SECTION.
1379 REPOSITORY.
1380   FUNCTION ALL INTRINSIC.
1381 INPUT-OUTPUT SECTION.
1382 FILE-CONTROL.
1383   SELECT F-Expanded-Src-FILE  ASSIGN TO WS-Expanded-Src-Fn-TXT
1384                   ORGANIZATION IS LINE SEQUENTIAL.
1385 GC0712   SELECT F-Listing-FILE   ASSIGN TO L-Listing-Fn-TXT
1386                   ORGANIZATION IS LINE SEQUENTIAL.
1387   SELECT F-Original-Src-FILE  ASSIGN TO L-Src-Fn-TXT
1388                   ORGANIZATION IS LINE SEQUENTIAL.
1389   SELECT F-Sort-Work-FILE    ASSIGN TO DISK.

1390 DATA DIVISION.
1391 FILE SECTION.
1392 FD F-Expanded-Src-FILE.
1393 01 F-Expanded-Src-REC.
1394   05 F-ES-1-CHR          PIC X.
1395   05 F-ES-2-256-TXT-256  PIC X(256).
1396 GC0712 01 F-Expanded-Src2-REC.
1397 GC0712 05 F-ES-1-7-TXT   PIC X(7).
1398 GC0712 05 F-ES-8-256-TXT  PIC X(249).

```

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| Line | Statement                             |
|------|---------------------------------------|
| 1399 |                                       |
| 1400 | 1400 GC0712 FD F-Listing-FILE.        |
| 1401 | 1401 GC0712 01 F-Listing-REC          |
| 1402 |                                       |
| 1403 | 1403 FD F-Original-Src-FILE.          |
| 1404 | 1404 01 F-Original-Src-REC            |
| 1405 | 1405 GC0410 05 F-OS-1-128-TXT.        |
| 1406 | 1406 GC0410 10 FILLER                 |
| 1407 | 1407 GC0410 10 F-OS-7-CHR             |
| 1408 | 1408 GC0712 10 F-OS-8-72-TXT          |
| 1409 | 1409 GC0712 10 FILLER                 |
| 1410 | 1410 05 F-OS-129-256-TXT              |
| 1411 |                                       |
| 1412 | 1412 SD F-Sort-Work-FILE.             |
| 1413 | 1413 01 F-Sort-Work-REC               |
| 1414 | 1414 05 F-SW-Prog-ID-TXT              |
| 1415 | 1415 05 F-SW-Token-Uc-TXT             |
| 1416 | 1416 05 F-SW-Token-TXT                |
| 1417 | 1417 05 F-SW-Section-TXT              |
| 1418 | 1418 05 F-SW-Def-Line-NUM             |
| 1419 | 1419 05 F-SW-Reference-TXT            |
| 1420 | 1420 10 F-SW-Ref-Line-NUM             |
| 1421 | 1421 10 F-SW-Ref-Flag-CHR             |
| 1422 |                                       |
| 1423 | 1423 WORKING-STORAGE SECTION.         |
| 1424 | 1424 78 WS-Lines-Per-Rec-CONST        |
| 1425 |                                       |
| 1426 | 1426 01 WS-Curr-CHR                   |
| 1427 | 1427 88 WS-Curr-Char-Is-Punct-BOOL    |
| 1428 |                                       |
| 1429 | 1429 88 WS-Curr-Char-Is-Quote-BOOL    |
| 1430 | 1430 88 WS-Curr-Char-Is-X-BOOL        |
| 1431 | 1431 88 WS-Curr-Char-Is-Z-BOOL        |
| 1432 |                                       |
| 1433 | 1433 01 WS-Curr-Division-TXT          |
| 1434 | 1434 88 WS-CD-In-IDENT-DIV-BOOL       |
| 1435 | 1435 88 WS-CD-In-ENV-DIV-BOOL         |
| 1436 | 1436 GC1010 88 WS-CD-In-DATA-DIV-BOOL |
| 1437 | 1437 GC1010 88 WS-CD-In-PROC-DIV-BOOL |
| 1438 |                                       |
| 1439 | 1439 GC1010 88 WS-CD-In-PROG-DIV-BOOL |
| 1440 |                                       |
| 1441 | 1441 01 WS-Curr-Line-NUM              |
| 1442 |                                       |
| 1443 | 1443 01 WS-Curr-Prog-ID-TXT           |
| 1444 | 1444 05 FILLER                        |
| 1445 | 1445 05 WS-CPI-13-15-TXT              |
| 1446 | 1446 GC0712 05 WS-CPI-16-CHR          |
| 1447 |                                       |
| 1448 | 1448 01 WS-Curr-Section-TXT           |
| 1449 | 1449 05 WS-CS-1-CHR                   |
| 1450 | 1450 05 WS-CS-2-14-TXT                |
| 1451 | 1451 10 FILLER                        |
| 1452 | 1452 10 WS-CS-11-14-TXT               |

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| Line | Statement                                           |
|------|-----------------------------------------------------|
| 1453 | 05 WS-CS-15-CHR PIC X(1).                           |
| 1454 | 01 WS-Curr-Verb-TXT PIC X(12).                      |
| 1455 | 01 WS-Delim-TXT PIC X(2).                           |
| 1456 | 01 WS-Dummy-TXT PIC X(1).                           |
| 1457 | 01 WS-Expanded-Src-Fn-TXT PIC X(256).               |
| 1458 | 01 WS-Filename-TXT PIC X(256).                      |
| 1459 | 01 WS-Group-Indicators-TXT.                         |
| 1460 | 05 WS-GI-Prog-ID-TXT PIC X(15).                     |
| 1461 | 05 WS-GI-Token-TXT PIC X(32).                       |
| 1462 | 01 WS-Held-Reference-TXT PIC X(100).                |
| 1463 | 01 WS-I-SUB USAGE BINARY-LONG.                      |
| 1464 | 01 WS-J-SUB USAGE BINARY-LONG.                      |
| 1465 | 01 WS-Lines-Left-NUM USAGE BINARY-LONG.             |
| 1466 | 01 WS-Lines-Per-Page-NUM USAGE BINARY-LONG.         |
| 1467 | 01 WS-Lines-Per-Page-Env-TXT PIC X(256).            |
| 1468 | GC1010 01 WS-Main-Module-Name-TXT PIC X(256).       |
| 1469 | 01 WS-Next-CHR PIC X(1).                            |
| 1470 | 88 WS-Next-Char-Is-Quote-BOOL VALUE ' ', ''''.      |
| 1471 | 01 WS-OS-Type-FILLER-TXT.                           |
| 1472 | 05 VALUE 'Windows' PIC X(14).                       |
| 1473 | 05 VALUE 'Windows/Cygwin' PIC X(14).                |
| 1474 | 05 VALUE 'UNIX/Linux' PIC X(14).                    |
| 1475 | 05 VALUE 'OSX' PIC X(14).                           |
| 1476 | 05 VALUE 'Windows/MinGW' PIC X(14).                 |
| 1477 | 01 WS-OS-Types-TXT REDEFINES WS-OS-Type-FILLER-TXT. |
| 1478 | 05 WS-OS-Type-TXT PIC X(14)                         |
| 1479 | OCCURS 5 TIMES .                                    |
| 1480 | GC0712 01 WS-Page-NUM USAGE BINARY-LONG.            |
| 1481 | GC0712 01 WS-Page-No-TXT.                           |
| 1482 | 05 WS-PN-Literal-TXT PIC X(6).                      |
| 1483 | 05 WS-PN-Page-NUM PIC Z(3)9.                        |
| 1484 | 01 WS-Program-Path-TXT PIC X(256).                  |
| 1485 | 01 WS-Reserved-Words-TXT.                           |
| 1486 | 05 VALUE ' ' PIC X(33).                             |
| 1487 | 05 VALUE 'IABS' PIC X(33).                          |

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| Line | Statement                     |                            |
|------|-------------------------------|----------------------------|
| 1507 | 05 VALUE 'VACCEPT             | ' PIC X(33).               |
| 1508 | 05 VALUE 'ACCESS              | ' PIC X(33).               |
| 1509 | 05 VALUE 'IACOS               | ' PIC X(33).               |
| 1510 | 05 VALUE 'ACTIVE-CLASS        | ' PIC X(33). UNIMPLEMENTED |
| 1511 | 05 VALUE 'VADD                | ' PIC X(33).               |
| 1512 | 05 VALUE 'ADDRESS             | ' PIC X(33).               |
| 1513 | 05 VALUE 'ADVANCING           | ' PIC X(33).               |
| 1514 | 05 VALUE 'KAFTER              | ' PIC X(33).               |
| 1515 | 05 VALUE 'ALIGNED             | ' PIC X(33). UNIMPLEMENTED |
| 1516 | 05 VALUE 'ALL                 | ' PIC X(33).               |
| 1517 | 05 VALUE 'VALLOCATE           | ' PIC X(33).               |
| 1518 | 05 VALUE 'ALPHABET            | ' PIC X(33).               |
| 1519 | 05 VALUE 'ALPHABETIC          | ' PIC X(33).               |
| 1520 | 05 VALUE 'ALPHABETIC-LOWER    | ' PIC X(33).               |
| 1521 | 05 VALUE 'ALPHABETIC-UPPER    | ' PIC X(33).               |
| 1522 | 05 VALUE 'ALPHANUMERIC        | ' PIC X(33).               |
| 1523 | 05 VALUE 'ALPHANUMERIC-EDITED | ' PIC X(33).               |
| 1524 | 05 VALUE 'ALSO                | ' PIC X(33).               |
| 1525 | 05 VALUE 'VALTER              | ' PIC X(33).               |
| 1526 | 05 VALUE 'ALTERNATE           | ' PIC X(33).               |
| 1527 | 05 VALUE 'AND                 | ' PIC X(33).               |
| 1528 | 05 VALUE 'IANNUNITY           | ' PIC X(33).               |
| 1529 | 05 VALUE 'ANY                 | ' PIC X(33).               |
| 1530 | 05 VALUE 'ANYCASE             | ' PIC X(33). UNIMPLEMENTED |
| 1531 | 05 VALUE 'ARE                 | ' PIC X(33).               |
| 1532 | 05 VALUE 'AREA                | ' PIC X(33).               |
| 1533 | 05 VALUE 'AREAS               | ' PIC X(33).               |
| 1534 | 05 VALUE 'ARGUMENT-NUMBER     | ' PIC X(33).               |
| 1535 | 05 VALUE 'ARGUMENT-VALUE      | ' PIC X(33).               |
| 1536 | 05 VALUE 'ARITHMETIC          | ' PIC X(33). UNIMPLEMENTED |
| 1537 | 05 VALUE 'AS                  | ' PIC X(33).               |
| 1538 | 05 VALUE 'ASCENDING           | ' PIC X(33).               |
| 1539 | 05 VALUE 'ASCII               | ' PIC X(33).               |
| 1540 | 05 VALUE 'IASIN               | ' PIC X(33).               |
| 1541 | 05 VALUE 'ASSIGN              | ' PIC X(33).               |
| 1542 | 05 VALUE 'AT                  | ' PIC X(33).               |
| 1543 | 05 VALUE 'IATAN               | ' PIC X(33).               |
| 1544 | 05 VALUE 'ATTRIBUTE           | ' PIC X(33).               |
| 1545 | 05 VALUE 'AUTHOR              | ' PIC X(33). OBSOLETE      |
| 1546 | 05 VALUE 'AUTO                | ' PIC X(33).               |
| 1547 | 05 VALUE 'AUTO-SKIP           | ' PIC X(33).               |
| 1548 | 05 VALUE 'AUTOMATIC           | ' PIC X(33).               |
| 1549 | 05 VALUE 'AUTOTERMINATE       | ' PIC X(33).               |
| 1550 | 05 VALUE 'AWAY-FROM-ZERO      | ' PIC X(33).               |
| 1551 | 05 VALUE 'B-AND               | ' PIC X(33). UNIMPLEMENTED |
| 1552 | 05 VALUE 'B-NOT               | ' PIC X(33). UNIMPLEMENTED |
| 1553 | 05 VALUE 'B-OR                | ' PIC X(33). UNIMPLEMENTED |
| 1554 | 05 VALUE 'B-XOR               | ' PIC X(33). UNIMPLEMENTED |
| 1555 | 05 VALUE 'BACKGROUND-COLOR    | ' PIC X(33).               |
| 1556 | 05 VALUE 'BACKGROUND-COLOUR   | ' PIC X(33).               |
| 1557 | 05 VALUE 'BASED               | ' PIC X(33).               |
| 1558 | 05 VALUE 'BEEP                | ' PIC X(33).               |
| 1559 | 05 VALUE 'BEFORE              | ' PIC X(33).               |
| 1560 | 05 VALUE 'BELL                | ' PIC X(33).               |

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| Line | Statement                     |                            |
|------|-------------------------------|----------------------------|
| 1561 | 05 VALUE ' BINARY             | ' PIC X(33).               |
| 1562 | 05 VALUE ' BINARY-C-LONG      | ' PIC X(33).               |
| 1563 | 05 VALUE ' BINARY-CHAR        | ' PIC X(33).               |
| 1564 | 05 VALUE ' BINARY-DOUBLE      | ' PIC X(33).               |
| 1565 | 05 VALUE ' BINARY-INT         | ' PIC X(33).               |
| 1566 | 05 VALUE ' BINARY-LONG        | ' PIC X(33).               |
| 1567 | 05 VALUE ' BINARY-LONG-LONG   | ' PIC X(33).               |
| 1568 | 05 VALUE ' BINARY-SHORT       | ' PIC X(33).               |
| 1569 | 05 VALUE ' BIT                | ' PIC X(33). UNIMPLEMENTED |
| 1570 | 05 VALUE ' BLANK              | ' PIC X(33).               |
| 1571 | 05 VALUE ' BLINK              | ' PIC X(33).               |
| 1572 | 05 VALUE ' BLOCK              | ' PIC X(33).               |
| 1573 | 05 VALUE ' BOOLEAN            | ' PIC X(33). UNIMPLEMENTED |
| 1574 | 05 VALUE 'IBOOLEAN-OF-INTEGER | ' PIC X(33). UNIMPLEMENTED |
| 1575 | 05 VALUE ' BOTTOM             | ' PIC X(33).               |
| 1576 | 05 VALUE 'YBY                 | ' PIC X(33).               |
| 1577 | 05 VALUE 'IBYTE-LENGTH        | ' PIC X(33).               |
| 1578 | 05 VALUE 'MC01                | ' PIC X(33).               |
| 1579 | 05 VALUE 'MC02                | ' PIC X(33).               |
| 1580 | 05 VALUE 'MC03                | ' PIC X(33).               |
| 1581 | 05 VALUE 'MC04                | ' PIC X(33).               |
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| 1597 | 05 VALUE ' CH                 | ' PIC X(33).               |
| 1598 | 05 VALUE ' CHAIN              | ' PIC X(33). UNIMPLEMENTED |
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| 1612 | 05 VALUE ' COLLATING          | ' PIC X(33).               |
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| 1867 | 05 VALUE ' LC_MONETARY                      | ' PIC X(33). UNIMPLEMENTED |
| 1868 | 05 VALUE ' LC_NUMERIC                       | ' PIC X(33). UNIMPLEMENTED |
| 1869 | 05 VALUE ' LC_TIME                          | ' PIC X(33). UNIMPLEMENTED |
| 1870 | 05 VALUE ' LEADING                          | ' PIC X(33).               |
| 1871 | 05 VALUE ' LEFT                             | ' PIC X(33).               |
| 1872 | 05 VALUE ' LEFT-JUSTIFY                     | ' PIC X(33). UNIMPLEMENTED |
| 1873 | 05 VALUE ' LEFTLINE                         | ' PIC X(33).               |
| 1874 | GC0712 05 VALUE ' LENGTH                    | ' PIC X(33).               |
| 1875 | GC0711 05 VALUE 'ILENGTH-AN                 | ' PIC X(33).               |
| 1876 | 05 VALUE ' LENGTH-CHECK                     | ' PIC X(33).               |
| 1877 | 05 VALUE ' LESS                             | ' PIC X(33).               |
| 1878 | 05 VALUE ' LIMIT                            | ' PIC X(33).               |
| 1879 | 05 VALUE ' LIMITS                           | ' PIC X(33).               |
| 1880 | 05 VALUE ' LINAGE                           | ' PIC X(33).               |
| 1881 | 05 VALUE 'ILINAGE-COUNTER                   | ' PIC X(33).               |
| 1882 | 05 VALUE ' LINE                             | ' PIC X(33).               |
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| 1886 | 05 VALUE 'KLOCAL-STORAGE                       | ' PIC X(33).               |
| 1887 | 05 VALUE 'LOCALE                               | ' PIC X(33).               |
| 1888 | GC0711 05 VALUE 'ILOCALE-COMPARE               | ' PIC X(33).               |
| 1889 | 05 VALUE 'ILOCALE-DATE                         | ' PIC X(33).               |
| 1890 | 05 VALUE 'ILOCALE-TIME                         | ' PIC X(33).               |
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| 1892 | 05 VALUE 'LOCK                                 | ' PIC X(33).               |
| 1893 | 05 VALUE 'ILOG                                 | ' PIC X(33).               |
| 1894 | 05 VALUE 'ILOG10                               | ' PIC X(33).               |
| 1895 | 05 VALUE 'LOW-VALUE                            | ' PIC X(33).               |
| 1896 | 05 VALUE 'LOW-VALUES                           | ' PIC X(33).               |
| 1897 | 05 VALUE 'LOWER                                | ' PIC X(33).               |
| 1898 | 05 VALUE 'ILOWER-CASE                          | ' PIC X(33).               |
| 1899 | GC0711 05 VALUE 'ILOWEST-ALGEBRAIC             | ' PIC X(33).               |
| 1900 | 05 VALUE 'LOWLIGHT                             | ' PIC X(33).               |
| 1901 | 05 VALUE 'MANUAL                               | ' PIC X(33).               |
| 1902 | 05 VALUE 'IMAX                                 | ' PIC X(33).               |
| 1903 | 05 VALUE 'IMEAN                                | ' PIC X(33).               |
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| 1906 | 05 VALUE 'VMERGE                               | ' PIC X(33).               |
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| 1910 | 05 VALUE 'IMIDRANGE                            | ' PIC X(33).               |
| 1911 | 05 VALUE 'IMIN                                 | ' PIC X(33).               |
| 1912 | 05 VALUE 'MINUS                                | ' PIC X(33).               |
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| 1914 | 05 VALUE 'MODE                                 | ' PIC X(33).               |
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| 1917 | 05 VALUE 'IMODULE-FORMATTED-DATE               | ' PIC X(33).               |
| 1918 | 05 VALUE 'IMODULE-ID                           | ' PIC X(33).               |
| 1919 | 05 VALUE 'IMODULE-PATH                         | ' PIC X(33).               |
| 1920 | 05 VALUE 'IMODULE-SOURCE                       | ' PIC X(33).               |
| 1921 | 05 VALUE 'IMODULE-TIME                         | ' PIC X(33).               |
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| 1923 | GC0711 05 VALUE 'IMONETARY-THOUSANDS-SEPARATOR | ' PIC X(33).               |
| 1924 | 05 VALUE 'VMOVE                                | ' PIC X(33).               |
| 1925 | 05 VALUE 'MULTIPLE                             | ' PIC X(33).               |
| 1926 | 05 VALUE 'VMULTIPLY                            | ' PIC X(33).               |
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| 1929 | 05 VALUE 'NATIONAL-EDITED                      | ' PIC X(33).               |
| 1930 | 05 VALUE 'INATIONAL-OF                         | ' PIC X(33). UNIMPLEMENTED |
| 1931 | 05 VALUE 'NATIVE                               | ' PIC X(33).               |
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| 1933 | 05 VALUE 'NEAREST-EVEN                         | ' PIC X(33).               |
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| 1935 | 05 VALUE 'NEGATIVE                             | ' PIC X(33).               |
| 1936 | 05 VALUE 'NESTED                               | ' PIC X(33). UNIMPLEMENTED |
| 1937 | 05 VALUE 'VNEXT                                | ' PIC X(33).               |
| 1938 | 05 VALUE 'NO                                   | ' PIC X(33).               |

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| 1940 | 05 VALUE ' NONE                                | ' PIC X(33). UNIMPLEMENTED |
| 1941 | 05 VALUE ' NORMAL                              | ' PIC X(33).               |
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| 1943 | 05 VALUE ' NULL                                | ' PIC X(33).               |
| 1944 | 05 VALUE ' NULLS                               | ' PIC X(33).               |
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| 1946 | 05 VALUE ' INUMBER-OF-CALL-PARAMETERS          | ' PIC X(33).               |
| 1947 | 05 VALUE ' NUMBERS                             | ' PIC X(33).               |
| 1948 | 05 VALUE ' NUMERIC                             | ' PIC X(33).               |
| 1949 | GC0711 05 VALUE ' INUMERIC-DECIMAL-POINT       | ' PIC X(33).               |
| 1950 | 05 VALUE ' NUMERIC-EDITED                      | ' PIC X(33).               |
| 1951 | GC0711 05 VALUE ' INUMERIC-THOUSANDS-SEPARATOR | ' PIC X(33).               |
| 1952 | 05 VALUE ' INUMVAL                             | ' PIC X(33).               |
| 1953 | 05 VALUE ' INUMVAL-C                           | ' PIC X(33).               |
| 1954 | GC0711 05 VALUE ' INUMVAL-F                    | ' PIC X(33).               |
| 1955 | 05 VALUE ' OBJECT                              | ' PIC X(33). UNIMPLEMENTED |
| 1956 | 05 VALUE ' OBJECT-COMPUTER                     | ' PIC X(33).               |
| 1957 | 05 VALUE ' OBJECT-REFERENCE                    | ' PIC X(33). UNIMPLEMENTED |
| 1958 | 05 VALUE ' OCCURS                              | ' PIC X(33).               |
| 1959 | 05 VALUE ' OF                                  | ' PIC X(33).               |
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| 1961 | 05 VALUE ' OMITTED                             | ' PIC X(33).               |
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| 1963 | 05 VALUE ' ONLY                                | ' PIC X(33).               |
| 1964 | 05 VALUE ' VOPEN                               | ' PIC X(33).               |
| 1965 | 05 VALUE ' OPTIONAL                            | ' PIC X(33).               |
| 1966 | 05 VALUE ' OPTIONS                             | ' PIC X(33). UNIMPLEMENTED |
| 1967 | 05 VALUE ' OR                                  | ' PIC X(33).               |
| 1968 | 05 VALUE ' IORD                                | ' PIC X(33).               |
| 1969 | 05 VALUE ' IORD-MAX                            | ' PIC X(33).               |
| 1970 | 05 VALUE ' IORD-MIN                            | ' PIC X(33).               |
| 1971 | 05 VALUE ' ORDER                               | ' PIC X(33).               |
| 1972 | 05 VALUE ' ORGANISATION                        | ' PIC X(33).               |
| 1973 | 05 VALUE ' ORGANIZATION                        | ' PIC X(33).               |
| 1974 | 05 VALUE ' OTHER                               | ' PIC X(33).               |
| 1975 | 05 VALUE ' OUTPUT                              | ' PIC X(33).               |
| 1976 | 05 VALUE ' OVERFLOW                            | ' PIC X(33).               |
| 1977 | 05 VALUE ' OVERLINE                            | ' PIC X(33).               |
| 1978 | 05 VALUE ' OVERRIDE                            | ' PIC X(33).               |
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| 1982 | 05 VALUE ' PAGE-COUNTER                        | ' PIC X(33).               |
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| 1984 | 05 VALUE ' VPERFORM                            | ' PIC X(33).               |
| 1985 | 05 VALUE ' PF                                  | ' PIC X(33).               |
| 1986 | 05 VALUE ' PH                                  | ' PIC X(33).               |
| 1987 | 05 VALUE ' IPI                                 | ' PIC X(33).               |
| 1988 | 05 VALUE ' KPIC                                | ' PIC X(33).               |
| 1989 | 05 VALUE ' KPICTURE                            | ' PIC X(33).               |
| 1990 | 05 VALUE ' PLUS                                | ' PIC X(33).               |
| 1991 | 05 VALUE ' KPOINTER                            | ' PIC X(33).               |
| 1992 | 05 VALUE ' POSITION                            | ' PIC X(33).               |

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| 1994 | 05 VALUE ' PREFIXED          | ' PIC X(33). UNIMPLEMENTED |
| 1995 | 05 VALUE ' PRESENT           | ' PIC X(33).               |
| 1996 | 05 VALUE ' IPRESENT-VALUE    | ' PIC X(33).               |
| 1997 | 05 VALUE ' PREVIOUS          | ' PIC X(33).               |
| 1998 | 05 VALUE ' MPRINTER          | ' PIC X(33).               |
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| 2002 | 05 VALUE ' PROCEDURES        | ' PIC X(33).               |
| 2003 | 05 VALUE ' PROCEED           | ' PIC X(33).               |
| 2004 | 05 VALUE ' PROGRAM           | ' PIC X(33).               |
| 2005 | 05 VALUE ' KPROGRAM-ID       | ' PIC X(33).               |
| 2006 | 05 VALUE ' PROGRAM-POINTER   | ' PIC X(33).               |
| 2007 | 05 VALUE ' PROHIBITED        | ' PIC X(33).               |
| 2008 | 05 VALUE ' PROMPT            | ' PIC X(33).               |
| 2009 | 05 VALUE ' PROPERTY          | ' PIC X(33). UNIMPLEMENTED |
| 2010 | 05 VALUE ' PROTOTYPE         | ' PIC X(33). UNIMPLEMENTED |
| 2011 | 05 VALUE ' PURGE             | ' PIC X(33). OBSOLETE      |
| 2012 | 05 VALUE ' QUEUE             | ' PIC X(33). OBSOLETE      |
| 2013 | 05 VALUE ' QUOTE             | ' PIC X(33).               |
| 2014 | 05 VALUE ' QUOTES            | ' PIC X(33).               |
| 2015 | 05 VALUE ' RAISE             | ' PIC X(33). UNIMPLEMENTED |
| 2016 | 05 VALUE ' RAISING           | ' PIC X(33). UNIMPLEMENTED |
| 2017 | 05 VALUE ' IRANDOM           | ' PIC X(33).               |
| 2018 | 05 VALUE ' IRANGE            | ' PIC X(33).               |
| 2019 | 05 VALUE ' RD                | ' PIC X(33).               |
| 2020 | 05 VALUE ' VREAD             | ' PIC X(33).               |
| 2021 | 05 VALUE ' VREADY            | ' PIC X(33).               |
| 2022 | 05 VALUE ' VRECEIVE          | ' PIC X(33). OBSOLETE      |
| 2023 | 05 VALUE ' RECORD            | ' PIC X(33).               |
| 2024 | 05 VALUE ' RECORDING         | ' PIC X(33).               |
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| 2028 | 05 VALUE ' REEL              | ' PIC X(33).               |
| 2029 | 05 VALUE ' AREFERENCE        | ' PIC X(33).               |
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| 2031 | 05 VALUE ' RELATION          | ' PIC X(33). UNIMPLEMENTED |
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| 2033 | 05 VALUE ' VRELEASE          | ' PIC X(33).               |
| 2034 | 05 VALUE ' IREM              | ' PIC X(33).               |
| 2035 | 05 VALUE ' REMAINDER         | ' PIC X(33).               |
| 2036 | 05 VALUE ' REMARKS           | ' PIC X(33). OBSOLETE      |
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| 2042 | 05 VALUE ' REPORTING         | ' PIC X(33).               |
| 2043 | 05 VALUE ' REPORTS           | ' PIC X(33).               |
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| 2048 | 05 VALUE 'RESUME                       | ' PIC X(33). UNIMPLEMENTED |
| 2049 | 05 VALUE 'RETRY                        | ' PIC X(33). UNIMPLEMENTED |
| 2050 | 05 VALUE 'VRETURN                      | ' PIC X(33).               |
| 2051 | 05 VALUE 'IRETURN-CODE                 | ' PIC X(33).               |
| 2052 | 05 VALUE 'KRETURNING                   | ' PIC X(33).               |
| 2053 | 05 VALUE 'IREVERSE                     | ' PIC X(33).               |
| 2054 | 05 VALUE 'REVERSE-VIDEO                | ' PIC X(33).               |
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| 2056 | 05 VALUE 'REWIND                       | ' PIC X(33).               |
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| 2170 | 05 VALUE ' SYMBOLIC                       | ' PIC X(33).               |
| 2171 | 05 VALUE ' SYNC                           | ' PIC X(33).               |
| 2172 | 05 VALUE ' SYNCHRONISED                   | ' PIC X(33).               |
| 2173 | 05 VALUE ' SYNCHRONIZED                   | ' PIC X(33).               |
| 2174 | 05 VALUE 'MSYSERR                         | ' PIC X(33).               |
| 2175 | 05 VALUE 'MSYSIN                          | ' PIC X(33).               |
| 2176 | 05 VALUE 'MSYSIPT                         | ' PIC X(33).               |
| 2177 | 05 VALUE 'MSYSLIST                        | ' PIC X(33).               |
| 2178 | 05 VALUE 'MSYSLST                         | ' PIC X(33).               |
| 2179 | 05 VALUE 'MSYSOUT                         | ' PIC X(33).               |
| 2180 | 05 VALUE ' SYSTEM-DEFAULT                 | ' PIC X(33).               |
| 2181 | 05 VALUE ' TABLE                          | ' PIC X(33). UNIMPLEMENTED |
| 2182 | 05 VALUE 'KTALLYING                       | ' PIC X(33).               |
| 2183 | 05 VALUE 'ITAN                            | ' PIC X(33).               |
| 2184 | 05 VALUE ' TAPE                           | ' PIC X(33).               |
| 2185 | 05 VALUE ' TERMINAL                       | ' PIC X(33).               |
| 2186 | 05 VALUE 'VTERMINATE                      | ' PIC X(33).               |
| 2187 | 05 VALUE ' TEST                           | ' PIC X(33).               |
| 2188 | 05 VALUE 'ITEST-DATE-YYYYMMDD             | ' PIC X(33).               |
| 2189 | 05 VALUE 'ITEST-DAY-YYYYDDD               | ' PIC X(33).               |
| 2190 | GC0711 05 VALUE 'ITEST-FORMATTED-DATETIME | ' PIC X(33). UNIMPLEMENTED |
| 2191 | GC0711 05 VALUE 'ITEST-NUMVAL             | ' PIC X(33).               |
| 2192 | GC0711 05 VALUE 'ITEST-NUMVAL-C           | ' PIC X(33).               |
| 2193 | GC0711 05 VALUE 'ITEST-NUMVAL-F           | ' PIC X(33).               |
| 2194 | 05 VALUE ' TEXT                           | ' PIC X(33). OBSOLETE      |
| 2195 | 05 VALUE ' THAN                           | ' PIC X(33).               |
| 2196 | 05 VALUE ' THEN                           | ' PIC X(33).               |
| 2197 | 05 VALUE ' THROUGH                        | ' PIC X(33).               |
| 2198 | 05 VALUE ' THRU                           | ' PIC X(33).               |
| 2199 | 05 VALUE ' TIME                           | ' PIC X(33).               |
| 2200 | GC0711 05 VALUE ' TIME-OUT                | ' PIC X(33).               |
| 2201 | GC0711 05 VALUE ' TIMEOUT                 | ' PIC X(33).               |
| 2202 | 05 VALUE ' TIMES                          | ' PIC X(33).               |
| 2203 | 05 VALUE 'KTO                             | ' PIC X(33).               |
| 2204 | 05 VALUE ' TOP                            | ' PIC X(33).               |
| 2205 | 05 VALUE ' TOWARD-GREATER                 | ' PIC X(33).               |
| 2206 | 05 VALUE ' TOWARD-LESSER                  | ' PIC X(33).               |
| 2207 | 05 VALUE ' TRAILING                       | ' PIC X(33).               |
| 2208 | 05 VALUE ' TRAILING-SIGN                  | ' PIC X(33). UNIMPLEMENTED |

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| Line | Statement                                                      |                            |
|------|----------------------------------------------------------------|----------------------------|
| 2209 | 05 VALUE 'VTRANSFORM                                           | ' PIC X(33).               |
| 2210 | 05 VALUE 'ITRIM                                                | ' PIC X(33).               |
| 2211 | 05 VALUE 'TRUE                                                 | ' PIC X(33).               |
| 2212 | 05 VALUE 'TRUNCATION                                           | ' PIC X(33).               |
| 2213 | 05 VALUE 'TYPE                                                 | ' PIC X(33).               |
| 2214 | 05 VALUE 'TYPEDEF                                              | ' PIC X(33). UNIMPLEMENTED |
| 2215 | 05 VALUE 'UCS-4                                                | ' PIC X(33). UNIMPLEMENTED |
| 2216 | 05 VALUE 'UNDERLINE                                            | ' PIC X(33).               |
| 2217 | 05 VALUE 'UNIT                                                 | ' PIC X(33).               |
| 2218 | 05 VALUE 'UNIVERSAL                                            | ' PIC X(33). UNIMPLEMENTED |
| 2219 | 05 VALUE 'VUNLOCK                                              | ' PIC X(33).               |
| 2220 | 05 VALUE 'UNSIGNED                                             | ' PIC X(33).               |
| 2221 | 05 VALUE 'UNSIGNED-INT                                         | ' PIC X(33).               |
| 2222 | 05 VALUE 'UNSIGNED-LONG                                        | ' PIC X(33).               |
| 2223 | 05 VALUE 'UNSIGNED-SHORT                                       | ' PIC X(33).               |
| 2224 | 05 VALUE 'VUNSTRING                                            | ' PIC X(33).               |
| 2225 | 05 VALUE 'UNTIL                                                | ' PIC X(33).               |
| 2226 | 05 VALUE 'KUP                                                  | ' PIC X(33).               |
| 2227 | 05 VALUE 'UPDATE                                               | ' PIC X(33).               |
| 2228 | 05 VALUE 'UPON                                                 | ' PIC X(33).               |
| 2229 | 05 VALUE 'UPPER                                                | ' PIC X(33).               |
| 2230 | 05 VALUE 'IUPPER-CASE                                          | ' PIC X(33).               |
| 2231 | 05 VALUE 'USAGE                                                | ' PIC X(33).               |
| 2232 | 05 VALUE 'VUSE                                                 | ' PIC X(33).               |
| 2233 | 05 VALUE 'USER                                                 | ' PIC X(33).               |
| 2234 | 05 VALUE 'USER-DEFAULT                                         | ' PIC X(33).               |
| 2235 | 05 VALUE 'KUSING                                               | ' PIC X(33).               |
| 2236 | 05 VALUE 'UTF-16                                               | ' PIC X(33). UNIMPLEMENTED |
| 2237 | 05 VALUE 'UTF-8                                                | ' PIC X(33). UNIMPLEMENTED |
| 2238 | 05 VALUE 'VAL-STATUS                                           | ' PIC X(33). UNIMPLEMENTED |
| 2239 | 05 VALUE 'VALID                                                | ' PIC X(33). UNIMPLEMENTED |
| 2240 | 05 VALUE 'VALIDATE                                             | ' PIC X(33). UNIMPLEMENTED |
| 2241 | 05 VALUE 'VALIDATE-STATUS                                      | ' PIC X(33). UNIMPLEMENTED |
| 2242 | 05 VALUE 'AVALUE                                               | ' PIC X(33).               |
| 2243 | 05 VALUE 'VALUES                                               | ' PIC X(33).               |
| 2244 | 05 VALUE 'IVARIANCE                                            | ' PIC X(33).               |
| 2245 | 05 VALUE 'KVARYING                                             | ' PIC X(33).               |
| 2246 | 05 VALUE 'VDISABLE                                             | ' PIC X(33). UNIMPLEMENTED |
| 2247 | 05 VALUE 'WAIT                                                 | ' PIC X(33).               |
| 2248 | 05 VALUE 'VWHEN                                                | ' PIC X(33).               |
| 2249 | 05 VALUE 'IWHEN-COMPILED                                       | ' PIC X(33).               |
| 2250 | 05 VALUE 'WITH                                                 | ' PIC X(33).               |
| 2251 | 05 VALUE 'WORDS                                                | ' PIC X(33).               |
| 2252 | 05 VALUE 'KWORKING-STORAGE                                     | ' PIC X(33).               |
| 2253 | 05 VALUE 'VWRITE                                               | ' PIC X(33).               |
| 2254 | 05 VALUE 'IYEAR-TO-YYYY                                        | ' PIC X(33).               |
| 2255 | 05 VALUE 'YYYYDDD                                              | ' PIC X(33).               |
| 2256 | 05 VALUE 'YYYYMMDD                                             | ' PIC X(33).               |
| 2257 | 05 VALUE 'ZERO                                                 | ' PIC X(33).               |
| 2258 | 05 VALUE 'ZERO-FILL                                            | ' PIC X(33). UNIMPLEMENTED |
| 2259 | 05 VALUE 'ZEROES                                               | ' PIC X(33).               |
| 2260 | 05 VALUE 'ZEROS                                                | ' PIC X(33).               |
| 2261 | 01 WS-Reserved-Word-Table-TXT REDEFINES WS-Reserved-Words-TXT. |                            |
| 2262 | 05 WS-Reserved-Word-TXT OCCURS 756 TIMES                       |                            |
| 2263 | GC1113                                                         |                            |

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| Line        | Statement                          |
|-------------|------------------------------------|
| 2263        | ASCENDING KEY                      |
| 2264        | WS-RW-Word-TXT                     |
| 2265        | INDEXED WS-RW-IDX.                 |
| 2266        | 10 WS-RW-Type-CD                   |
| 2267        | 10 WS-RW-Word-TXT                  |
| 2268        | PIC X(1).                          |
| 2269        | PIC X(32).                         |
| 2270 GC0710 | 01 WS-Runtime-Switches.            |
| 2271        | 05 WS-RS-Duplicate-CHR             |
| 2272        | PIC X(1).                          |
| 2273        | 05 WS-RS-In-Which-Pgm-CHR          |
| 2274        | 88 WS-RS-In-Main-Module-BOOL       |
| 2275        | VALUE 'M'.                         |
| 2276        | 88 WS-RS-In-Copybook-BOOL          |
| 2277 GC0710 | 05 WS-RS-Last-Token-Ended-Sent-CHR |
| 2278        | PIC X(1).                          |
| 2279        | 05 WS-RS-Processing-PICTURE-CHR    |
| 2280        | PIC X(1).                          |
| 2281        | 05 WS-RS-Token-Ended-Sentence-CHR  |
| 2282        | PIC X(1).                          |
| 2283        | 05 WS-RS-Verb-Has-Been-Found-CHR   |
| 2284        | PIC X(1).                          |
| 2285        | 01 WS-Saved-Section-TXT            |
| 2286 GC0712 | PIC X(15).                         |
| 2287 GC0712 | 01 WS-Src-Detail-Line-TXT.         |
| 2288        | 05 WS-SDL-Line-NUM                 |
| 2289        | PIC ZZZZZ9.                        |
| 2290        | 05 FILLER                          |
| 2291        | PIC X(1).                          |
| 2292 GC0712 | 05 WS-SDL-Statement-TXT            |
| 2293 GC0712 | PIC X(128).                        |
| 2294 GC0712 | 01 WS-Src-Header-1-TXT.            |
| 2295 GC0712 | 05 WS-SH1-Title-TXT                |
| 2296 GC0712 | PIC X(125).                        |
| 2297 GC0712 | 05 WS-SH1-DT                       |
| 2298 GC0712 | PIC 9999/99/99.                    |
| 2299        | 01 WS-Src-Header-2-TXT             |
| 2300        | PIC X(135).                        |
| 2301        | 01 WS-Src-Header-3-TXT.            |
| 2302        | 05 VALUE 'Line Statement'          |
| 2303        | PIC X(125).                        |
| 2304 GC0712 | 05 WS-SH3-Page-No-TXT              |
| 2305 GC0712 | PIC X(10).                         |
| 2306        | 01 WS-Src-Header-4-TXT.            |
| 2307 GC0712 | 05 VALUE '====='                   |
| 2308 GC0712 | PIC X(7).                          |
| 2309        | 05 VALUE ALL '='                   |
| 2310        | PIC X(128).                        |
| 2311        | 01 WS-Src-Line-NUM                 |
| 2312        | PIC 9(6).                          |
| 2313 GC0711 | 01 WS-Src-SUB                      |
| 2314        | USAGE BINARY-LONG.                 |
| 2315 GC0711 | 01 WS-Argument-Type-CD             |
| 2316        | PIC X(1).                          |
| 2317 GC0712 | 88 WS-Argument-Is-Updateable-BOOL  |
| 2318        | VALUE 'U' FALSE ''.                |
| 2319        | 01 WS-Tally-QTY                    |
| 2320        | USAGE BINARY-LONG.                 |
| 2321        | 01 WS-Temp-10-Chars-TXT            |
| 2322        | PIC X(10).                         |
| 2323        | 01 WS-Temp-32-Chars-1-TXT          |
| 2324        | PIC X(32).                         |
| 2325 GC0711 | 01 WS-Temp-32-Chars-2-TXT          |
| 2326        | PIC X(32).                         |
| 2327 GC0711 | 01 WS-Temp-32-Chars-3-TXT          |
| 2328        | PIC X(32).                         |

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| Line | Statement                                                          |
|------|--------------------------------------------------------------------|
| 2317 | 2317 GC0712 01 WS-Temp-65-Chars-TXT PIC X(65).                     |
| 2318 | 2318       01 WS-Temp-256-Chars-TXT PIC X(256).                    |
| 2319 | 2319       01 WS-Today-DT PIC 9(8).                                |
| 2320 | 2320       01 WS-Token-Curr-TXT PIC X(32).                         |
| 2321 | 2321       01 WS-Token-Curr-Uc-TXT PIC X(32).                      |
| 2322 | 2322       01 WS-Token-Prev-TXT PIC X(32).                         |
| 2323 | 2323       01 WS-Token-Search-TXT PIC X(32).                       |
| 2324 | 2324       01 WS-Token-Type-CD PIC X(1).                           |
| 2325 | 2325 GC0712 88 WS-TT-Token-Is-Argtype-BOOL VALUE 'A'.              |
| 2326 | 2326       88 WS-TT-Token-Is-EOF-BOOL VALUE HIGH-VALUES.           |
| 2327 | 2327       88 WS-TT-Token-Is-Identifier-BOOL VALUE 'I'.            |
| 2328 | 2328       88 WS-TT-Token-Is-Keyword-BOOL VALUE 'K', 'V', 'A'.     |
| 2329 | 2329       88 WS-TT-Token-Is-Lit-Alpha-BOOL VALUE 'L'.             |
| 2330 | 2330       88 WS-TT-Token-Is-Lit-Number-BOOL VALUE 'N'.            |
| 2331 | 2331       88 WS-TT-Token-Is-Verb-BOOL VALUE 'V'.                  |
| 2332 | 2332 GC0710 88 WS-TT-Token-Is-Reserved-Wd-BOOL VALUE ' '.          |
| 2333 | 2333       01 WS-Usernames-QTY USAGE BINARY-LONG.                  |
| 2334 | 2334       01 WS-Xref-Detail-Line-TXT.                             |
| 2335 | 2335        05 WS-XDL-Prog-ID-TXT PIC X(15).                       |
| 2336 | 2336        05 FILLER PIC X(1).                                    |
| 2337 | 2337        05 WS-XDL-Token-TXT PIC X(32).                         |
| 2338 | 2338        05 FILLER PIC X(1).                                    |
| 2339 | 2339        05 WS-XDL-Def-Line-NUM PIC ZZZZZ9.                     |
| 2340 | 2340        05 FILLER PIC X(1).                                    |
| 2341 | 2341        05 WS-XDL-Section-TXT PIC X(15).                       |
| 2342 | 2342        05 FILLER PIC X(1).                                    |
| 2343 | 2343        05 WS-XDL-Reference-TXT OCCURS WS-Lines-Per-Rec-CONST. |
| 2344 | 2344         10 WS-XDL-Ref-Line-NUM PIC ZZZZZ9.                    |
| 2345 | 2345         10 WS-XDL-Ref-Flag-CHR PIC X(1).                      |
| 2346 | 2346         10 FILLER PIC X(1).                                   |
| 2347 | 2347       01 WS-Xref-Header-1-TXT.                                |
| 2348 | 2348 GC0712 05 WS-XH1-Title-TXT PIC X(125).                        |
| 2349 | 2349       05 WS-XH1-DT PIC 9999/99/99.                            |
| 2350 | 2350       01 WS-Xref-Header-2-TXT PIC X(135).                     |
| 2351 | 2351       01 WS-Xref-Header-3-TXT.                                |
| 2352 | 2352 GC0712 05 VALUE 'PROGRAM-ID' PIC X(16).                       |
| 2353 | 2353       05 VALUE 'Identifier/Register/' PIC X(20).              |
| 2354 | 2354       05 VALUE 'Function' PIC X(13).                          |
| 2355 | 2355       05 VALUE 'Defn' PIC X(7).                               |
| 2356 | 2356       05 VALUE 'Where Defined' PIC X(16).                     |
| 2357 | 2357 GC0712 05 VALUE 'References (* = Updated)' PIC X(53).         |
| 2358 | 2358       05 WS-XH3-Page-No-TXT PIC X(10).                        |

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```
=====
2371
2372 GC0712 01 WS-Xref-Header-4-TXT.
2373 GC0712    05 VALUE ALL '='          PIC X(15).
2374 GC0712    05 VALUE SPACE          PIC X(1).
2375 GC0712    05 VALUE ALL '='          PIC X(32).
2376 GC0712    05 VALUE SPACE          PIC X(1).
2377 GC0712    05 VALUE ALL '='          PIC X(6).
2378 GC0712    05 VALUE SPACE          PIC X(1).
2379 GC0712    05 VALUE ALL '='          PIC X(15).
2380 GC0712    05 VALUE SPACE          PIC X(1).
2381 GC0712    05 VALUE ALL '='          PIC X(63).
2382
2383     LINKAGE SECTION.
2384 GC0712 01 L-Listing-Fn-TXT      PIC X(256).
2385
2386     01 L-Src-Fn-TXT            PIC X(256).
2387
2388 GC0712 01 L-OS-Type-CD        PIC 9(1).
```

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| Line | Statement                                        |
|------|--------------------------------------------------|
| 2389 | /                                                |
| 2390 | GC0712 PROCEDURE DIVISION USING L-Listing-Fn-TXT |
| 2391 | L-Src-Fn-TXT                                     |
| 2392 | L-OS-Type-CD.                                    |
| 2393 | 000-Main SECTION.                                |
| 2394 | PERFORM 100-Initialization                       |
| 2395 | OPEN OUTPUT F-Listing-FILE                       |
| 2396 | PERFORM 500-Produce-Source-Listing               |
| 2397 | SORT F-Sort-Work-FILE                            |
| 2398 | ASCENDING KEY    F-SW-Prog-ID-TXT                |
| 2399 | F-SW-Token-Uc-TXT                                |
| 2400 | F-SW-Ref-Line-NUM                                |
| 2401 | INPUT PROCEDURE  300-Tokenize-Source             |
| 2402 | OUTPUT PROCEDURE 400-Produce-Xref-Listing        |
| 2403 | CLOSE F-Listing-FILE                             |
| 2404 | GOBACK                                           |
| 2405 | .                                                |

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Line Statement

```

=====
2406   /
2407   *>*****  

2408   *> Perform all program-wide initialization operations      **  

2409   *>*****  

2410   100-Initialization SECTION.  

2411 GC0712   MOVE 0 TO WS-Page-NUM  

2412 GC0712   STRING 'GNU COBOL V2.0 11FEB2012 Source Listing - GCic for '  

2413 GC0712           DELIMITED SIZE  

2414 GC0712           WS-OS-Type-TXT(L-OS-Type-CD) DELIMITED SPACE  

2415 GC0712           ' Copyright (C) 2009 - 2013, Gary L. Cutler, GPL'  

2416 GC0712           DELIMITED SIZE  

2417 GC0712           INTO WS-SH1-Title-TXT  

2418 GC0712   STRING 'GNU COBOL V2.0 11FEB2012 Cross-Reference Listing - ' &  

2419 GC0712           ' GCic for ' DELIMITED SIZE  

2420 GC0712           WS-OS-Type-TXT(L-OS-Type-CD) DELIMITED SPACE  

2421 GC0712           ' Copyright (C) 2009 - 2013, Gary L. Cutler, GPL'  

2422 GC0712           DELIMITED SIZE  

2423 GC0712           INTO WS-XH1-Title-TXT  

2424   MOVE TRIM(L-Src-Fn-TXT,Leading) TO L-Src-Fn-TXT  

2425 GC1010   PERFORM VARYING WS-I-SUB FROM LENGTH(L-Src-Fn-TXT) BY -1 *> Locate last directory delimiter character so that the fil  

  ename can be extracted  

2426 GC1010           UNTIL L-Src-Fn-TXT(WS-I-SUB:1) = '/' OR '\'  

2427 GC1010           OR WS-I-SUB = 0  

2428 GC1010           END-PERFORM  

2429 GC1010           IF WS-I-SUB = 0  

2430 GC1010           MOVE UPPER-CASE(L-Src-Fn-TXT) TO WS-Main-Module-Name-TXT *> No directory delimiter, whole thing is filename  

2431 GC1010           ELSE  

2432 GC1010           ADD 1 TO WS-I-SUB  

2433 GC1010           MOVE UPPER-CASE(L-Src-Fn-TXT(WS-I-SUB:))  

2434 GC1010           TO WS-Main-Module-Name-TXT *> Extract filename  

2435 GC1010           END-IF  

2436   ACCEPT WS-Lines-Per-Page-Env-TXT  

2437           FROM ENVIRONMENT 'OCXREF_LINES'  

2438           INSPECT L-Src-Fn-TXT REPLACING ALL '\' BY '/'  

2439           MOVE L-Src-Fn-TXT TO WS-Program-Path-TXT  

2440           MOVE WS-Program-Path-TXT TO WS-Src-Header-2-TXT  

2441           CALL 'C$JUSTIFY' USING WS-Src-Header-2-TXT, 'Right'  

2442           MOVE WS-Src-Header-2-TXT TO WS-Xref-Header-2-TXT  

2443           MOVE LENGTH(TRIM(L-Src-Fn-TXT,Trailing)) TO WS-I-SUB  

2444           MOVE 0 TO WS-J-SUB  

2445           PERFORM UNTIL L-Src-Fn-TXT(WS-I-SUB:1) = '/'  

2446           OR WS-I-SUB = 0  

2447           SUBTRACT 1 FROM WS-I-SUB  

2448           ADD 1 TO WS-J-SUB  

2449           END-PERFORM  

2450           UNSTRING L-Src-Fn-TXT((WS-I-SUB + 1):WS-J-SUB)  

2451           DELIMITED BY '.'  

2452           INTO WS-Filename-TXT  

2453           WS-Dummy-TXT  

2454 GC1010           STRING  

2455 GC1010           TRIM(WS-Filename-TXT,Trailing)  

2456 GC1010           '.i'  

2457 GC1010           DELIMITED SIZE  

2458 GC1010           INTO WS-Expanded-Src-Fn-TXT
=====
```

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```
=====
2459 GC1010    CALL 'CBL_CHECK_FILE_EXIST' USING WS-Expanded-Src-Fn-TXT
2460 GC1010          WS-Temp-256-Chars-TXT
2461 GC1010    IF RETURN-CODE NOT = 0
2462 GC1010        GOBACK
2463 GC1010    END-IF
2464 GC1010    IF WS-Lines-Per-Page-Env-TXT NOT = SPACES
2465         MOVE NUMVAL(WS-Lines-Per-Page-Env-TXT)
2466             TO WS-Lines-Per-Page-NUM
2467 ELSE
2468     MOVE 58
2469         TO WS-Lines-Per-Page-NUM
2470 END-IF
2471 ACCEPT WS-Today-DT FROM DATE YYYYMMDD
2472 MOVE WS-Today-DT TO WS-XH1-DT
2473             WS-SH1-DT
2474 MOVE '?????????????...' TO WS-Curr-Prog-ID-TXT
2475 MOVE SPACES      TO WS-Curr-Verb-TXT
2476                 WS-Held-Reference-TXT
2477 .
.
```

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|------|-------------------------------------------------------|
| 2478 | /                                                     |
| 2479 | 300-Tokenize-Source SECTION.                          |
| 2480 | OPEN INPUT F-Expanded-Src-FILE                        |
| 2481 | MOVE SPACES TO F-Expanded-Src-REC                     |
| 2482 | MOVE 256 TO WS-Src-SUB                                |
| 2483 | MOVE 0 TO WS-Usernames-QTY                            |
| 2484 | WS-Curr-Line-NUM                                      |
| 2485 | MOVE '?' TO WS-Curr-Division-TXT                      |
| 2486 | GC0710 MOVE 'N' TO WS-RS-Verb-Has-Been-Found-CHR      |
| 2487 | PERFORM FOREVER                                       |
| 2488 | PERFORM 310-Get-Token                                 |
| 2489 | IF WS-TT-Token-Is-EOF-BOOL                            |
| 2490 | EXIT PERFORM                                          |
| 2491 | END-IF                                                |
| 2492 | MOVE UPPER-CASE(WS-Token-Curr-TXT)                    |
| 2493 | TO WS-Token-Curr-Uc-TXT                               |
| 2494 | GC1010 IF WS-TT-Token-Is-Keyword-BOOL                 |
| 2495 | GC1010 OR WS-TT-Token-Is-Reserved-Wd-BOOL             |
| 2496 | GC1010 MOVE WS-Token-Curr-Uc-TXT TO WS-Token-Curr-TXT |
| 2497 | GC1010 END-IF                                         |
| 2498 | IF WS-TT-Token-Is-Verb-BOOL                           |
| 2499 | MOVE WS-Token-Curr-Uc-TXT TO WS-Curr-Verb-TXT         |
| 2500 | WS-Token-Prev-TXT                                     |
| 2501 | IF WS-Held-Reference-TXT NOT = SPACES                 |
| 2502 | MOVE WS-Held-Reference-TXT TO F-Sort-Work-REC         |
| 2503 | MOVE SPACES TO WS-Held-Reference-TXT                  |
| 2504 | RELEASE F-Sort-Work-REC                               |
| 2505 | END-IF                                                |
| 2506 | END-IF                                                |
| 2507 | EVALUATE TRUE                                         |
| 2508 | WHEN WS-CD-In-IDENT-DIV-BOOL                          |
| 2509 | PERFORM 320-IDENTIFICATION-DIVISION                   |
| 2510 | WHEN WS-CD-In-ENV-DIV-BOOL                            |
| 2511 | PERFORM 330-ENVIRONMENT-DIVISION                      |
| 2512 | WHEN WS-CD-In-DATA-DIV-BOOL                           |
| 2513 | PERFORM 340-DATA-DIVISION                             |
| 2514 | WHEN WS-CD-In-PROC-DIV-BOOL                           |
| 2515 | PERFORM 350-PROCEDURE-DIVISION                        |
| 2516 | END-EVALUATE                                          |
| 2517 | IF WS-TT-Token-Is-Keyword-BOOL                        |
| 2518 | MOVE WS-Token-Curr-Uc-TXT TO WS-Token-Prev-TXT        |
| 2519 | END-IF                                                |
| 2520 | IF WS-RS-Token-Ended-Sentence-CHR = 'Y'               |
| 2521 | AND WS-Curr-Division-TXT NOT = 'I'                    |
| 2522 | MOVE SPACES TO WS-Token-Prev-TXT                      |
| 2523 | WS-Curr-Verb-TXT                                      |
| 2524 | END-IF                                                |
| 2525 | END-PERFORM                                           |
| 2526 | CLOSE F-Expanded-Src-FILE                             |
| 2527 | .                                                     |

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| Line | Statement                                                               |
|------|-------------------------------------------------------------------------|
| 2529 | /                                                                       |
| 2530 | 310-Get-Token SECTION.                                                  |
| 2531 | *>-- Position to 1st non-blank character                                |
| 2532 | MOVE WS-RS-Token-Ended-Sentence-CHR                                     |
| 2533 | TO WS-RS-Last-Token-Ended-Sent-CHR                                      |
| 2534 | MOVE 'N' TO WS-RS-Token-Ended-Sentence-CHR                              |
| 2535 | PERFORM UNTIL F-Expanded-Src-REC(WS-Src-SUB : 1) NOT = SPACE            |
| 2536 | IF WS-Src-SUB > 255                                                     |
| 2537 | READ F-Expanded-Src-FILE AT END                                         |
| 2538 | IF WS-Held-Reference-TXT NOT = SPACES                                   |
| 2539 | MOVE WS-Held-Reference-TXT TO F-Sort-Work-REC                           |
| 2540 | MOVE SPACES TO WS-Held-Reference-TXT                                    |
| 2541 | RELEASE F-Sort-Work-REC                                                 |
| 2542 | END-IF                                                                  |
| 2543 | SET WS-TT-Token-Is-EOF-BOOL TO TRUE                                     |
| 2544 | MOVE 0 TO WS-Curr-Line-NUM                                              |
| 2545 | EXIT SECTION                                                            |
| 2546 | END-READ                                                                |
| 2547 | IF F-ES-1-7-TXT NOT = '#DEFLIT'                                         |
| 2548 | IF F-ES-1-CHR = '#'                                                     |
| 2549 | PERFORM 311-Control-Record                                              |
| 2550 | ELSE                                                                    |
| 2551 | PERFORM 312-Expanded-Src-Record                                         |
| 2552 | END-IF                                                                  |
| 2553 | END-IF                                                                  |
| 2554 | ELSE                                                                    |
| 2555 | ADD 1 TO WS-Src-SUB                                                     |
| 2556 | END-IF                                                                  |
| 2557 | END-PERFORM                                                             |
| 2558 | *>-- Extract token string                                               |
| 2559 | MOVE F-Expanded-Src-REC(WS-Src-SUB : 1)                                 |
| 2560 | TO WS-Curr-CHR                                                          |
| 2561 | MOVE F-Expanded-Src-REC(WS-Src-SUB + 1: 1)                              |
| 2562 | TO WS-Next-CHR                                                          |
| 2563 | IF WS-Curr-CHR = '.'                                                    |
| 2564 | ADD 1 TO WS-Src-SUB                                                     |
| 2565 | MOVE WS-Curr-CHR TO WS-Token-Curr-TXT                                   |
| 2566 | MOVE SPACE TO WS-Token-Type-CD                                          |
| 2567 | MOVE 'Y' TO WS-RS-Token-Ended-Sentence-CHR                              |
| 2568 | EXIT SECTION                                                            |
| 2569 | END-IF                                                                  |
| 2570 | IF WS-Curr-Char-Is-Punct-BOOL                                           |
| 2571 | AND WS-Curr-CHR = '='                                                   |
| 2572 | AND WS-Curr-Division-TXT = 'P'                                          |
| 2573 | ADD 1 TO WS-Src-SUB                                                     |
| 2574 | MOVE 'EQUALS' TO WS-Token-Curr-TXT                                      |
| 2575 | MOVE 'K' TO WS-Token-Type-CD                                            |
| 2576 | EXIT SECTION                                                            |
| 2577 | END-IF                                                                  |
| 2578 | IF WS-Curr-Char-Is-Punct-BOOL *> So subscripts don't get flagged w/ '*' |
| 2579 | AND WS-Curr-CHR = '('                                                   |
| 2580 | AND WS-Curr-Division-TXT = 'P'                                          |
| 2581 | MOVE SPACES TO WS-Token-Prev-TXT                                        |
| 2582 | END-IF                                                                  |

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| Line | Statement                                                |
|------|----------------------------------------------------------|
| 2583 | IF WS-Curr-Char-Is-Punct-BOOL                            |
| 2584 | ADD 1 TO WS-Src-SUB                                      |
| 2585 | MOVE WS-Curr-CHR TO WS-Token-Curr-TXT                    |
| 2586 | MOVE SPACE TO WS-Token-Type-CD                           |
| 2587 | EXIT SECTION                                             |
| 2588 | END-IF                                                   |
| 2589 | IF WS-Curr-Char-Is-Quote-BOOL                            |
| 2590 | ADD 1 TO WS-Src-SUB                                      |
| 2591 | UNSTRING F-Expanded-Src-REC                              |
| 2592 | DELIMITED BY WS-Curr-CHR                                 |
| 2593 | INTO WS-Token-Curr-TXT                                   |
| 2594 | WITH POINTER WS-Src-SUB                                  |
| 2595 | IF F-Expanded-Src-REC(WS-Src-SUB : 1) = '.'              |
| 2596 | MOVE 'Y' TO WS-RS-Token-Ended-Sentence-CHR               |
| 2597 | ADD 1 TO WS-Src-SUB                                      |
| 2598 | END-IF                                                   |
| 2599 | SET WS-TT-Token-Is-Lit-Alpha-BOOL TO TRUE                |
| 2600 | EXIT SECTION                                             |
| 2601 | END-IF                                                   |
| 2602 | IF WS-Curr-Char-Is-X-BOOL AND WS-Next-Char-Is-Quote-BOOL |
| 2603 | ADD 2 TO WS-Src-SUB                                      |
| 2604 | UNSTRING F-Expanded-Src-REC                              |
| 2605 | DELIMITED BY WS-Next-CHR                                 |
| 2606 | INTO WS-Token-Curr-TXT                                   |
| 2607 | WITH POINTER WS-Src-SUB                                  |
| 2608 | IF F-Expanded-Src-REC(WS-Src-SUB : 1) = '.'              |
| 2609 | MOVE 'Y' TO WS-RS-Token-Ended-Sentence-CHR               |
| 2610 | ADD 1 TO WS-Src-SUB                                      |
| 2611 | END-IF                                                   |
| 2612 | SET WS-TT-Token-Is-Lit-Number-BOOL TO TRUE               |
| 2613 | EXIT SECTION                                             |
| 2614 | END-IF                                                   |
| 2615 | IF WS-Curr-Char-Is-Z-BOOL AND WS-Next-Char-Is-Quote-BOOL |
| 2616 | ADD 2 TO WS-Src-SUB                                      |
| 2617 | UNSTRING F-Expanded-Src-REC                              |
| 2618 | DELIMITED BY WS-Next-CHR                                 |
| 2619 | INTO WS-Token-Curr-TXT                                   |
| 2620 | WITH POINTER WS-Src-SUB                                  |
| 2621 | IF F-Expanded-Src-REC(WS-Src-SUB : 1) = '.'              |
| 2622 | MOVE 'Y' TO WS-RS-Token-Ended-Sentence-CHR               |
| 2623 | ADD 1 TO WS-Src-SUB                                      |
| 2624 | END-IF                                                   |
| 2625 | SET WS-TT-Token-Is-Lit-Alpha-BOOL TO TRUE                |
| 2626 | EXIT SECTION                                             |
| 2627 | END-IF                                                   |
| 2628 | IF WS-RS-Processing-PICTURE-CHR = 'Y'                    |
| 2629 | UNSTRING F-Expanded-Src-REC                              |
| 2630 | DELIMITED BY '.' OR ','                                  |
| 2631 | INTO WS-Token-Curr-TXT                                   |
| 2632 | DELIMITER IN WS-Delim-TXT                                |
| 2633 | WITH POINTER WS-Src-SUB                                  |
| 2634 | IF WS-Delim-TXT = '.'                                    |
| 2635 | MOVE 'Y' TO WS-RS-Token-Ended-Sentence-CHR               |
| 2636 | ADD 1 TO WS-Src-SUB                                      |

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| Line | Statement                                                                                                         |
|------|-------------------------------------------------------------------------------------------------------------------|
| 2637 | END-IF                                                                                                            |
| 2638 | IF UPPER-CASE(WS-Token-Curr-TXT) = 'IS'                                                                           |
| 2639 | MOVE SPACE TO WS-Token-Type-CD                                                                                    |
| 2640 | EXIT SECTION                                                                                                      |
| 2641 | ELSE                                                                                                              |
| 2642 | MOVE 'N' TO WS-RS-Processing-PICTURE-CHR                                                                          |
| 2643 | MOVE SPACE TO WS-Token-Type-CD                                                                                    |
| 2644 | EXIT SECTION                                                                                                      |
| 2645 | END-IF                                                                                                            |
| 2646 | END-IF                                                                                                            |
| 2647 | UNSTRING F-Expanded-Src-REC                                                                                       |
| 2648 | DELIMITED BY '.' OR ',' OR '=' OR '(' OR ')' OR '*'<br>OR '/' OR '&' OR ';' OR ',' OR ',' OR '<'<br>OR '>' OR ':' |
| 2649 | INTO WS-Token-Curr-TXT                                                                                            |
| 2650 | DELIMITER IN WS-Delim-TXT                                                                                         |
| 2651 | WITH POINTER WS-Src-SUB                                                                                           |
| 2652 | IF WS-Delim-TXT = '.'                                                                                             |
| 2653 | MOVE 'Y' TO WS-RS-Token-Ended-Sentence-CHR                                                                        |
| 2654 | END-IF                                                                                                            |
| 2655 | IF WS-Delim-TXT NOT = '.' AND ''                                                                                  |
| 2656 | SUBTRACT 1 FROM WS-Src-SUB                                                                                        |
| 2657 | END-IF                                                                                                            |
| 2658 | *>-- Classify Token                                                                                               |
| 2659 | MOVE UPPER-CASE(WS-Token-Curr-TXT) TO WS-Token-Search-TXT                                                         |
| 2660 | IF WS-Token-Search-TXT = 'EQUAL' OR 'EQUALS'                                                                      |
| 2661 | MOVE 'EQUALS' TO WS-Token-Curr-TXT                                                                                |
| 2662 | MOVE 'K' TO WS-Token-Type-CD                                                                                      |
| 2663 | EXIT SECTION                                                                                                      |
| 2664 | END-IF                                                                                                            |
| 2665 | SEARCH ALL WS-Reserved-Word-TXT                                                                                   |
| 2666 | WHEN WS-RW-Word-TXT (WS-RW-IDX) = WS-Token-Search-TXT                                                             |
| 2667 | MOVE WS-RW-Type-CD (WS-RW-IDX) TO WS-Token-Type-CD                                                                |
| 2668 | IF WS-TT-Token-Is-Verb-BOOL                                                                                       |
| 2669 | MOVE 'Y' TO WS-RS-Verb-Has-Been-Found-CHR                                                                         |
| 2670 | END-IF                                                                                                            |
| 2671 | EXIT SECTION                                                                                                      |
| 2672 | END-SEARCH                                                                                                        |
| 2673 | *>-- Not a reserved word, must be a user name                                                                     |
| 2674 | SET WS-TT-Token-Is-Identifier-BOOL TO TRUE                                                                        |
| 2675 | PERFORM 313-Check-For-Numeric-Token                                                                               |
| 2676 | IF WS-TT-Token-Is-Lit-Number-BOOL                                                                                 |
| 2677 | IF (WS-RS-Last-Token-Ended-Sent-CHR = 'Y')<br>AND (WS-Curr-Division-TXT = 'D')                                    |
| 2678 | MOVE 'LEVEL #' TO WS-Token-Curr-TXT                                                                               |
| 2679 | MOVE 'K' TO WS-Token-Type-CD                                                                                      |
| 2680 | EXIT SECTION                                                                                                      |
| 2681 | ELSE                                                                                                              |
| 2682 | EXIT SECTION                                                                                                      |
| 2683 | END-IF                                                                                                            |
| 2684 | END-IF                                                                                                            |
| 2685 | .                                                                                                                 |

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| Line | Statement                                                |
|------|----------------------------------------------------------|
| 2689 | /                                                        |
| 2690 | 311-Control-Record SECTION.                              |
| 2691 | UNSTRING F-ES-2-256-TXT-256                              |
| 2692 | DELIMITED BY '''                                         |
| 2693 | INTO WS-Temp-10-Chars-TXT                                |
| 2694 | WS-Temp-256-Chars-TXT                                    |
| 2695 | WS-Dummy-TXT                                             |
| 2696 | INSPECT WS-Temp-10-Chars-TXT REPLACING ALL '''' BY SPACE |
| 2697 | IF WS-Temp-10-Chars-TXT(1:4) = 'line'                    |
| 2698 | MOVE SPACES TO WS-Temp-10-Chars-TXT(1:4)                 |
| 2699 | END-IF                                                   |
| 2700 | COMPUTE WS-I-SUB = NUMVAL(WS-Temp-10-Chars-TXT) - 1      |
| 2701 | IF UPPER-CASE(TRIM(WS-Temp-256-Chars-TXT,Trailing)) =    |
| 2702 | TRIM(WS-Main-Module-Name-TXT)                            |
| 2703 | MOVE WS-I-SUB TO WS-Curr-Line-NUM                        |
| 2704 | SET WS-RS-In-Main-Module-BOOL TO TRUE                    |
| 2705 | IF WS-Saved-Section-TXT NOT = SPACES                     |
| 2706 | MOVE WS-Saved-Section-TXT TO WS-Curr-Section-TXT         |
| 2707 | END-IF                                                   |
| 2708 | ELSE                                                     |
| 2709 | SET WS-RS-In-Copybook-BOOL TO TRUE                       |
| 2710 | IF WS-Saved-Section-TXT = SPACES                         |
| 2711 | MOVE WS-Curr-Section-TXT TO WS-Saved-Section-TXT         |
| 2712 | END-IF                                                   |
| 2713 | MOVE LENGTH(TRIM(WS-Temp-256-Chars-TXT,Trailing))        |
| 2714 | TO WS-I-SUB                                              |
| 2715 | MOVE 0 TO WS-J-SUB                                       |
| 2716 | PERFORM UNTIL WS-Temp-256-Chars-TXT(WS-I-SUB:1) = '/'    |
| 2717 | OR WS-I-SUB = 0                                          |
| 2718 | SUBTRACT 1 FROM WS-I-SUB                                 |
| 2719 | ADD 1 TO WS-J-SUB                                        |
| 2720 | END-PERFORM                                              |
| 2721 | UNSTRING WS-Temp-256-Chars-TXT((WS-I-SUB + 1):WS-J-SUB)  |
| 2722 | DELIMITED BY '.'                                         |
| 2723 | INTO WS-Filename-TXT                                     |
| 2724 | WS-Dummy-TXT                                             |
| 2725 | MOVE '[' TO WS-CS-1-CHR                                  |
| 2726 | MOVE WS-Filename-TXT TO WS-CS-2-14-TXT                   |
| 2727 | IF WS-CS-11-14-TXT NOT = SPACES                          |
| 2728 | MOVE '...' TO WS-CS-11-14-TXT                            |
| 2729 | END-IF                                                   |
| 2730 | MOVE ']' TO WS-CS-15-CHR                                 |
| 2731 | END-IF                                                   |
| 2732 | MOVE SPACES TO F-Expanded-Src-REC *> Force another READ  |
| 2733 | MOVE 256 TO WS-Src-SUB                                   |
| 2734 | .                                                        |

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| Line | Statement                        |
|------|----------------------------------|
| 2735 | /                                |
| 2736 | 312-Expanded-Src-Record SECTION. |
| 2737 | GC0711 MOVE 2 TO WS-Src-SUB      |
| 2738 | IF WS-RS-In-Main-Module-BOOL     |
| 2739 | ADD 1 To WS-Curr-Line-NUM        |
| 2740 | END-IF                           |
| 2741 | .                                |

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| Line | Statement                                                                     |
|------|-------------------------------------------------------------------------------|
| 2742 | /                                                                             |
| 2743 | 313-Check-For-Numeric-Token SECTION.                                          |
| 2744 | MOVE WS-Token-Curr-TXT TO WS-Temp-32-Chars-1-TXT                              |
| 2745 | INSPECT WS-Temp-32-Chars-1-TXT                                                |
| 2746 | GC0711 CONVERTING '0123456789' TO SPACES                                      |
| 2747 | GC0711 IF WS-Temp-32-Chars-1-TXT = SPACES * > Simple Unsigned Integer         |
| 2748 | SET WS-TT-Token-Is-Lit-Number-BOOL TO TRUE                                    |
| 2749 | EXIT SECTION                                                                  |
| 2750 | END-IF                                                                        |
| 2751 | GC0711 MOVE SPACES TO WS-Temp-32-Chars-2-TXT                                  |
| 2752 | GC0711 WS-Temp-32-Chars-3-TXT                                                 |
| 2753 | GC0711 WS-Dummy-TXT                                                           |
| 2754 | GC0711 UNSTRING WS-Temp-32-Chars-1-TXT                                        |
| 2755 | GC0711 DELIMITED BY 'e' OR 'E'                                                |
| 2756 | GC0711 INTO WS-Temp-32-Chars-2-TXT                                            |
| 2757 | GC0711 WS-Temp-32-Chars-3-TXT                                                 |
| 2758 | GC0711 WS-Dummy-TXT                                                           |
| 2759 | GC0711 IF WS-Dummy-TXT NOT = SPACES * > More than one 'E' - Not Numeric       |
| 2760 | GC0711 EXIT SECTION                                                           |
| 2761 | GC0711 END-IF                                                                 |
| 2762 | GC0711 IF WS-Temp-32-Chars-2-TXT(1:1) = '+' OR '-'                            |
| 2763 | GC0711 MOVE SPACE TO WS-Temp-32-Chars-2-TXT(1:1)                              |
| 2764 | GC0711 END-IF                                                                 |
| 2765 | GC0711 IF WS-Temp-32-Chars-3-TXT(1:1) = '+' OR '-'                            |
| 2766 | GC0711 MOVE SPACE TO WS-Temp-32-Chars-3-TXT(1:1)                              |
| 2767 | GC0711 END-IF                                                                 |
| 2768 | MOVE 0 TO WS-Tally-QTY                                                        |
| 2769 | GC0711 INSPECT WS-Temp-32-Chars-2-TXT                                         |
| 2770 | TALLYING WS-Tally-QTY FOR ALL '.'                                             |
| 2771 | IF WS-Tally-QTY = 1                                                           |
| 2772 | GC0711 INSPECT WS-Temp-32-Chars-2-TXT REPLACING ALL '.' BY SPACE              |
| 2773 | END-IF                                                                        |
| 2774 | GC0711 INSPECT WS-Temp-32-Chars-3-TXT                                         |
| 2775 | GC0711 TALLYING WS-Tally-QTY FOR ALL '.'                                      |
| 2776 | GC0711 IF WS-Tally-QTY = 1                                                    |
| 2777 | GC0711 INSPECT WS-Temp-32-Chars-3-TXT REPLACING ALL '.' BY SPACE              |
| 2778 | GC0711 END-IF                                                                 |
| 2779 | GC0711 IF WS-Temp-32-Chars-2-TXT = SPACES AND WS-Temp-32-Chars-3-TXT = SPACES |
| 2780 | SET WS-TT-Token-Is-Lit-Number-BOOL TO TRUE                                    |
| 2781 | EXIT SECTION                                                                  |
| 2782 | END-IF                                                                        |
| 2783 | .                                                                             |

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Line Statement

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2784 /  
2785 320-IDENTIFICATION-DIVISION SECTION.  
2786 GC0712 IF WS-TT-Token-Is-Argtype-BOOL  
2787 GC0712 SET WS-TT-Token-Is-Reserved-Wd-BOOL TO TRUE  
2788 GC0712 END-IF  
2789 GC0710 MOVE 'N' TO WS-RS-Verb-Has-Been-Found-CHR  
2790 IF WS-TT-Token-Is-Keyword-BOOL  
2791 AND WS-Token-Curr-TXT = 'DIVISION'  
2792 MOVE WS-Token-Prev-TXT TO WS-Curr-Division-TXT  
2793 EXIT SECTION  
2794 END-IF  
2795 GC0712 IF WS-Token-Prev-TXT = 'PROGRAM-ID' OR 'FUNCTION-ID'  
2796 MOVE SPACES TO WS-Token-Prev-TXT  
2797 MOVE WS-Token-Curr-TXT TO WS-Curr-Prog-ID-TXT  
2798 GC0712 IF WS-CPI-16-CHR NOT = SPACES  
2799 MOVE '...' TO WS-CPI-13-15-TXT  
2800 END-IF  
2801 GC0712 SEARCH ALL WS-Reserved-Word-TXT  
2802 GC0712 WHEN WS-RW-Word-TXT (WS-RW-IDX) = 'LENGTH'  
2803 GC0712 MOVE ' ' TO WS-RW-Type-CD (WS-RW-IDX)  
2804 GC0712 END-SEARCH  
2805 GC0712 EXIT SECTION  
2806 GC0712 END-IF  
2807 .

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| Line | Statement                                      |
|------|------------------------------------------------|
| 2808 | /                                              |
| 2809 | 330-ENVIRONMENT-DIVISION SECTION.              |
| 2810 | GC0712 IF WS-TT-Token-Is-Argtype-BOOL          |
| 2811 | SET WS-TT-Token-Is-Reserved-Wd-BOOL TO TRUE    |
| 2812 | GC0712 END-IF                                  |
| 2813 | IF WS-TT-Token-Is-Keyword-BOOL                 |
| 2814 | AND WS-Token-Curr-TXT = 'DIVISION'             |
| 2815 | MOVE WS-Token-Prev-TXT TO WS-Curr-Division-TXT |
| 2816 | EXIT SECTION                                   |
| 2817 | END-IF                                         |
| 2818 | IF WS-TT-Token-Is-Keyword-BOOL                 |
| 2819 | AND WS-Token-Curr-TXT = 'SECTION'              |
| 2820 | MOVE WS-Token-Prev-TXT TO WS-Curr-Section-TXT  |
| 2821 | EXIT SECTION                                   |
| 2822 | END-IF                                         |
| 2823 | IF WS-TT-Token-Is-Identifier-BOOL              |
| 2824 | IF WS-Token-Prev-TXT = 'FUNCTION'              |
| 2825 | PERFORM 360-Release-Def                        |
| 2826 | ELSE                                           |
| 2827 | PERFORM 361-Release-Ref                        |
| 2828 | END-IF                                         |
| 2829 | END-IF                                         |
| 2830 | .                                              |

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| Line | Statement                                      |
|------|------------------------------------------------|
| 2831 | /                                              |
| 2832 | 340-DATA-DIVISION SECTION.                     |
| 2833 | GC0712 IF WS-TT-Token-Is-Argtype-BOOL          |
| 2834 | SET WS-TT-Token-Is-Reserved-Wd-BOOL TO TRUE    |
| 2835 | GC0712 END-IF                                  |
| 2836 | IF WS-TT-Token-Is-Keyword-BOOL                 |
| 2837 | AND WS-Token-Curr-TXT = 'DIVISION'             |
| 2838 | GC0712 SEARCH ALL WS-Reserved-Word-TXT         |
| 2839 | WHEN WS-RW-Word-TXT (WS-RW-IDX) = 'LENGTH'     |
| 2840 | MOVE 'I' TO WS-RW-Type-CD (WS-RW-IDX)          |
| 2841 | GC0712 END-SEARCH                              |
| 2842 | MOVE WS-Token-Prev-TXT TO WS-Curr-Division-TXT |
| 2843 | EXIT SECTION                                   |
| 2844 | END-IF                                         |
| 2845 | IF WS-TT-Token-Is-Keyword-BOOL                 |
| 2846 | AND WS-Token-Curr-TXT = 'SECTION'              |
| 2847 | MOVE WS-Token-Prev-TXT TO WS-Curr-Section-TXT  |
| 2848 | EXIT SECTION                                   |
| 2849 | END-IF                                         |
| 2850 | IF (WS-Token-Curr-TXT = 'PIC' OR 'PICTURE')    |
| 2851 | AND (WS-TT-Token-Is-Keyword-BOOL)              |
| 2852 | MOVE 'Y' TO WS-RS-Processing-PICTURE-CHR       |
| 2853 | EXIT SECTION                                   |
| 2854 | END-IF                                         |
| 2855 | GC0710 IF WS-TT-Token-Is-Reserved-Wd-BOOL      |
| 2856 | AND WS-Token-Prev-TXT = 'LEVEL #'              |
| 2857 | MOVE SPACES TO WS-Token-Prev-TXT               |
| 2858 | GC0710 EXIT SECTION                            |
| 2859 | GC0710 END-IF                                  |
| 2860 | IF WS-TT-Token-Is-Identifier-BOOL              |
| 2861 | EVALUATE WS-Token-Prev-TXT                     |
| 2862 | WHEN 'FD'                                      |
| 2863 | PERFORM 360-Release-Def                        |
| 2864 | MOVE SPACES TO WS-Token-Prev-TXT               |
| 2865 | WHEN 'SD'                                      |
| 2866 | PERFORM 360-Release-Def                        |
| 2867 | MOVE SPACES TO WS-Token-Prev-TXT               |
| 2868 | WHEN 'LEVEL #'                                 |
| 2869 | PERFORM 360-Release-Def                        |
| 2870 | MOVE SPACES TO WS-Token-Prev-TXT               |
| 2871 | WHEN 'INDEXED'                                 |
| 2872 | PERFORM 360-Release-Def                        |
| 2873 | MOVE SPACES TO WS-Token-Prev-TXT               |
| 2874 | WHEN 'USING'                                   |
| 2875 | PERFORM 362-Release-Upd                        |
| 2876 | MOVE SPACES TO WS-Token-Prev-TXT               |
| 2877 | WHEN 'INTO'                                    |
| 2878 | PERFORM 362-Release-Upd                        |
| 2879 | MOVE SPACES TO WS-Token-Prev-TXT               |
| 2880 | WHEN OTHER                                     |
| 2881 | PERFORM 361-Release-Ref                        |
| 2882 | END-EVALUATE                                   |
| 2883 | EXIT SECTION                                   |
| 2884 | END-IF                                         |

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2885 .

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| Line | Statement                                           |
|------|-----------------------------------------------------|
| 2886 | /                                                   |
| 2887 | 350-PROCEDURE-DIVISION SECTION.                     |
| 2888 | IF WS-Curr-Section-TXT NOT = 'PROCEDURE'            |
| 2889 | MOVE 'PROCEDURE' TO WS-Curr-Section-TXT             |
| 2890 | END-IF                                              |
| 2891 | IF WS-Token-Curr-Uc-TXT = 'PROGRAM'                 |
| 2892 | AND WS-Token-Prev-TXT = 'END'                       |
| 2893 | MOVE '?' TO WS-Curr-Division-TXT                    |
| 2894 | EXIT SECTION                                        |
| 2895 | END-IF                                              |
| 2896 | IF WS-TT-Token-Is-Keyword-BOOL                      |
| 2897 | AND WS-Token-Curr-TXT = 'DIVISION'                  |
| 2898 | MOVE WS-Token-Prev-TXT TO WS-Curr-Division-TXT      |
| 2899 | SEARCH ALL WS-Reserved-Word-TXT                     |
| 2900 | WHEN WS-RW-Word-TXT (WS-RW-IDX) = 'LENGTH'          |
| 2901 | MOVE 'I' TO WS-RW-Type-CD (WS-RW-IDX)               |
| 2902 | END-SEARCH                                          |
| 2903 | EXIT SECTION                                        |
| 2904 | END-IF                                              |
| 2905 | IF WS-TT-Token-Is-Identifier-BOOL                   |
| 2906 | AND WS-Token-Prev-TXT = SPACES                      |
| 2907 | AND WS-Curr-Verb-TXT = SPACES                       |
| 2908 | GC0313*> ----- Definition of a Paragraph or Section |
| 2909 | PERFORM 360-Release-Def                             |
| 2910 | MOVE SPACES TO WS-Token-Prev-TXT                    |
| 2911 | EXIT SECTION                                        |
| 2912 | END-IF                                              |
| 2913 | IF WS-Token-Curr-TXT = 'CALL'                       |
| 2914 | SET WS-Argument-Is-Updatable-BOOL TO TRUE           |
| 2915 | END-IF                                              |
| 2916 | IF WS-Curr-Verb-TXT = 'CALL'                        |
| 2917 | IF WS-TT-Token-Is-Arctype-BOOL                      |
| 2918 | IF WS-Token-Curr-TXT = 'REFERENCE'                  |
| 2919 | SET WS-Argument-Is-Updatable-BOOL TO TRUE           |
| 2920 | ELSE                                                |
| 2921 | SET WS-Argument-Is-Updatable-BOOL TO FALSE          |
| 2922 | END-IF                                              |
| 2923 | EXIT SECTION                                        |
| 2924 | END-IF                                              |
| 2925 | ELSE                                                |
| 2926 | SET WS-Argument-Is-Updatable-BOOL TO FALSE          |
| 2927 | END-IF                                              |
| 2928 | IF NOT WS-TT-Token-Is-Identifier-BOOL               |
| 2929 | EXIT SECTION                                        |
| 2930 | END-IF                                              |
| 2931 | EVALUATE WS-Curr-Verb-TXT                           |
| 2932 | WHEN 'ACCEPT'                                       |
| 2933 | PERFORM 351-ACCEPT                                  |
| 2934 | WHEN 'ADD'                                          |
| 2935 | PERFORM 351-ADD                                     |
| 2936 | WHEN 'ALLOCATE'                                     |
| 2937 | PERFORM 351-ALLOCATE                                |
| 2938 | WHEN 'CALL'                                         |
| 2939 | PERFORM 351-CALL                                    |

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| Line | Statement               |
|------|-------------------------|
| 2940 | WHEN 'COMPUTE'          |
| 2941 | PERFORM 351-COMPUTE     |
| 2942 | WHEN 'DIVIDE'           |
| 2943 | PERFORM 351-DIVIDE      |
| 2944 | WHEN 'FREE'             |
| 2945 | PERFORM 351-FREE        |
| 2946 | WHEN 'INITIALIZE'       |
| 2947 | PERFORM 351-INITIALIZE  |
| 2948 | WHEN 'INSPECT'          |
| 2949 | PERFORM 351-INSPECT     |
| 2950 | WHEN 'MOVE'             |
| 2951 | PERFORM 351-MOVE        |
| 2952 | WHEN 'MULTIPLY'         |
| 2953 | PERFORM 351-MULTIPLY    |
| 2954 | WHEN 'PERFORM'          |
| 2955 | PERFORM 351-PERFORM     |
| 2956 | WHEN 'SET'              |
| 2957 | PERFORM 351-SET         |
| 2958 | WHEN 'STRING'           |
| 2959 | PERFORM 351-STRING      |
| 2960 | WHEN 'SUBTRACT'         |
| 2961 | PERFORM 351-SUBTRACT    |
| 2962 | WHEN 'TRANSFORM'        |
| 2963 | PERFORM 351-TRANSFORM   |
| 2964 | WHEN 'UNSTRING'         |
| 2965 | PERFORM 351-UNSTRING    |
| 2966 | WHEN OTHER              |
| 2967 | PERFORM 361-Release-Ref |
| 2968 | END-EVALUATE            |
| 2969 | .                       |

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```
=====
2970      /
2971      351-ACCEPT SECTION.
2972          EVALUATE WS-Token-Prev-TXT
2973          WHEN 'ACCEPT'
2974              PERFORM 362-Release-Upd
2975              MOVE SPACES TO WS-Token-Prev-TXT
2976          WHEN OTHER
2977              PERFORM 361-Release-Ref
2978          END-EVALUATE
2979
2980      .
2981
2982      351-ADD SECTION.
2983          EVALUATE WS-Token-Prev-TXT
2984          WHEN 'GIVING'
2985              PERFORM 362-Release-Upd
2986          WHEN 'TO'
2987              PERFORM 362-Release-Upd
2988          WHEN OTHER
2989              PERFORM 361-Release-Ref
2990          END-EVALUATE
2991
2992      .
2993      351-ALLOCATE SECTION.
2994          EVALUATE WS-Token-Prev-TXT
2995          WHEN 'ALLOCATE'
2996              PERFORM 362-Release-Upd
2997              MOVE SPACES TO WS-Token-Prev-TXT
2998          WHEN 'RETURNING'
2999              PERFORM 362-Release-Upd
3000          WHEN OTHER
3001              PERFORM 361-Release-Ref
3002          END-EVALUATE
3003
3004      .
3005      351-CALL SECTION.
3006          EVALUATE WS-Token-Prev-TXT
3007          WHEN 'RETURNING'
3008              PERFORM 362-Release-Upd
3009          WHEN 'GIVING'
3010              PERFORM 362-Release-Upd
3011      GC0712      WHEN OTHER
3012          IF WS-Argument-Is-Updatable-BOOL
3013          GC0712      PERFORM 362-Release-Upd
3014          GC0712      ELSE
3015          GC0712      PERFORM 361-Release-Ref
3016          GC0712      END-IF
3017          END-EVALUATE
3018
3019      .
3020      351-COMPUTE SECTION.
3021          EVALUATE WS-Token-Prev-TXT
3022          WHEN 'COMPUTE'
3023              PERFORM 362-Release-Upd
WHEN OTHER
```

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| Line | Statement                                     |
|------|-----------------------------------------------|
| 3024 | PERFORM 361-Release-Ref                       |
| 3025 | END-EVALUATE                                  |
| 3026 | .                                             |
| 3027 |                                               |
| 3028 | 351-DIVIDE SECTION.                           |
| 3029 | EVALUATE WS-Token-Prev-TXT                    |
| 3030 | WHEN 'INTO'                                   |
| 3031 | PERFORM 363-Set-Upd                           |
| 3032 | MOVE F-Sort-Work-REC TO WS-Held-Reference-TXT |
| 3033 | WHEN 'GIVING'                                 |
| 3034 | IF WS-Held-Reference-TXT NOT = SPACES         |
| 3035 | MOVE WS-Held-Reference-TXT To F-Sort-Work-REC |
| 3036 | MOVE SPACES To WS-Held-Reference-TXT          |
| 3037 | F-SW-Ref-Flag-CHR                             |
| 3038 | RELEASE F-Sort-Work-REC                       |
| 3039 | END-IF                                        |
| 3040 | PERFORM 362-Release-Upd                       |
| 3041 | WHEN 'REMAINDER'                              |
| 3042 | PERFORM 362-Release-Upd                       |
| 3043 | WHEN OTHER                                    |
| 3044 | PERFORM 361-Release-Ref                       |
| 3045 | END-EVALUATE                                  |
| 3046 | .                                             |
| 3047 |                                               |
| 3048 | 351-FREE SECTION.                             |
| 3049 | PERFORM 362-Release-Upd                       |
| 3050 | .                                             |
| 3051 |                                               |
| 3052 | 351-INITIALIZE SECTION.                       |
| 3053 | EVALUATE WS-Token-Prev-TXT                    |
| 3054 | WHEN 'INITIALIZE'                             |
| 3055 | PERFORM 362-Release-Upd                       |
| 3056 | WHEN 'REPLACING'                              |
| 3057 | PERFORM 361-Release-Ref                       |
| 3058 | END-EVALUATE                                  |
| 3059 | .                                             |
| 3060 |                                               |
| 3061 | 351-INSPECT SECTION.                          |
| 3062 | EVALUATE WS-Token-Prev-TXT                    |
| 3063 | WHEN 'INSPECT'                                |
| 3064 | PERFORM 364-Set-Ref                           |
| 3065 | MOVE SPACES TO WS-Held-Reference-TXT          |
| 3066 | MOVE SPACES TO WS-Token-Prev-TXT              |
| 3067 | WHEN 'TALLYING'                               |
| 3068 | PERFORM 362-Release-Upd                       |
| 3069 | MOVE SPACES TO WS-Token-Prev-TXT              |
| 3070 | WHEN 'REPLACING'                              |
| 3071 | IF WS-Held-Reference-TXT NOT = SPACES         |
| 3072 | MOVE WS-Held-Reference-TXT To F-Sort-Work-REC |
| 3073 | MOVE SPACES To WS-Held-Reference-TXT          |
| 3074 | MOVE '*' To F-SW-Ref-Flag-CHR                 |
| 3075 | RELEASE F-Sort-Work-REC                       |
| 3076 | END-IF                                        |
| 3077 | MOVE SPACES To WS-Token-Prev-TXT              |

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| Line | Statement                                     |
|------|-----------------------------------------------|
| 3078 | WHEN 'CONVERTING'                             |
| 3079 | IF WS-Held-Reference-TXT NOT = SPACES         |
| 3080 | MOVE WS-Held-Reference-TXT TO F-Sort-Work-REC |
| 3081 | MOVE SPACES TO WS-Held-Reference-TXT          |
| 3082 | MOVE '*' TO F-SW-Ref-Flag-CHR                 |
| 3083 | RELEASE F-Sort-Work-REC                       |
| 3084 | END-IF                                        |
| 3085 | MOVE SPACES TO WS-Token-Prev-TXT              |
| 3086 | WHEN OTHER                                    |
| 3087 | PERFORM 361-Release-Ref                       |
| 3088 | END-EVALUATE                                  |
| 3089 | .                                             |
| 3090 | .                                             |
| 3091 | 351-MOVE SECTION.                             |
| 3092 | EVALUATE WS-Token-Prev-TXT                    |
| 3093 | WHEN 'TO'                                     |
| 3094 | PERFORM 362-Release-Upd                       |
| 3095 | WHEN OTHER                                    |
| 3096 | PERFORM 361-Release-Ref                       |
| 3097 | END-EVALUATE                                  |
| 3098 | .                                             |
| 3099 | .                                             |
| 3100 | 351-MULTIPLY SECTION.                         |
| 3101 | EVALUATE WS-Token-Prev-TXT                    |
| 3102 | WHEN 'BY'                                     |
| 3103 | PERFORM 363-Set-Upd                           |
| 3104 | MOVE F-Sort-Work-REC TO WS-Held-Reference-TXT |
| 3105 | WHEN 'GIVING'                                 |
| 3106 | MOVE WS-Held-Reference-TXT TO F-Sort-Work-REC |
| 3107 | MOVE SPACES TO WS-Held-Reference-TXT          |
| 3108 | F-SW-Ref-Flag-CHR                             |
| 3109 | RELEASE F-Sort-Work-REC                       |
| 3110 | PERFORM 362-Release-Upd                       |
| 3111 | WHEN OTHER                                    |
| 3112 | PERFORM 361-Release-Ref                       |
| 3113 | END-EVALUATE                                  |
| 3114 | .                                             |
| 3115 | .                                             |
| 3116 | 351-PERFORM SECTION.                          |
| 3117 | EVALUATE WS-Token-Prev-TXT                    |
| 3118 | WHEN 'VARYING'                                |
| 3119 | PERFORM 362-Release-Upd                       |
| 3120 | MOVE SPACES TO WS-Token-Prev-TXT              |
| 3121 | WHEN 'AFTER'                                  |
| 3122 | PERFORM 362-Release-Upd                       |
| 3123 | MOVE SPACES TO WS-Token-Prev-TXT              |
| 3124 | WHEN OTHER                                    |
| 3125 | PERFORM 361-Release-Ref                       |
| 3126 | END-EVALUATE                                  |
| 3127 | .                                             |
| 3128 | .                                             |
| 3129 | 351-SET SECTION.                              |
| 3130 | EVALUATE WS-Token-Prev-TXT                    |
| 3131 | WHEN 'SET'                                    |

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```
=====
3132      PERFORM 362-Release-Upd
3133      WHEN OTHER
3134          PERFORM 361-Release-Ref
3135      END-EVALUATE
3136      .
3137
3138 351-STRING SECTION.
3139      EVALUATE WS-Token-Prev-TXT
3140      WHEN 'INTO'
3141          PERFORM 362-Release-Upd
3142      WHEN 'POINTER'
3143          PERFORM 362-Release-Upd
3144      WHEN OTHER
3145          PERFORM 361-Release-Ref
3146      END-EVALUATE
3147      .
3148
3149 351-SUBTRACT SECTION.
3150      EVALUATE WS-Token-Prev-TXT
3151      WHEN 'GIVING'
3152          PERFORM 362-Release-Upd
3153      WHEN 'FROM'
3154          PERFORM 362-Release-Upd
3155      WHEN OTHER
3156          PERFORM 361-Release-Ref
3157      END-EVALUATE
3158      .
3159
3160 351-TRANSFORM SECTION.
3161      EVALUATE WS-Token-Prev-TXT
3162      WHEN 'TRANSFORM'
3163          PERFORM 362-Release-Upd
3164          MOVE SPACES TO WS-Token-Prev-TXT
3165      WHEN OTHER
3166          PERFORM 361-Release-Ref
3167      END-EVALUATE
3168      .
3169
3170 351-UNSTRING SECTION.
3171      EVALUATE WS-Token-Prev-TXT
3172      WHEN 'INTO'
3173          PERFORM 362-Release-Upd
3174      WHEN 'DELIMITER'
3175          PERFORM 362-Release-Upd
3176      WHEN 'COUNT'
3177          PERFORM 362-Release-Upd
3178      WHEN 'POINTER'
3179          PERFORM 362-Release-Upd
3180      WHEN 'TALLYING'
3181          PERFORM 362-Release-Upd
3182      WHEN OTHER
3183          PERFORM 361-Release-Ref
3184      END-EVALUATE
3185      .
```

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```
=====
3186
3187      360-Release-Def SECTION.
3188      MOVE SPACES TO F-Sort-Work-REC
3189      MOVE WS-Curr-Prog-ID-TXT TO F-SW-Prog-ID-TXT
3190      MOVE WS-Token-Curr-Uc-TXT TO F-SW-Token-Uc-TXT
3191      MOVE WS-Token-Curr-TXT TO F-SW-Token-TXT
3192      MOVE WS-Curr-Section-TXT TO F-SW-Section-TXT
3193      MOVE WS-Curr-Line-NUM TO F-SW-Def-Line-NUM
3194      MOVE 0 TO F-SW-Ref-Line-NUM
3195      RELEASE F-Sort-Work-REC
3196
3197 .
3198      361-Release-Ref SECTION.
3199      PERFORM 364-Set-Ref
3200      RELEASE F-Sort-Work-REC
3201
3202 .
3203      362-Release-Upd SECTION.
3204      PERFORM 363-Set-Upd
3205      RELEASE F-Sort-Work-REC
3206
3207 .
3208      363-Set-Upd SECTION.
3209      MOVE SPACES TO F-Sort-Work-REC
3210      MOVE WS-Curr-Prog-ID-TXT TO F-SW-Prog-ID-TXT
3211      MOVE WS-Token-Curr-Uc-TXT TO F-SW-Token-Uc-TXT
3212      MOVE WS-Token-Curr-TXT TO F-SW-Token-TXT
3213      MOVE WS-Curr-Section-TXT TO F-SW-Section-TXT
3214      MOVE WS-Curr-Line-NUM TO F-SW-Ref-Line-NUM
3215      MOVE '*' TO F-SW-Ref-Flag-CHR
3216
3217 .
3218      364-Set-Ref SECTION.
3219      MOVE SPACES TO F-Sort-Work-REC
3220      MOVE WS-Curr-Prog-ID-TXT TO F-SW-Prog-ID-TXT
3221      MOVE WS-Token-Curr-Uc-TXT TO F-SW-Token-Uc-TXT
3222      MOVE WS-Token-Curr-TXT TO F-SW-Token-TXT
3223      MOVE WS-Curr-Section-TXT TO F-SW-Section-TXT
3224      MOVE WS-Curr-Line-NUM TO F-SW-Ref-Line-NUM
3225 .

```

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| Line | Statement                                         |
|------|---------------------------------------------------|
| 3226 | /                                                 |
| 3227 | 400-Produce-Xref-Listing SECTION.                 |
| 3228 | MOVE SPACES TO WS-Xref-Detail-Line-TXT            |
| 3229 | WS-Group-Indicators-TXT                           |
| 3230 | MOVE 0 TO WS-I-SUB                                |
| 3231 | WS-Lines-Left-NUM                                 |
| 3232 | MOVE 'N' TO WS-RS-Duplicate-CHR                   |
| 3233 | PERFORM FOREVER                                   |
| 3234 | RETURN F-Sort-Work-FILE AT END                    |
| 3235 | EXIT PERFORM                                      |
| 3236 | END-RETURN                                        |
| 3237 | IF F-SW-Prog-ID-TXT NOT = WS-GI-Prog-ID-TXT       |
| 3238 | OR F-SW-Token-Uc-TXT NOT = WS-GI-Token-TXT        |
| 3239 | MOVE 'N' TO WS-RS-Duplicate-CHR                   |
| 3240 | IF WS-Xref-Detail-Line-TXT NOT = SPACES           |
| 3241 | PERFORM 410-Generate-Report-Line                  |
| 3242 | END-IF                                            |
| 3243 | IF F-SW-Prog-ID-TXT NOT = WS-GI-Prog-ID-TXT       |
| 3244 | MOVE 0 TO WS-Lines-Left-NUM                       |
| 3245 | END-IF                                            |
| 3246 | MOVE F-SW-Prog-ID-TXT TO WS-GI-Prog-ID-TXT        |
| 3247 | MOVE F-SW-Token-Uc-TXT TO WS-GI-Token-TXT         |
| 3248 | END-IF                                            |
| 3249 | IF F-SW-Token-Uc-TXT = WS-GI-Token-TXT            |
| 3250 | AND F-SW-Def-Line-NUM NOT = SPACES                |
| 3251 | AND WS-Xref-Detail-Line-TXT NOT = SPACES          |
| 3252 | MOVE 'Y' TO WS-RS-Duplicate-CHR                   |
| 3253 | PERFORM 410-Generate-Report-Line                  |
| 3254 | MOVE 0 TO WS-I-SUB                                |
| 3255 | MOVE F-SW-Prog-ID-TXT TO WS-XDL-Prog-ID-TXT       |
| 3256 | MOVE '(Duplicate Definition)' TO WS-XDL-Token-TXT |
| 3257 | MOVE F-SW-Section-TXT TO WS-XDL-Section-TXT       |
| 3258 | MOVE F-SW-Def-Line-NUM TO WS-XDL-Def-Line-NUM     |
| 3259 | EXIT PERFORM CYCLE                                |
| 3260 | END-IF                                            |
| 3261 | IF F-SW-Token-Uc-TXT = WS-GI-Token-TXT            |
| 3262 | AND F-SW-Def-Line-NUM = SPACES                    |
| 3263 | AND WS-RS-Duplicate-CHR = 'Y'                     |
| 3264 | MOVE 'N' TO WS-RS-Duplicate-CHR                   |
| 3265 | PERFORM 410-Generate-Report-Line                  |
| 3266 | MOVE 0 TO WS-I-SUB                                |
| 3267 | MOVE F-SW-Prog-ID-TXT TO WS-XDL-Prog-ID-TXT       |
| 3268 | MOVE '(Duplicate References)' TO WS-XDL-Token-TXT |
| 3269 | END-IF                                            |
| 3270 | IF WS-Xref-Detail-Line-TXT = SPACES               |
| 3271 | MOVE F-SW-Prog-ID-TXT TO WS-XDL-Prog-ID-TXT       |
| 3272 | MOVE F-SW-Token-TXT TO WS-XDL-Token-TXT           |
| 3273 | MOVE F-SW-Section-TXT TO WS-XDL-Section-TXT       |
| 3274 | IF F-SW-Def-Line-NUM NOT = SPACES                 |
| 3275 | MOVE F-SW-Def-Line-NUM TO WS-XDL-Def-Line-NUM     |
| 3276 | END-IF                                            |
| 3277 | END-IF                                            |
| 3278 | IF F-SW-Reference-TXT > '000000'                  |
| 3279 | ADD 1 TO WS-I-SUB                                 |

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| Line | Statement                               |
|------|-----------------------------------------|
| 3280 | IF WS-I-SUB > WS-Lines-Per-Rec-CONST    |
| 3281 | PERFORM 410-Generate-Report-Line        |
| 3282 | MOVE 1 TO WS-I-SUB                      |
| 3283 | END-IF                                  |
| 3284 | MOVE F-SW-Ref-Line-NUM                  |
| 3285 | TO WS-XDL-Ref-Line-NUM (WS-I-SUB)       |
| 3286 | MOVE F-SW-Ref-Flag-CHR                  |
| 3287 | TO WS-XDL-Ref-Flag-CHR (WS-I-SUB)       |
| 3288 | END-IF                                  |
| 3289 | END-PERFORM                             |
| 3290 | IF WS-Xref-Detail-Line-TXT NOT = SPACES |
| 3291 | PERFORM 410-Generate-Report-Line        |
| 3292 | END-IF                                  |
| 3293 | .                                       |

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| Line | Statement                                                        |
|------|------------------------------------------------------------------|
| 3294 | /                                                                |
| 3295 | 410-Generate-Report-Line SECTION.                                |
| 3296 | IF WS-Lines-Left-NUM < 1                                         |
| 3297 | GC0712 MOVE SPACES TO F-Listing-REC                              |
| 3298 | GC0712 WRITE F-Listing-REC BEFORE PAGE                           |
| 3299 | GC0712 MOVE SPACES TO F-Listing-REC                              |
| 3300 | GC0712 WRITE F-Listing-REC BEFORE 1                              |
| 3301 | GC0712 WRITE F-Listing-REC FROM WS-Xref-Header-1-TXT BEFORE 1    |
| 3302 | GC0712 ADD 1 TO WS-Page-NUM                                      |
| 3303 | GC0712 MOVE 'Page:' TO WS-PN-Literal-TXT                         |
| 3304 | GC0712 MOVE WS-Page-NUM TO WS-PN-Page-NUM                        |
| 3305 | GC0712 CALL 'C\$JUSTIFY' USING WS-PN-Page-NUM, 'Left'            |
| 3306 | GC0712 CALL 'C\$JUSTIFY' USING WS-Page-No-TXT, 'Right'           |
| 3307 | GC0712 MOVE WS-Page-No-TXT TO WS-XH3-Page-No-TXT                 |
| 3308 | GC0712 WRITE F-Listing-REC FROM WS-Xref-Header-2-TXT BEFORE 1    |
| 3309 | GC0712 WRITE F-Listing-REC FROM WS-Xref-Header-3-TXT BEFORE 1    |
| 3310 | GC0712 WRITE F-Listing-REC FROM WS-Xref-Header-4-TXT BEFORE 1    |
| 3311 | COMPUTE WS-Lines-Left-NUM = WS-Lines-Per-Page-NUM - 4            |
| 3312 | END-IF                                                           |
| 3313 | GC0712 WRITE F-Listing-REC FROM WS-Xref-Detail-Line-TXT BEFORE 1 |
| 3314 | MOVE SPACES TO WS-Xref-Detail-Line-TXT                           |
| 3315 | MOVE 0 TO WS-I-SUB                                               |
| 3316 | SUBTRACT 1 FROM WS-Lines-Left-NUM                                |
| 3317 | .                                                                |

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Line Statement

```
=====
3318      /
3319      500-Produce-Source-Listing SECTION.
3320          OPEN INPUT F-Original-Src-FILE
3321              F-Expanded-Src-FILE
3322          MOVE 0 TO WS-Src-Line-NUM
3323          PERFORM FOREVER
3324              READ F-Expanded-Src-FILE AT END
3325                  EXIT PERFORM
3326          END-READ
3327 GC0712      IF F-ES-1-7-TXT NOT = '#DEFLIT'
3328 GC0712          IF F-ES-1-CHR = '#'
3329 GC0712              PERFORM 510-Control-Record
3330 GC0712          ELSE
3331 GC0712              PERFORM 520-Expanded-Src-Record
3332 GC0712          END-IF
3333 GC0712      END-IF
3334          END-PERFORM
3335      CLOSE F-Original-Src-FILE
3336          F-Expanded-Src-FILE
3337      .
```

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Line Statement

```
=====
3338      /
3339      510-Control-Record SECTION.
3340          UNSTRING F-ES-2-256-TXT-256
3341              DELIMITED BY ''
3342                  INTO WS-Temp-10-Chars-TXT
3343                      WS-Temp-256-Chars-TXT
3344                          WS-Dummy-TXT
3345 GC1010    IF UPPER-CASE(TRIM(WS-Temp-256-Chars-TXT,Trailing)) =
3346 GC1010        TRIM(WS-Main-Module-Name-TXT) *> Main Pgm
3347            SET WS-RS-In-Main-Module-BOOL TO TRUE
3348            IF WS-Src-Line-NUM > 0
3349                READ F-Expanded-Src-FILE END-READ
3350            END-IF
3351        ELSE *> COPY
3352            SET WS-RS-In-Copybook-BOOL TO TRUE
3353        END-IF
3354    .
```

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```

Line Statement
=====
3355      /
3356      520-Expanded-Src-Record SECTION.
3357      IF WS-RS-In-Main-Module-BOOL
3358          ADD 1 To WS-Curr-Line-NUM
3359 GC0712      READ F-Original-Src-FILE AT END CONTINUE END-READ
3360          ADD 1 TO WS-Src-Line-NUM
3361          MOVE SPACES TO WS-Src-Detail-Line-TXT
3362          MOVE WS-Src-Line-NUM TO WS-SDL-Line-NUM
3363          MOVE F-OS-1-128-TXT TO WS-SDL-Statement-TXT
3364 GC0712      MOVE LOWER-CASE(TRIM(F-OS-8-72-TXT,LEADING))
3365 GC0712      TO WS-Temp-65-Chars-TXT
3366 GC0712      INSPECT WS-Temp-65-Chars-TXT REPLACING ALL '.' BY SPACE
3367 GC0712      EVALUATE TRUE
3368 GC0712          WHEN F-OS-7-CHR = '/'
3369 GC0712              MOVE 0 TO WS-Lines-Left-NUM
3370 GC0712          WHEN WS-Temp-65-Chars-TXT = "eject"
3371 GC0712              MOVE 0 TO WS-Lines-Left-NUM
3372 GC0712          EXIT SECTION
3373 GC0712          WHEN WS-Temp-65-Chars-TXT = "skip1"
3374 GC0712              MOVE SPACES TO WS-Src-Detail-Line-TXT
3375 GC0712              PERFORM 530-Generate-Source-Line
3376 GC0712          EXIT SECTION
3377 GC0712          WHEN WS-Temp-65-Chars-TXT = "skip2"
3378 GC0712              MOVE SPACES TO WS-Src-Detail-Line-TXT
3379 GC0712              PERFORM 530-Generate-Source-Line 2 TIMES
3380 GC0712          EXIT SECTION
3381 GC0712          WHEN WS-Temp-65-Chars-TXT = "skip3"
3382 GC0712              MOVE SPACES TO WS-Src-Detail-Line-TXT
3383 GC0712              PERFORM 530-Generate-Source-Line 3 TIMES
3384 GC0712          EXIT SECTION
3385 GC0712      END-EVALUATE
3386      PERFORM 530-Generate-Source-Line
3387      IF F-OS-129-256-TXT NOT = SPACES
3388          MOVE SPACES TO WS-Src-Detail-Line-TXT
3389          MOVE F-OS-129-256-TXT TO WS-SDL-Statement-TXT
3390          PERFORM 530-Generate-Source-Line
3391      END-IF
3392      ELSE
3393          IF F-Expanded-Src-REC NOT = SPACES
3394              MOVE SPACES TO WS-Src-Detail-Line-TXT
3395              MOVE F-Expanded-Src-REC(1:128)
3396                  TO WS-SDL-Statement-TXT
3397 GC0712              MOVE LOWER-CASE(TRIM(F-OS-8-72-TXT,LEADING))
3398 GC0712              TO WS-Temp-65-Chars-TXT
3399 GC0712              INSPECT WS-Temp-65-Chars-TXT
3400 GC0712                  REPLACING ALL '.' BY SPACE
3401 GC0712          EVALUATE TRUE
3402 GC0712              WHEN WS-Temp-65-Chars-TXT = "eject"
3403 GC0712                  MOVE 0 TO WS-Lines-Left-NUM
3404 GC0712                  EXIT SECTION
3405 GC0712              WHEN WS-Temp-65-Chars-TXT = "skip1"
3406 GC0712                  MOVE SPACES TO WS-Src-Detail-Line-TXT
3407 GC0712                  PERFORM 530-Generate-Source-Line
3408 GC0712          EXIT SECTION

```

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| Line | Statement                                       |
|------|-------------------------------------------------|
| 3409 | GC0712 WHEN WS-Temp-65-Chars-TXT = "skip2"      |
| 3410 | GC0712 MOVE SPACES TO WS-Src-Detail-Line-TXT    |
| 3411 | GC0712 PERFORM 530-Generate-Source-Line 2 TIMES |
| 3412 | GC0712 EXIT SECTION                             |
| 3413 | GC0712 WHEN WS-Temp-65-Chars-TXT = "skip3"      |
| 3414 | GC0712 MOVE SPACES TO WS-Src-Detail-Line-TXT    |
| 3415 | GC0712 PERFORM 530-Generate-Source-Line 3 TIMES |
| 3416 | GC0712 EXIT SECTION                             |
| 3417 | GC0712 END-EVALUATE                             |
| 3418 | PERFORM 530-Generate-Source-Line                |
| 3419 | IF F-Expanded-Src-REC(129:128) NOT = SPACES     |
| 3420 | MOVE SPACES TO WS-Src-Detail-Line-TXT           |
| 3421 | MOVE F-Expanded-Src-REC(129:128)                |
| 3422 | TO WS-SDL-Statement-TXT                         |
| 3423 | PERFORM 530-Generate-Source-Line                |
| 3424 | END-IF                                          |
| 3425 | END-IF                                          |
| 3426 | END-IF                                          |
| 3427 | .                                               |

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Line Statement

```
=====
3428      /
3429      530-Generate-Source-Line SECTION.
3430      IF WS-Lines-Left-NUM < 1
3431      GC0712      WRITE F-Listing-REC FROM SPACES BEFORE PAGE
3432      GC0712      WRITE F-Listing-REC FROM SPACES BEFORE 1
3433      GC0712      WRITE F-Listing-REC FROM WS-Src-Header-1-TXT BEFORE 1
3434      GC0712      ADD 1 TO WS-Page-NUM
3435      GC0712      MOVE 'Page:' TO WS-PN-Literal-TXT
3436      GC0712      MOVE WS-Page-NUM TO WS-PN-Page-NUM
3437      GC0712      CALL 'C$JUSTIFY' USING WS-PN-Page-NUM, 'Left'
3438      GC0712      CALL 'C$JUSTIFY' USING WS-Page-No-TXT, 'Right'
3439      GC0712      MOVE WS-Page-No-TXT TO WS-SH3-Page-No-TXT
3440      GC0712      WRITE F-Listing-REC FROM WS-Src-Header-2-TXT BEFORE 1
3441      GC0712      WRITE F-Listing-REC FROM WS-Src-Header-3-TXT BEFORE 1
3442      GC0712      WRITE F-Listing-REC FROM WS-Src-Header-4-TXT BEFORE 1
3443      COMPUTE WS-Lines-Left-NUM = WS-Lines-Per-Page-NUM - 4
3444      END-IF
3445      GC0712      WRITE F-Listing-REC FROM WS-Src-Detail-Line-TXT BEFORE 1
3446      MOVE SPACES TO WS-Src-Detail-Line-TXT
3447      SUBTRACT 1 FROM WS-Lines-Left-NUM
3448      .
3449
3450      END PROGRAM LISTING.
```

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------|-----------------|--------------------------|-------|-------|-------|
| PROGRAM-ID                                                                                                                                                           | Identifier/Register/Function  | Defn | Where Defined   | References (* = Updated) |       |       |       |
| CHECKSRC                                                                                                                                                             | 000-Main                      | 1294 | PROCEDURE       |                          |       |       |       |
| CHECKSRC                                                                                                                                                             | L-A1-CHR                      | 1284 | LINKAGE         | 1296                     | 1308  | 1311  | 1318  |
| CHECKSRC                                                                                                                                                             | L-A2-IDENT-DIVISION-BOOL      | 1289 | LINKAGE         | 1340*                    |       |       |       |
| CHECKSRC                                                                                                                                                             | L-A2-LINKAGE-SECTION-BOOL     | 1288 | LINKAGE         | 1334*                    |       |       |       |
| CHECKSRC                                                                                                                                                             | L-A2-Nothing-Special-BOOL     | 1290 | LINKAGE         | 1295*                    |       |       |       |
| CHECKSRC                                                                                                                                                             | L-Argument-1-TXT              | 1283 | LINKAGE         | 1292                     |       |       |       |
| CHECKSRC                                                                                                                                                             | L-Argument-2-CHR              | 1287 | LINKAGE         | 1293                     |       |       |       |
| CHECKSRC                                                                                                                                                             | UPPER-CASE                    |      | PROCEDURE       | 1311                     |       |       |       |
| CHECKSRC                                                                                                                                                             | WS-Compressed-Src-TXT         | 1270 | WORKING-STORAGE | 1305*                    | 1328  | 1332  | 1338  |
| CHECKSRC                                                                                                                                                             | WS-CS-CHR                     | 1271 | WORKING-STORAGE | 1312*                    | 1318* | 1327  | 1331  |
| CHECKSRC                                                                                                                                                             | WS-I-SUB                      | 1279 | WORKING-STORAGE | 1306*                    | 1307  | 1308  | 1311  |
|                                                                                                                                                                      |                               |      |                 | 1328                     | 1331  | 1331  | 1332  |
|                                                                                                                                                                      |                               |      |                 |                          | 1332  | 1337  | 1337  |
|                                                                                                                                                                      |                               |      |                 |                          |       | 1337  | 1338  |
| CHECKSRC                                                                                                                                                             | WS-J-SUB                      | 1281 | WORKING-STORAGE | 1304*                    | 1310* | 1312  | 1317* |
| CHECKSRC                                                                                                                                                             | WS-RS-Found-SPACE-CHR         | 1275 | WORKING-STORAGE |                          |       |       | 1318  |
| CHECKSRC                                                                                                                                                             | WS-RS-Not-Skipping-SPACE-BOOL | 1277 | WORKING-STORAGE | 1303*                    | 1309  | 1316* |       |
| CHECKSRC                                                                                                                                                             | WS-RS-Skipping-SPACE-BOOL     | 1276 | WORKING-STORAGE | 1313*                    |       |       |       |
| CHECKSRC                                                                                                                                                             | WS-Runtime-Switches-TXT       | 1274 | WORKING-STORAGE |                          |       |       |       |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------|---------------|--------------------------|-------------|-------------|
| PROGRAM-ID                                                                                                                                                           | Identifier/Register/Function | Defn            | Where Defined | References (* = Updated) |             | Page: 84    |
| GCic                                                                                                                                                                 | 000-File-Error               | 642 PROCEDURE   |               |                          |             |             |
| GCic                                                                                                                                                                 | 000-Main                     | 663 PROCEDURE   |               |                          |             |             |
| GCic                                                                                                                                                                 | 100-Initialization           | 688 PROCEDURE   | 664           |                          |             |             |
| GCic                                                                                                                                                                 | 200-Let-User-Set-Switches    | 800 PROCEDURE   | 667           |                          |             |             |
| GCic                                                                                                                                                                 | 210-Run-Compiler             | 881 PROCEDURE   | 668           |                          |             |             |
| GCic                                                                                                                                                                 | 220-Make-Listing             | 1017 PROCEDURE  | 672           |                          |             |             |
| GCic                                                                                                                                                                 | 230-Run-Program              | 1045 PROCEDURE  | 676           |                          |             |             |
| GCic                                                                                                                                                                 | 240-Find-LINKAGE-SECTION     | 1152 PROCEDURE  | 734           |                          |             |             |
| GCic                                                                                                                                                                 | 250-Autoload-Listing         | 1191 PROCEDURE  | 678           | 1008 1039                |             |             |
| GCic                                                                                                                                                                 | 900-Terminate                | 1237 PROCEDURE  | 680           | 728 861 1009 1145        |             |             |
| GCic                                                                                                                                                                 | COB-COLOR-BLACK              | 170 [screenio ] | 427 579       | 432 522 532 542          | 547         | 557 564     |
| GCic                                                                                                                                                                 | COB-COLOR-BLUE               | 170 [screenio ] | 594           | 610 617                  | 624         |             |
| GCic                                                                                                                                                                 | COB-COLOR-CYAN               | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-COLOR-GREEN              | 170 [screenio ] | 433           | 548 595                  | 611         |             |
| GCic                                                                                                                                                                 | COB-COLOR-MAGENTA            | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-COLOR-RED                | 170 [screenio ] | 516           | 580                      |             |             |
| GCic                                                                                                                                                                 | COB-COLOR-WHITE              | 170 [screenio ] | 428           | 511                      | 517 533 543 | 558 565 618 |
| GCic                                                                                                                                                                 | COB-COLOR-YELLOW             | 170 [screenio ] | 625           |                          |             |             |
| GCic                                                                                                                                                                 | COB-CRT-STATUS               |                 |               | 804 805                  |             |             |
| GCic                                                                                                                                                                 | COB-SCR-ESC                  | 170 [screenio ] |               | 860                      |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F1                   | 170 [screenio ] |               | 806                      |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F10                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F11                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F12                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F13                  | 170 [screenio ] |               |                          | 863         |             |
| GCic                                                                                                                                                                 | COB-SCR-F14                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F15                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F16                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F17                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F18                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F19                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F2                   | 170 [screenio ] |               |                          | 812         |             |
| GCic                                                                                                                                                                 | COB-SCR-F20                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F21                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F22                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F23                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F24                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F25                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F26                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F27                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F28                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F29                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F3                   | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F30                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F31                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F32                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F33                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F34                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F35                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F36                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F37                  | 170 [screenio ] |               |                          |             |             |
| GCic                                                                                                                                                                 | COB-SCR-F38                  | 170 [screenio ] |               |                          |             |             |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------|-----------------|------------------------------------------------------------|---------------|----------------------|
| PROGRAM-ID                                                                                                                                                           | Identifier/Register/Function | Defn      | Where Defined   | References (* = Updated)                                   |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F39                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F4                   | 170       | [screenio ]     | 824                                                        |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F40                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F41                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F42                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F43                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F44                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F45                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F46                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F47                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F48                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F49                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F5                   | 170       | [screenio ]     | 830                                                        |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F50                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F51                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F52                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F53                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F54                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F55                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F56                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F57                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F58                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F59                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F6                   | 170       | [screenio ]     | 836                                                        |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F60                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F61                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F62                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F63                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F64                  | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F7                   | 170       | [screenio ]     | 842                                                        |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F8                   | 170       | [screenio ]     | 848                                                        |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-F9                   | 170       | [screenio ]     | 854                                                        |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-FATAL                | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-KEY-DOWN             | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-KEY-UP               | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-MAX-FIELD            | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-NO-FIELD             | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-OK                   | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-PAGE_DOWN            | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-PAGE_UP              | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-PRINT                | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | COB-SCR-TIME-OUT             | 170       | [screenio ]     |                                                            |               |                      |
| GCic                                                                                                                                                                 | CONCATENATE                  | PROCEDURE |                 | 789    968    990    996    1215    1218    1222*    1224* |               |                      |
|                                                                                                                                                                      |                              |           |                 | 1226*    1228*    1230*                                    |               |                      |
| GCic                                                                                                                                                                 | F-Cobc-Output-FILE           | 163       | FILE            | 154    985    1003                                         |               |                      |
| GCic                                                                                                                                                                 | F-Cobc-Output-REC            | 164       | FILE            | 986    991*    992                                         | 1000*    1001 |                      |
| GCic                                                                                                                                                                 | F-Source-Code-FILE           | 166       | FILE            | 157    643    1153                                         | 1157    1158  | 1171    1172    1179 |
| GCic                                                                                                                                                                 | F-Source-Code-REC            | 167       | FILE            | 1162    1176                                               |               |                      |
| GCic                                                                                                                                                                 | F1                           |           | WORKING-STORAGE | 198                                                        |               |                      |
| GCic                                                                                                                                                                 | F12                          |           | WORKING-STORAGE | 192                                                        |               |                      |
| GCic                                                                                                                                                                 | F2                           |           | WORKING-STORAGE | 205                                                        |               |                      |
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| GCic                                                                                                                                                                 | F4                           |           | WORKING-STORAGE | 199                                                        |               |                      |
| GCic                                                                                                                                                                 | F5                           |           | WORKING-STORAGE | 202                                                        |               |                      |

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|                                                                                                                                                                      |                              |      |                 | 412                      | 474   | 490   | 504   | Page: 86 |
| GCic                                                                                                                                                                 | F6                           |      | WORKING-STORAGE | 203                      |       |       |       |          |
| GCic                                                                                                                                                                 | F7                           |      | WORKING-STORAGE | 206                      |       |       |       |          |
| GCic                                                                                                                                                                 | F8                           |      | WORKING-STORAGE | 200                      |       |       |       |          |
| GCic                                                                                                                                                                 | F9                           |      | WORKING-STORAGE | 204                      |       |       |       |          |
| GCic                                                                                                                                                                 | LD-Horiz-Line                | 412  | SCREEN          | 788                      |       |       |       |          |
| GCic                                                                                                                                                                 | LD-LL-Corner                 | 407  | SCREEN          | 444                      | 474   | 490   | 504   |          |
| GCic                                                                                                                                                                 | LD-Lower-T                   | 411  | SCREEN          | 476                      |       |       |       |          |
| GCic                                                                                                                                                                 | LD-LR-Corner                 | 409  | SCREEN          | 446                      | 478   | 492   | 506   |          |
| GCic                                                                                                                                                                 | LD-UL-Corner                 | 406  | SCREEN          | 434                      | 448   | 480   | 494   |          |
| GCic                                                                                                                                                                 | LD-Upper-T                   | 410  | SCREEN          | 450                      |       |       |       |          |
| GCic                                                                                                                                                                 | LD-UR-Corner                 | 408  | SCREEN          | 436                      | 452   | 482   | 496   |          |
| GCic                                                                                                                                                                 | LD-Vert-Line                 | 413  | SCREEN          | 438                      | 439   | 441   | 442   | 454      |
|                                                                                                                                                                      |                              |      |                 | 459                      | 460   | 462   | 463   | 464      |
|                                                                                                                                                                      |                              |      |                 | 470                      | 471   | 472   | 484   | 485      |
|                                                                                                                                                                      |                              |      |                 | 499                      | 501   | 502   |       | 487      |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 488      |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 498      |
| GCic                                                                                                                                                                 | LENGTH                       |      | PROCEDURE       | 742                      | 770   | 1070  |       |          |
| GCic                                                                                                                                                                 | LOWER-CASE                   |      | PROCEDURE       | 887                      | 1065  |       |       |          |
| GCic                                                                                                                                                                 | RETURN-CODE                  |      | PROCEDURE       | 987                      | 1020* | 1031* | 1033  |          |
| GCic                                                                                                                                                                 | S-Blank-SCR                  | 425  | SCREEN          | 671                      | 1142  | 1213  | 1242  |          |
| GCic                                                                                                                                                                 | S-Switches-SCR               | 427  | SCREEN          | 803*                     | 885   | 975   | 1004  | 1019     |
| GCic                                                                                                                                                                 | SELCHAR                      |      | PROCEDURE       | 808                      | 814   | 820   | 826   | 832      |
|                                                                                                                                                                      |                              |      |                 | 856                      | 1181  |       |       | 838      |
|                                                                                                                                                                      |                              |      |                 | 1197                     | 1199* | 1204  | 1206* | 1215     |
|                                                                                                                                                                      |                              |      |                 | 1226*                    | 1228* | 1230* |       | 1218     |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 1222*    |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 1224*    |
| GCic                                                                                                                                                                 | TRIM                         |      | PROCEDURE       | 651                      | 656   | 761*  | 790   | 894      |
|                                                                                                                                                                      |                              |      |                 | 978                      | 984*  | 997   | 1070  | 1082     |
|                                                                                                                                                                      |                              |      |                 | 1197                     | 1199* | 1204  | 1206* | 1215     |
|                                                                                                                                                                      |                              |      |                 | 1226*                    | 1228* | 1230* |       | 1218     |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 1222*    |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 1224*    |
| GCic                                                                                                                                                                 | WHEN-COMPILED                |      | PROCEDURE       | 697                      |       |       |       |          |
| GCic                                                                                                                                                                 | WS-Cmd-Args-TXT              | 221  | WORKING-STORAGE | 710*                     | 712   | 713   | 716   | 721      |
| GCic                                                                                                                                                                 | WS-Cmd-End-Quote-CHR         | 223  | WORKING-STORAGE | 714*                     | 717   |       |       |          |
| GCic                                                                                                                                                                 | WS-Cmd-SUB                   | 225  | WORKING-STORAGE | 711*                     | 712   | 713   | 715*  | 719*     |
| GCic                                                                                                                                                                 | WS-Cmd-TXT                   | 219  | WORKING-STORAGE | 882*                     | 977*  | 982*  | 984*  | 1046*    |
|                                                                                                                                                                      |                              |      |                 | 1073*                    | 1077* | 1083* | 1088* | 1093*    |
|                                                                                                                                                                      |                              |      |                 | 1121*                    | 1126* | 1131* | 1135* | 1143*    |
|                                                                                                                                                                      |                              |      |                 | 1201*                    | 1205* | 1206* | 1216* | 1219*    |
|                                                                                                                                                                      |                              |      |                 | 1228*                    | 1230* |       |       | 1222*    |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 1224*    |
| GCic                                                                                                                                                                 | WS-Cobc-Cmd-TXT              | 227  | WORKING-STORAGE | 883*                     | 892*  | 896*  | 900*  | 904*     |
|                                                                                                                                                                      |                              |      |                 | 924*                     | 929*  | 934*  | 938*  | 951*     |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 959*     |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 963*     |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 978      |
| GCic                                                                                                                                                                 | WS-Compilation-Switches-TXT  | 172  | WORKING-STORAGE | 888*                     | 894   |       |       |          |
| GCic                                                                                                                                                                 | WS-Config-Fn-TXT             | 229  | WORKING-STORAGE |                          |       |       |       |          |
| GCic                                                                                                                                                                 | WS-CS-All-Switches-TXT       | 207  | WORKING-STORAGE |                          |       |       |       |          |
| GCic                                                                                                                                                                 | WS-CS-Arg-H1-TXT             | 174  | WORKING-STORAGE | 628*                     |       |       |       |          |
| GCic                                                                                                                                                                 | WS-CS-Arg-H2-TXT             | 175  | WORKING-STORAGE | 629*                     |       |       |       |          |
| GCic                                                                                                                                                                 | WS-CS-Args-TXT               | 173  | WORKING-STORAGE | 1124                     | 1125  |       |       |          |
| GCic                                                                                                                                                                 | WS-CS-Config-NUM             | 192  | WORKING-STORAGE | 620                      | 864*  | 865   | 866*  | 887      |
| GCic                                                                                                                                                                 | WS-CS-DEBUG-CHR              | 209  | WORKING-STORAGE | 581                      | 807   | 808*  | 810*  | 907      |
| GCic                                                                                                                                                                 | WS-CS-EXECUTE-CHR            | 210  | WORKING-STORAGE | 584                      | 674   | 825   | 826*  | 828*     |
| GCic                                                                                                                                                                 | WS-CS-Extra-H1-TXT           | 195  | WORKING-STORAGE | 626*                     |       |       |       |          |
| GCic                                                                                                                                                                 | WS-CS-Extra-H2-TXT           | 196  | WORKING-STORAGE | 627*                     |       |       |       |          |
| GCic                                                                                                                                                                 | WS-CS-Extra-TXT              | 194  | WORKING-STORAGE | 955                      | 957   |       |       |          |
| GCic                                                                                                                                                                 | WS-CS-Filename-TXT           | 185  | WORKING-STORAGE | 620                      | 887   |       |       |          |
| GCic                                                                                                                                                                 | WS-CS-Filenames-Table-TXT    | 184  | WORKING-STORAGE |                          |       |       |       |          |
| GCic                                                                                                                                                                 | WS-CS-Filenames-TXT          | 176  | WORKING-STORAGE | 184                      |       |       |       |          |
| GCic                                                                                                                                                                 | WS-CS-FREE-CHR               | 211  | WORKING-STORAGE | 589                      | 849   | 850*  | 852*  | 932      |
| GCic                                                                                                                                                                 | WS-CS-LIBRARY-CHR            | 212  | WORKING-STORAGE | 583                      | 819   | 820*  | 822*  | 898      |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 1051     |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 1106     |
|                                                                                                                                                                      |                              |      |                 |                          |       |       |       | 1154*    |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------|-----------------|--------------------------|-------|-------|-------|-------|-------|-------|-------|
| PROGRAM-ID                                                                                                                                                           | Identifier/Register/Function | Defn | Where Defined   | References (* = Updated) |       |       |       |       |       |       |       |
| 1181*                                                                                                                                                                |                              |      |                 |                          |       |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-CS-LISTING-CHR            | 213  | WORKING-STORAGE | 585                      | 670   | 831   | 832*  | 834*  | 945   | 947*  | 949   |
| GCic                                                                                                                                                                 | WS-CS-NOFUNC-CHR             | 214  | WORKING-STORAGE | 587                      | 837   | 838*  | 840*  | 922   |       |       |       |
| GCic                                                                                                                                                                 | WS-CS-NOTRUNC-CHR            | 215  | WORKING-STORAGE | 590                      | 855   | 856*  | 858*  | 912   |       |       |       |
| GCic                                                                                                                                                                 | WS-CS-Switch-Defaults-TXT    | 197  | WORKING-STORAGE | 208                      |       |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-CS-TRACEALL-CHR           | 216  | WORKING-STORAGE | 582                      | 813   | 814*  | 816*  | 917   |       |       |       |
| GCic                                                                                                                                                                 | WS-CS-WARNALL-CHR            | 217  | WORKING-STORAGE | 588                      | 843   | 844*  | 846*  | 927   |       |       |       |
| GCic                                                                                                                                                                 | WS-Delete-Fn-TXT             | 231  | WORKING-STORAGE |                          |       |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-File-Name-TXT             | 233  | WORKING-STORAGE | 157                      | 651   | 656   | 718*  | 723*  | 726   | 739   | 742   |
|                                                                                                                                                                      |                              |      |                 | 749                      | 752   | 763   | 1026* |       |       |       |       |
| GCic                                                                                                                                                                 | WS-File-Status-Message-TXT   | 237  | WORKING-STORAGE |                          |       |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-FN-CHR                    | 234  | WORKING-STORAGE | 744                      | 751*  | 755*  |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-FSM-Msg-TXT               | 241  | WORKING-STORAGE | 646*                     | 646*  | 646*  | 646*  | 646*  | 646*  | 646*  | 646*  |
|                                                                                                                                                                      |                              |      |                 | 646*                     | 646*  | 646*  | 646*  | 646*  | 646*  | 646*  | 646*  |
|                                                                                                                                                                      |                              |      |                 | 646*                     | 646*  | 646*  | 646*  | 646*  | 646*  | 646*  | 646*  |
| GCic                                                                                                                                                                 | WS-FSM-Status-CD             | 239  | WORKING-STORAGE | 159                      | 646   | 648   |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-Horizontal-Line-TXT       | 243  | WORKING-STORAGE | 435                      | 445   | 449   | 451   | 475   | 477   | 481   | 491   |
|                                                                                                                                                                      |                              |      |                 | 495                      | 505   | 788*  |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-I-SUB                     | 245  | WORKING-STORAGE | 742*                     | 743   | 744   | 745   | 747   | 751   | 755   | 770*  |
|                                                                                                                                                                      |                              |      |                 | 771                      | 772   | 773   | 775   | 779   | 783   | 886*  | 897*  |
|                                                                                                                                                                      |                              |      |                 | 901*                     | 905*  | 910*  | 915*  | 920*  | 925*  | 930*  | 935*  |
|                                                                                                                                                                      |                              |      |                 | 939*                     | 952*  | 960*  | 964*  | 1047* | 1054* | 1064* | 1067* |
|                                                                                                                                                                      |                              |      |                 | 1074*                    | 1078* | 1084* | 1089* | 1094* | 1102* | 1110* | 1116* |
|                                                                                                                                                                      |                              |      |                 | 1122*                    | 1127* | 1132* | 1136* |       |       |       |       |
| GCic                                                                                                                                                                 | WS-J-SUB                     | 247  | WORKING-STORAGE | 1069*                    | 1070  | 1071  | 1076  |       |       |       |       |
| GCic                                                                                                                                                                 | WS-Listing-Filename-TXT      | 249  | WORKING-STORAGE | 154                      | 969*  | 970*  | 979   | 997   | 1025* | 1197  | 1204  |
| GCic                                                                                                                                                                 | WS-OC-Compile-DT             | 251  | WORKING-STORAGE | 513                      | 697*  |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-OS-Cygwin-BOOL            | 285  | WORKING-STORAGE | 739                      | 763   | 1061  | 1091  | 1193  |       |       |       |
| GCic                                                                                                                                                                 | WS-OS-Dir-CHR                | 260  | WORKING-STORAGE | 740*                     | 744   | 755   | 764*  | 1087  |       |       |       |
| GCic                                                                                                                                                                 | WS-OS-Exe-Ext-CONST          | 261  | WORKING-STORAGE | 1107                     | 1108  |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-OS-Lib-Ext-CONST          | 262  | WORKING-STORAGE | 1113                     | 1114  |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-OS-Lib-Type-CONST         | 263  | WORKING-STORAGE | 599                      |       |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-OS-OSX-BOOL               | 287  | WORKING-STORAGE | 1200                     |       |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-OS-Type-CD                | 264  | WORKING-STORAGE | 790                      | 1027* |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-OS-Type-FILLER-TXT        | 289  | WORKING-STORAGE | 295                      |       |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-OS-Type-TXT               | 296  | WORKING-STORAGE | 790                      |       |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-OS-Types-TXT              | 295  | WORKING-STORAGE |                          |       |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-OS-UNIX-BOOL              | 286  | WORKING-STORAGE | 1091                     |       |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-OS-Windows-BOOL           | 284  | WORKING-STORAGE | 1129                     | 1193  | 1214  |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-Output-Msg-TXT            | 299  | WORKING-STORAGE | 518                      | 647*  | 793*  | 870*  | 884*  | 974*  | 989*  | 990   |
|                                                                                                                                                                      |                              |      |                 | 998*                     | 1006* | 1018* | 1024* | 1030* | 1035* | 1144* | 1238  |
| GCic                                                                                                                                                                 | WS-Path-Delimiter-CHR        | 301  | WORKING-STORAGE |                          |       |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-PFN-CHR                   | 308  | WORKING-STORAGE | 772                      | 779*  | 783*  |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-Pgm-Nm-TXT                | 311  | WORKING-STORAGE | 776*                     | 781*  | 968   | 1100  | 1215  | 1218  |       |       |
| GCic                                                                                                                                                                 | WS-Prog-Extension-TXT        | 303  | WORKING-STORAGE | 777*                     | 782*  |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-Prog-File-Name-TXT        | 307  | WORKING-STORAGE | 559                      | 749*  | 754*  | 770   | 776   | 780   | 962   |       |
| GCic                                                                                                                                                                 | WS-Prog-Folder-TXT           | 305  | WORKING-STORAGE | 560                      | 748*  | 753*  | 757   | 758*  | 761*  | 1060  | 1061  |
|                                                                                                                                                                      |                              |      |                 | 1065                     | 1070  | 1071  | 1076  | 1082  |       |       |       |
| GCic                                                                                                                                                                 | WS-RS-1st-Prog-Complete-BOOL | 324  | WORKING-STORAGE | 1156                     | 1165* |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-RS-Compile-Failed-BOOL    | 317  | WORKING-STORAGE | 995*                     | 1007  |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-RS-Compile-OK-BOOL        | 315  | WORKING-STORAGE | 669                      | 988*  |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-RS-Compile-OK-CHR         | 314  | WORKING-STORAGE |                          |       |       |       |       |       |       |       |
| GCic                                                                                                                                                                 | WS-RS-Compile-OK-Warn-BOOL   | 316  | WORKING-STORAGE | 669                      |       |       |       |       |       |       |       |

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| GCic                                                                                                                                                                 | WS-RS-Complete-BOOL           | 319  | WORKING-STORAGE | 666 993*                 |          |
| GCic                                                                                                                                                                 | WS-RS-Complete-CHR            | 318  | WORKING-STORAGE |                          |          |
| GCic                                                                                                                                                                 | WS-RS-Double-Quote-Used-BOOL  | 322  | WORKING-STORAGE | 1059* 1085* 1119         |          |
| GCic                                                                                                                                                                 | WS-RS-IDENT-DIV-CHR           | 323  | WORKING-STORAGE |                          |          |
| GCic                                                                                                                                                                 | WS-RS-More-To-1st-Prog-BOOL   | 325  | WORKING-STORAGE | 1155*                    |          |
| GCic                                                                                                                                                                 | WS-RS-No-Switch-Changes-BOOL  | 327  | WORKING-STORAGE | 802 873*                 |          |
| GCic                                                                                                                                                                 | WS-RS-No-Switch-Chgs-CHR      | 326  | WORKING-STORAGE |                          |          |
| GCic                                                                                                                                                                 | WS-RS-Not-Complete-BOOL       | 320  | WORKING-STORAGE | 665*                     |          |
| GCic                                                                                                                                                                 | WS-RS-Output-File-Avail-BOOL  | 331  | WORKING-STORAGE | 675 976*                 |          |
| GCic                                                                                                                                                                 | WS-RS-Output-File-Busy-BOOL   | 330  | WORKING-STORAGE |                          |          |
| GCic                                                                                                                                                                 | WS-RS-Output-File-Busy-CHR    | 329  | WORKING-STORAGE |                          |          |
| GCic                                                                                                                                                                 | WS-RS-Quote-CHR               | 321  | WORKING-STORAGE |                          |          |
| GCic                                                                                                                                                                 | WS-RS-Source-Rec-Ident-BOOL   | 334  | WORKING-STORAGE | 1164 1170                |          |
| GCic                                                                                                                                                                 | WS-RS-Source-Rec-Ignored-BOOL | 335  | WORKING-STORAGE | 1168*                    |          |
| GCic                                                                                                                                                                 | WS-RS-Source-Rec-Linkage-BOOL | 333  | WORKING-STORAGE | 1169 1180                |          |
| GCic                                                                                                                                                                 | WS-RS-Source-Record-Type-CHR  | 332  | WORKING-STORAGE | 1163* 1177*              |          |
| GCic                                                                                                                                                                 | WS-RS-Switch-Changes-BOOL     | 328  | WORKING-STORAGE | 801*                     |          |
| GCic                                                                                                                                                                 | WS-RS-Switch-Error-CHR        | 336  | WORKING-STORAGE |                          |          |
| GCic                                                                                                                                                                 | WS-RS-Switch-Is-Bad-BOOL      | 337  | WORKING-STORAGE |                          |          |
| GCic                                                                                                                                                                 | WS-RS-Switch-Is-Good-BOOL     | 338  | WORKING-STORAGE |                          |          |
| GCic                                                                                                                                                                 | WS-Runtime-Switches-TXT       | 313  | WORKING-STORAGE |                          |          |
| GCic                                                                                                                                                                 | WS-Tally-QTY                  | 340  | WORKING-STORAGE | 942* 944* 946            |          |

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| LISTING                                                                                                                                                              | 000-Main                     | 2393 | PROCEDURE     |                          |       |      |          |
| LISTING                                                                                                                                                              | 100-Initialization           | 2410 | PROCEDURE     | 2394                     |       |      |          |
| LISTING                                                                                                                                                              | 300-Tokenize-Source          | 2479 | PROCEDURE     | 2401                     |       |      |          |
| LISTING                                                                                                                                                              | 310-Get-Token                | 2530 | PROCEDURE     | 2488                     |       |      |          |
| LISTING                                                                                                                                                              | 311-Control-Record           | 2690 | PROCEDURE     | 2549                     |       |      |          |
| LISTING                                                                                                                                                              | 312-Expanded-Src-Record      | 2736 | PROCEDURE     | 2551                     |       |      |          |
| LISTING                                                                                                                                                              | 313-Check-For-Numeric-Token  | 2743 | PROCEDURE     | 2677                     |       |      |          |
| LISTING                                                                                                                                                              | 320-IDENTIFICATION-DIVISION  | 2785 | PROCEDURE     | 2509                     |       |      |          |
| LISTING                                                                                                                                                              | 330-ENVIRONMENT-DIVISION     | 2809 | PROCEDURE     | 2511                     |       |      |          |
| LISTING                                                                                                                                                              | 340-DATA-DIVISION            | 2832 | PROCEDURE     | 2513                     |       |      |          |
| LISTING                                                                                                                                                              | 350-PROCEDURE-DIVISION       | 2887 | PROCEDURE     | 2515                     |       |      |          |
| LISTING                                                                                                                                                              | 351-ACCEPT                   | 2971 | PROCEDURE     | 2933                     |       |      |          |
| LISTING                                                                                                                                                              | 351-ADD                      | 2981 | PROCEDURE     | 2935                     |       |      |          |
| LISTING                                                                                                                                                              | 351-ALLOCATE                 | 2992 | PROCEDURE     | 2937                     |       |      |          |
| LISTING                                                                                                                                                              | 351-CALL                     | 3004 | PROCEDURE     | 2939                     |       |      |          |
| LISTING                                                                                                                                                              | 351-COMPUTE                  | 3019 | PROCEDURE     | 2941                     |       |      |          |
| LISTING                                                                                                                                                              | 351-DIVIDE                   | 3028 | PROCEDURE     | 2943                     |       |      |          |
| LISTING                                                                                                                                                              | 351-FREE                     | 3048 | PROCEDURE     | 2945                     |       |      |          |
| LISTING                                                                                                                                                              | 351-INITIALIZE               | 3052 | PROCEDURE     | 2947                     |       |      |          |
| LISTING                                                                                                                                                              | 351-INСПЕКТ                  | 3061 | PROCEDURE     | 2949                     |       |      |          |
| LISTING                                                                                                                                                              | 351-MOVE                     | 3091 | PROCEDURE     | 2951                     |       |      |          |
| LISTING                                                                                                                                                              | 351-MULTIPLY                 | 3100 | PROCEDURE     | 2953                     |       |      |          |
| LISTING                                                                                                                                                              | 351-PERFORM                  | 3116 | PROCEDURE     | 2955                     |       |      |          |
| LISTING                                                                                                                                                              | 351-SET                      | 3129 | PROCEDURE     | 2957                     |       |      |          |
| LISTING                                                                                                                                                              | 351-STRING                   | 3138 | PROCEDURE     | 2959                     |       |      |          |
| LISTING                                                                                                                                                              | 351-SUBTRACT                 | 3149 | PROCEDURE     | 2961                     |       |      |          |
| LISTING                                                                                                                                                              | 351-TRANSFORM                | 3160 | PROCEDURE     | 2963                     |       |      |          |
| LISTING                                                                                                                                                              | 351-UNSTRING                 | 3170 | PROCEDURE     | 2965                     |       |      |          |
| LISTING                                                                                                                                                              | 360-Release-Def              | 3187 | PROCEDURE     | 2825                     | 2863  | 2866 | 2869     |
| LISTING                                                                                                                                                              | 361-Release-Ref              | 3198 | PROCEDURE     | 2827                     | 2881  | 2967 | 2977     |
|                                                                                                                                                                      |                              |      |               | 3044                     | 3057  | 3087 | 3096     |
|                                                                                                                                                                      |                              |      |               | 3156                     | 3166  | 3183 |          |
|                                                                                                                                                                      |                              |      |               | 3156                     | 3166  | 3183 |          |
| LISTING                                                                                                                                                              | 362-Release-Upd              | 3203 | PROCEDURE     | 2875                     | 2878  | 2974 | 2984     |
|                                                                                                                                                                      |                              |      |               | 3009                     | 3012  | 3022 | 3040     |
|                                                                                                                                                                      |                              |      |               | 3094                     | 3110  | 3119 | 3122     |
|                                                                                                                                                                      |                              |      |               | 3154                     | 3163  | 3173 | 3175     |
|                                                                                                                                                                      |                              |      |               | 3031                     | 3103  | 3204 |          |
| LISTING                                                                                                                                                              | 363-Set-Upd                  | 3208 | PROCEDURE     | 3064                     | 3199  |      |          |
| LISTING                                                                                                                                                              | 364-Set-Ref                  | 3218 | PROCEDURE     | 3227                     | 2402  |      |          |
| LISTING                                                                                                                                                              | 400-Produce-Xref-Listing     | 3227 | PROCEDURE     | 3295                     | 3241  | 3265 | 3281     |
| LISTING                                                                                                                                                              | 410-Generate-Report-Line     | 3295 | PROCEDURE     | 3319                     | 3253  | 3281 | 3291     |
| LISTING                                                                                                                                                              | 500-Produce-Source-Listing   | 3319 | PROCEDURE     | 3339                     | 3329  |      |          |
| LISTING                                                                                                                                                              | 510-Control-Record           | 3339 | PROCEDURE     | 3356                     | 3331  |      |          |
| LISTING                                                                                                                                                              | 520-Expanded-Src-Record      | 3356 | PROCEDURE     | 3429                     | 3375  | 3383 | 3386     |
| LISTING                                                                                                                                                              | 530-Generate-Source-Line     | 3429 | PROCEDURE     | 3418                     | 3379  | 3386 | 3390     |
|                                                                                                                                                                      |                              |      |               | 3423                     | 3423  | 3423 |          |
| LISTING                                                                                                                                                              | F-ES-1-7-TXT                 | 1397 | FILE          | 1398                     | 2547  | 3327 |          |
| LISTING                                                                                                                                                              | F-ES-1-CHR                   | 1394 | FILE          | 1395                     | 2548  | 3328 |          |
| LISTING                                                                                                                                                              | F-ES-2-256-TXT-256           | 1395 | FILE          | 1398                     | 2691  | 3340 |          |
| LISTING                                                                                                                                                              | F-ES-8-256-TXT               | 1398 | FILE          | 1392                     | 2480  | 2527 | 2537     |
| LISTING                                                                                                                                                              | F-Expanded-Src-FILE          | 1392 | FILE          | 1393                     | 2481* | 2535 | 2559     |
| LISTING                                                                                                                                                              | F-Expanded-Src-REC           | 1393 | FILE          |                          | 2617  | 2621 | 2629     |
|                                                                                                                                                                      |                              |      |               |                          | 3421  | 2647 | 2732*    |
| LISTING                                                                                                                                                              | F-Expanded-Src2-REC          | 1396 | FILE          |                          |       |      |          |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------|-----------------|--------------------------|-------|-------|-------|-------|-------|-------|-------|----------|
| PROGRAM-ID                                                                                                                                                           | Identifier/Register/Function  | Defn | Where Defined   | References (* = Updated) |       |       |       |       |       |       |       | Page: 90 |
| LISTING                                                                                                                                                              | F-Listing-FILE                | 1400 | FILE            | 1385                     | 2395  | 2403  |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | F-Listing-REC                 | 1401 | FILE            | 3297*                    | 3298  | 3299* | 3300  | 3301  | 3308  | 3309  | 3310  |          |
|                                                                                                                                                                      |                               |      |                 | 3313                     | 3431  | 3432  | 3433  | 3440  | 3441  | 3442  | 3445  |          |
| LISTING                                                                                                                                                              | F-Original-Src-FILE           | 1403 | FILE            | 1387                     | 3320  | 3335  | 3359  |       |       |       |       |          |
| LISTING                                                                                                                                                              | F-Original-Src-REC            | 1404 | FILE            |                          |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | F-OS-1-128-TXT                | 1405 | FILE            | 3363                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | F-OS-129-256-TXT              | 1410 | FILE            | 3387                     | 3389  |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | F-OS-7-CHR                    | 1407 | FILE            | 3368                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | F-OS-8-72-TXT                 | 1408 | FILE            | 3364                     | 3397  |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | F-Sort-Work-FILE              | 1412 | FILE            | 1389                     | 2397  | 3234  |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | F-Sort-Work-REC               | 1413 | FILE            | 2502*                    | 2504  | 2539* | 2541  | 3032  | 3035* | 3038  | 3072* |          |
|                                                                                                                                                                      |                               |      |                 | 3075                     | 3080* | 3083  | 3104  | 3106* | 3109  | 3188* | 3195  |          |
|                                                                                                                                                                      |                               |      |                 | 3200                     | 3205  | 3209* | 3219* |       |       |       |       |          |
| LISTING                                                                                                                                                              | F-SW-Def-Line-NUM             | 1418 | FILE            | 3193*                    | 3250  | 3258  | 3262  | 3274  | 3275  |       |       |          |
| LISTING                                                                                                                                                              | F-SW-Prog-ID-TXT              | 1414 | FILE            | 2398                     | 3189* | 3210* | 3220* | 3237  | 3243  | 3246  | 3255  |          |
|                                                                                                                                                                      |                               |      |                 | 3267                     | 3271  |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | F-SW-Ref-Flag-CHR             | 1421 | FILE            | 3037*                    | 3074* | 3082* | 3108* | 3215* | 3286  |       |       |          |
| LISTING                                                                                                                                                              | F-SW-Ref-Line-NUM             | 1420 | FILE            | 2400                     | 3194* | 3214* | 3224* | 3284  |       |       |       |          |
| LISTING                                                                                                                                                              | F-SW-Reference-TXT            | 1419 | FILE            | 3278                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | F-SW-Section-TXT              | 1417 | FILE            | 3192*                    | 3213* | 3223* | 3257  | 3273  |       |       |       |          |
| LISTING                                                                                                                                                              | F-SW-Token-TXT                | 1416 | FILE            | 3191*                    | 3212* | 3222* | 3272  |       |       |       |       |          |
| LISTING                                                                                                                                                              | F-SW-Token-Uc-TXT             | 1415 | FILE            | 2399                     | 3190* | 3211* | 3221* | 3238  | 3247  | 3249  | 3261  |          |
| LISTING                                                                                                                                                              | L-Listing-Fn-TXT              | 2384 | LINKAGE         | 1385                     | 2390  |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | L-OS-Type-CD                  | 2388 | LINKAGE         | 2392                     | 2414  | 2420  |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | L-Src-Fn-TXT                  | 2386 | LINKAGE         | 1387                     | 2391  | 2424  | 2424* | 2425  | 2426  | 2430  | 2433  |          |
|                                                                                                                                                                      |                               |      |                 | 2439                     | 2443  | 2445  | 2450  |       |       |       |       |          |
| LISTING                                                                                                                                                              | LENGTH                        |      | PROCEDURE       | 2425                     | 2443  | 2713  |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | LOWER-CASE                    |      | PROCEDURE       | 3364                     | 3397  |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | NUMVAL                        |      | PROCEDURE       | 2465                     | 2700  |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | RETURN-CODE                   |      | PROCEDURE       | 2461                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | TRIM                          |      | PROCEDURE       | 2424                     | 2443  | 2455  | 2701  | 2702  | 2713  | 3345  | 3346  |          |
|                                                                                                                                                                      |                               |      |                 | 3364                     | 3397  |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | UPPER-CASE                    |      | PROCEDURE       | 2430                     | 2433  | 2492  | 2638  | 2661  | 2701  | 3345  |       |          |
| LISTING                                                                                                                                                              | WS-Argument-Is-Updatable-BOOL | 2305 | WORKING-STORAGE | 2914*                    | 2919* | 2921* | 2926* | 3011  |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Argument-Type-CD           | 2304 | WORKING-STORAGE |                          |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-CD-In-DATA-DIV-BOOL        | 1438 | WORKING-STORAGE | 2512                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-CD-In-ENV-DIV-BOOL         | 1437 | WORKING-STORAGE | 2510                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-CD-In-IDENT-DIV-BOOL       | 1436 | WORKING-STORAGE | 2508                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-CD-In-PROC-DIV-BOOL        | 1439 | WORKING-STORAGE | 2514                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-CPI-13-15-TXT              | 1445 | WORKING-STORAGE | 2799*                    |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-CPI-16-CHR                 | 1446 | WORKING-STORAGE | 2798                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-CS-1-CHR                   | 1449 | WORKING-STORAGE | 2725*                    |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-CS-11-14-TXT               | 1452 | WORKING-STORAGE | 2727                     | 2728* |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-CS-15-CHR                  | 1453 | WORKING-STORAGE | 2730*                    |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-CS-2-14-TXT                | 1450 | WORKING-STORAGE | 2726*                    |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Curr-Char-Is-Punct-BOOL    | 1427 | WORKING-STORAGE | 2570                     | 2578  | 2583  |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Curr-Char-Is-Quote-BOOL    | 1431 | WORKING-STORAGE | 2589                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Curr-Char-Is-X-BOOL        | 1432 | WORKING-STORAGE | 2602                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Curr-Char-Is-Z-BOOL        | 1433 | WORKING-STORAGE | 2615                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Curr-CHR                   | 1426 | WORKING-STORAGE | 2560*                    | 2563  | 2565  | 2571  | 2579  | 2585  | 2592  |       |          |
| LISTING                                                                                                                                                              | WS-Curr-Division-TXT          | 1435 | WORKING-STORAGE | 2485*                    | 2521  | 2572  | 2580  | 2680  | 2792* | 2815* | 2842* |          |
|                                                                                                                                                                      |                               |      |                 | 2893*                    | 2898* |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Curr-Line-NUM              | 1441 | WORKING-STORAGE | 2484*                    | 2544* | 2703* | 2739* | 3193  | 3214  | 3224  | 3358* |          |
| LISTING                                                                                                                                                              | WS-Curr-Prog-ID-TXT           | 1443 | WORKING-STORAGE | 2474*                    | 2797* | 3189  | 3210  | 3220  |       |       |       |          |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|------|-----------------|--------------------------|-------|-------|-------|-------|-------|----------|-------|
| PROGRAM-ID                                                                                                                                                           | Identifier/Register/Function    | Defn | Where Defined   | References (* = Updated) |       |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Curr-Section-TXT             | 1448 | WORKING-STORAGE | 2706*                    | 2711  | 2820* | 2847* | 2888  | 2889* | 3192     | 3213  |
|                                                                                                                                                                      |                                 |      |                 | 3223                     |       |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Curr-Verb-TXT                | 1455 | WORKING-STORAGE | 2475*                    | 2499* | 2523* | 2907  | 2916  | 2931  |          |       |
| LISTING                                                                                                                                                              | WS-Delim-TXT                    | 1457 | WORKING-STORAGE | 2632*                    | 2634  | 2652* | 2654  | 2657  |       |          |       |
| LISTING                                                                                                                                                              | WS-Dummy-TXT                    | 1459 | WORKING-STORAGE | 2453*                    | 2695* | 2724* | 2753* | 2758* | 2759  | 3344*    |       |
| LISTING                                                                                                                                                              | WS-Expanded-Src-Fn-TXT          | 1461 | WORKING-STORAGE | 1383                     | 2458* | 2459* |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Filename-TXT                 | 1463 | WORKING-STORAGE | 2452*                    | 2455  | 2723* | 2726  |       |       |          |       |
| LISTING                                                                                                                                                              | WS-GI-Prog-ID-TXT               | 1466 | WORKING-STORAGE | 3237                     | 3243  | 3246* |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-GI-Token-TXT                 | 1467 | WORKING-STORAGE | 3238                     | 3247* | 3249  | 3261  |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Group-Indicators-TXT         | 1465 | WORKING-STORAGE | 3229*                    |       |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Held-Reference-TXT           | 1469 | WORKING-STORAGE | 2476*                    | 2501  | 2502  | 2503* | 2538  | 2539  | 2540*    | 3032* |
|                                                                                                                                                                      |                                 |      |                 | 3034                     | 3035  | 3036* | 3065* | 3071  | 3072  | 3073*    | 3079  |
|                                                                                                                                                                      |                                 |      |                 | 3080                     | 3081* | 3104* | 3106  | 3107* |       |          |       |
| LISTING                                                                                                                                                              | WS-I-SUB                        | 1471 | WORKING-STORAGE | 2425*                    | 2426  | 2427  | 2429  | 2432* | 2433  | 2443*    | 2445  |
|                                                                                                                                                                      |                                 |      |                 | 2446                     | 2447  | 2450  | 2700* | 2703  | 2714* | 2716     | 2717  |
|                                                                                                                                                                      |                                 |      |                 | 2718                     | 2721  | 3230* | 3254* | 3266* | 3279* | 3280     | 3282* |
|                                                                                                                                                                      |                                 |      |                 | 3285                     | 3287  | 3315* |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-J-SUB                        | 1473 | WORKING-STORAGE | 2444*                    | 2448* | 2450  | 2715* | 2719* | 2721  |          |       |
| LISTING                                                                                                                                                              | WS-Lines-Left-NUM               | 1475 | WORKING-STORAGE | 3231*                    | 3244* | 3296  | 3311* | 3316  | 3369* | 3371*    | 3403* |
|                                                                                                                                                                      |                                 |      |                 | 3430                     | 3443* | 3447  |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Lines-Per-Page-Env-TXT       | 1479 | WORKING-STORAGE | 2436*                    | 2464  | 2465  |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Lines-Per-Page-NUM           | 1477 | WORKING-STORAGE | 2466*                    | 2469* | 3311  | 3443  |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Lines-Per-Rec-CONST          | 1424 | WORKING-STORAGE | 2352                     | 3280  |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Main-Module-Name-TXT         | 1481 | WORKING-STORAGE | 2430*                    | 2434* | 2702  | 3346  |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Next-Char-Is-Quote-BOOL      | 1484 | WORKING-STORAGE | 2602                     | 2615  |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Next-CHR                     | 1483 | WORKING-STORAGE | 2562*                    | 2605  | 2618  |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-OS-Type-FILLER-TXT           | 1486 | WORKING-STORAGE | 1492                     |       |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-OS-Type-TXT                  | 1493 | WORKING-STORAGE | 2414                     | 2420  |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-OS-Types-TXT                 | 1492 | WORKING-STORAGE |                          |       |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Page-No-TXT                  | 1498 | WORKING-STORAGE | 3306*                    | 3307  | 3438* | 3439  |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Page-NUM                     | 1496 | WORKING-STORAGE | 2411*                    | 3302* | 3304  | 3434* | 3436  |       |          |       |
| LISTING                                                                                                                                                              | WS-PN-Literal-TXT               | 1499 | WORKING-STORAGE | 3303*                    | 3435* |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-PN-Page-NUM                  | 1500 | WORKING-STORAGE | 3304*                    | 3305* | 3436* | 3437* |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Program-Path-TXT             | 1502 | WORKING-STORAGE | 2439*                    | 2440  |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Reserved-Word-Table-TXT      | 2261 | WORKING-STORAGE |                          |       |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Reserved-Word-TXT            | 2262 | WORKING-STORAGE | 2667                     | 2801  | 2838  | 2899  |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Reserved-Words-TXT           | 1504 | WORKING-STORAGE | 2261                     |       |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-RS-Duplicate-CHR             | 2270 | WORKING-STORAGE | 3232*                    | 3239* | 3252* | 3263  | 3264* |       |          |       |
| LISTING                                                                                                                                                              | WS-RS-In-Copybook-BOOL          | 2273 | WORKING-STORAGE | 2709*                    | 3352* |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-RS-In-Main-Module-BOOL       | 2272 | WORKING-STORAGE | 2704*                    | 2738  | 3347* | 3357  |       |       |          |       |
| LISTING                                                                                                                                                              | WS-RS-In-Which-Pgm-CHR          | 2271 | WORKING-STORAGE |                          |       |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-RS-Last-Token-Ended-Sent-CHR | 2274 | WORKING-STORAGE | 2533*                    | 2679  |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-RS-Processing-PICTURE-CHR    | 2275 | WORKING-STORAGE | 2628                     | 2642* | 2852* |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-RS-Token-Ended-Sentence-CHR  | 2276 | WORKING-STORAGE | 2520                     | 2532  | 2534* | 2567* | 2596* | 2609* | 2622*    | 2635* |
|                                                                                                                                                                      |                                 |      |                 | 2655*                    |       |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-RS-Verb-Has-Been-Found-CHR   | 2277 | WORKING-STORAGE | 2486*                    | 2671* | 2789* |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-Runtime-Switches             | 2269 | WORKING-STORAGE |                          |       |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-RW-IDX                       | 2265 | WORKING-STORAGE | 2668                     | 2669  | 2802  | 2803  | 2839  | 2840  | 2900     | 2901  |
| LISTING                                                                                                                                                              | WS-RW-Type-CD                   | 2266 | WORKING-STORAGE | 2669                     | 2803* | 2840* | 2901* |       |       |          |       |
| LISTING                                                                                                                                                              | WS-RW-Word-TXT                  | 2267 | WORKING-STORAGE | 2264                     | 2668  | 2802  | 2839  | 2900  |       |          |       |
| LISTING                                                                                                                                                              | WS-Saved-Section-TXT            | 2279 | WORKING-STORAGE | 2705                     | 2706  | 2710  | 2711* |       |       |          |       |
| LISTING                                                                                                                                                              | WS-SDL-Line-NUM                 | 2282 | WORKING-STORAGE | 3362*                    |       |       |       |       |       |          |       |
| LISTING                                                                                                                                                              | WS-SDL-Statement-TXT            | 2284 | WORKING-STORAGE | 3363*                    | 3389* | 3396* | 3422* |       |       |          |       |
| LISTING                                                                                                                                                              | WS-SH1-DT                       | 2288 | WORKING-STORAGE | 2473*                    |       |       |       |       |       |          |       |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|------|-----------------|--------------------------|-------|-------|-------|-------|-------|-------|-------|----------|
| PROGRAM-ID                                                                                                                                                           | Identifier/Register/Function    | Defn | Where Defined   | References (* = Updated) |       |       |       |       |       |       |       | Page: 92 |
| LISTING                                                                                                                                                              | WS-SH1-Title-TXT                | 2287 | WORKING-STORAGE | 2417*                    |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-SH3-Page-No-TXT              | 2294 | WORKING-STORAGE | 3439*                    |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Src-Detail-Line-TXT          | 2281 | WORKING-STORAGE | 3361*                    | 3374* | 3378* | 3382* | 3388* | 3394* | 3406* | 3410* |          |
| LISTING                                                                                                                                                              | WS-Src-Header-1-TXT             | 2286 | WORKING-STORAGE | 3433                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Src-Header-2-TXT             | 2290 | WORKING-STORAGE | 2440*                    | 2441* | 2442  | 3440  |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Src-Header-3-TXT             | 2292 | WORKING-STORAGE | 3441                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Src-Header-4-TXT             | 2296 | WORKING-STORAGE | 3442                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Src-Line-NUM                 | 2300 | WORKING-STORAGE | 3322*                    | 3348  | 3360* | 3362  |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Src-SUB                      | 2302 | WORKING-STORAGE | 2482*                    | 2535  | 2536  | 2555* | 2559  | 2561  | 2564* | 2573* |          |
|                                                                                                                                                                      |                                 |      |                 | 2584*                    | 2590* | 2594* | 2595  | 2597* | 2603* | 2607* | 2608  |          |
|                                                                                                                                                                      |                                 |      |                 | 2610*                    | 2616* | 2620* | 2621  | 2623* | 2633* | 2636* | 2653* |          |
| LISTING                                                                                                                                                              | WS-Tally-QTY                    | 2307 | WORKING-STORAGE | 2768*                    | 2770* | 2771  | 2775* | 2776  |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Temp-10-Chars-TXT            | 2309 | WORKING-STORAGE | 2693*                    | 2697  | 2698* | 2700  | 3342* |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Temp-256-Chars-TXT           | 2319 | WORKING-STORAGE | 2460*                    | 2694* | 2701  | 2713  | 2716  | 2721  | 3343* | 3345  |          |
| LISTING                                                                                                                                                              | WS-Temp-32-Chars-1-TXT          | 2311 | WORKING-STORAGE | 2744*                    | 2747  | 2754  |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Temp-32-Chars-2-TXT          | 2313 | WORKING-STORAGE | 2751*                    | 2756* | 2762  | 2763* | 2779  |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Temp-32-Chars-3-TXT          | 2315 | WORKING-STORAGE | 2752*                    | 2757* | 2765  | 2766* | 2779  |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Temp-65-Chars-TXT            | 2317 | WORKING-STORAGE | 3365*                    | 3370  | 3373  | 3377  | 3381  | 3398* | 3402  | 3405  |          |
|                                                                                                                                                                      |                                 |      |                 | 3409                     | 3413  |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Today-DT                     | 2321 | WORKING-STORAGE | 2471*                    | 2472  |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Token-Curr-TXT               | 2323 | WORKING-STORAGE | 2492                     | 2496* | 2565* | 2574* | 2585* | 2593* | 2606* | 2619* |          |
|                                                                                                                                                                      |                                 |      |                 | 2631*                    | 2638  | 2651* | 2661  | 2663* | 2681* | 2744  | 2791  |          |
|                                                                                                                                                                      |                                 |      |                 | 2797                     | 2814  | 2819  | 2837  | 2846  | 2850  | 2897  | 2913  |          |
| LISTING                                                                                                                                                              | WS-Token-Curr-Uc-TXT            | 2325 | WORKING-STORAGE | 2493*                    | 2496  | 2499  | 2518  | 2891  | 3190  | 3211  | 3221  |          |
| LISTING                                                                                                                                                              | WS-Token-Prev-TXT               | 2327 | WORKING-STORAGE | 2500*                    | 2518* | 2522* | 2581* | 2792  | 2795  | 2796* | 2815  |          |
|                                                                                                                                                                      |                                 |      |                 | 2820                     | 2824  | 2842  | 2847  | 2856  | 2857* | 2861  | 2864* |          |
|                                                                                                                                                                      |                                 |      |                 | 2867*                    | 2870* | 2873* | 2876* | 2879* | 2892  | 2898  | 2906  |          |
|                                                                                                                                                                      |                                 |      |                 | 2910*                    | 2972  | 2975* | 2982  | 2993  | 2996* | 3005  | 3020  |          |
|                                                                                                                                                                      |                                 |      |                 | 3029                     | 3053  | 3062  | 3066* | 3069* | 3077* | 3085* | 3092  |          |
|                                                                                                                                                                      |                                 |      |                 | 3101                     | 3117  | 3120* | 3123* | 3130  | 3139  | 3150  | 3161  |          |
|                                                                                                                                                                      |                                 |      |                 | 3164*                    | 3171  |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Token-Search-TXT             | 2329 | WORKING-STORAGE | 2661*                    | 2662  | 2668  |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Token-Type-CD                | 2331 | WORKING-STORAGE | 2566*                    | 2575* | 2586* | 2639* | 2643* | 2664* | 2669* | 2682* |          |
| LISTING                                                                                                                                                              | WS-TT-Token-Is-Argtype-BOOL     | 2332 | WORKING-STORAGE | 2786                     | 2810  | 2833  | 2917  |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-TT-Token-Is-EOF-BOOL         | 2333 | WORKING-STORAGE | 2489                     | 2543* |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-TT-Token-Is-Identifier-BOOL  | 2334 | WORKING-STORAGE | 2676*                    | 2823  | 2860  | 2905  | 2928  |       |       |       |          |
| LISTING                                                                                                                                                              | WS-TT-Token-Is-Keyword-BOOL     | 2335 | WORKING-STORAGE | 2494                     | 2517  | 2790  | 2813  | 2818  | 2836  | 2845  | 2851  |          |
|                                                                                                                                                                      |                                 |      |                 | 2896                     |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-TT-Token-Is-Lit-Alpha-BOOL   | 2336 | WORKING-STORAGE | 2599*                    | 2625* |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-TT-Token-Is-Lit-Number-BOOL  | 2337 | WORKING-STORAGE | 2612*                    | 2678  | 2748* | 2780* |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-TT-Token-Is-Reserved-Wd-BOOL | 2339 | WORKING-STORAGE | 2495                     | 2787* | 2811* | 2834* | 2855  |       |       |       |          |
| LISTING                                                                                                                                                              | WS-TT-Token-Is-Verb-BOOL        | 2338 | WORKING-STORAGE | 2498                     | 2670  |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-Usernames-QTY                | 2341 | WORKING-STORAGE | 2483*                    |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-XDL-Def-Line-NUM             | 2348 | WORKING-STORAGE | 3258*                    | 3275* |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-XDL-Prog-ID-TXT              | 2344 | WORKING-STORAGE | 3255*                    | 3267* | 3271* |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-XDL-Ref-Flag-CHR             | 2354 | WORKING-STORAGE | 3287*                    |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-XDL-Ref-Line-NUM             | 2353 | WORKING-STORAGE | 3285*                    |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-XDL-Reference-TXT            | 2352 | WORKING-STORAGE |                          |       |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-XDL-Section-TXT              | 2350 | WORKING-STORAGE | 3257*                    | 3273* |       |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-XDL-Token-TXT                | 2346 | WORKING-STORAGE | 3256*                    | 3268* | 3272* |       |       |       |       |       |          |
| LISTING                                                                                                                                                              | WS-XH1-DT                       | 2359 | WORKING-STORAGE | 2472*                    |       |       |       |       |       |       |       |          |

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| PROGRAM-ID | Identifier/Register/Function | Defn | Where Defined   | References (* = Updated)             |
|------------|------------------------------|------|-----------------|--------------------------------------|
| LISTING    | WS-XH1-Title-TXT             | 2358 | WORKING-STORAGE | 2423*                                |
| LISTING    | WS-XH3-Page-No-TXT           | 2370 | WORKING-STORAGE | 3307*                                |
| LISTING    | WS-Xref-Detail-Line-TXT      | 2343 | WORKING-STORAGE | 3228* 3240 3251 3270 3290 3313 3314* |
| LISTING    | WS-Xref-Header-1-TXT         | 2357 | WORKING-STORAGE | 3301                                 |
| LISTING    | WS-Xref-Header-2-TXT         | 2361 | WORKING-STORAGE | 2442* 3308                           |
| LISTING    | WS-Xref-Header-3-TXT         | 2363 | WORKING-STORAGE | 3309                                 |
| LISTING    | WS-Xref-Header-4-TXT         | 2372 | WORKING-STORAGE | 3310                                 |

## 10.5. STREAMIO – A Utility Subroutine to Simplify Stream I/O

**STREAMIO** is a utility I created to assist with handling stream I/O functions. I've used it to construct a number of useful little command-line utilities.

Usage of this subroutine is completely documented in the program comments. The program **COPYs** a copybook named **STREAMIOcb**, the format of which is described in the program comments.

Both **STREAMIO.cbl** and **STREAMIOcb.cpy** are included in the "samples" directory of any pre-built distributions of GNU COBOL that I have created.

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| Line | Statement                                                                                   |
|------|---------------------------------------------------------------------------------------------|
| 1    | >>SOURCE FORMAT IS FIXED                                                                    |
| 2    | IDENTIFICATION DIVISION.                                                                    |
| 3    | PROGRAM-ID. STREAMIO.                                                                       |
| 4    | *>*****                                                                                     |
| 5    | *> Author: Gary L. Cutler                       **                                          |
| 6    | *>                                                **                                        |
| 7    | *>                                                **                                        |
| 8    | *>                                                **                                        |
| 9    | *> This routine centralizes all bytestream file I/O functions                        **     |
| 10   | *> into one routine. The manner in which this routine is                                **  |
| 11   | *> CALLED is as follows:                            **                                      |
| 12   | *>                                                **                                        |
| 13   | *>                                                **                                        |
| 14   | *>                                                **                                        |
| 15   | *> where 'control-block' is defined by the "STREAMIOcb.cpy"                        **       |
| 16   | *> copybook and 'arg2' will vary, depending upon the function                        **     |
| 17   | *> specified in the control block.                **                                        |
| 18   | *>                                                **                                        |
| 19   | *> The STREAMIO routine has an advantage over the various                                ** |
| 20   | *> "CBL_xxxxxx_FILE" routines in that:            **                                        |
| 21   | *>                                                **                                        |
| 22   | *> 1. It automates the establishment and on-going adjustment of                        **   |
| 23   | *> the file-offset value in such a way as to simplify the                            **     |
| 24   | *> sequential processing of a bytestream file (you may still                        **      |
| 25   | *> specify a file-offset manually on each read or write, if                        **       |
| 26   | *> you wish)                                        **                                      |
| 27   | *>                                                **                                        |
| 28   | *> 2. It auto-detects the size of the I/O buffer you supply to                        **    |
| 29   | *> STREAMIO, using that as the byte-count of all read and                            **     |
| 30   | *> write operations.                                **                                      |
| 31   | *>                                                **                                        |
| 32   | *> 3. Not only does it support the raw input and output of data                        **   |
| 33   | *> that the CBL_READ_FILE and CBL_WRITE_FILE routines do,                        **         |
| 34   | *> but on input it is also capable of delivering just a                            **       |
| 35   | *> single newline-delimited or carriage-return/newline de-                        **        |
| 36   | *> limited record to the caller.                    **                                      |
| 37   | *>                                                **                                        |
| 38   | *> 4. On output, STREAMIO can optionally append either a new-                            ** |
| 39   | *> line or carriage-return/newline sequence (your choice) to                        **      |
| 40   | *> the end of every record it writes.                **                                     |
| 41   | *>                                                **                                        |
| 42   | *> 5. STREAMIO can automatically generate filenames for output                        **    |
| 43   | *> files if you wish, simplifying the process of creating                        **         |
| 44   | *> scratch or work files.                            **                                     |
| 45   | *>                                                **                                        |
| 46   | *> 6. The STREAMIO routine also allows you to (optionally) re-                        **    |
| 47   | *> gister a general error-handling routine to be given con-                        **       |
| 48   | *> trol should a fatal error be detected with STREAMIO.                        **           |
| 49   | *>                                                **                                        |
| 50   | *> This routine can be "turned on" and "turned off" at will.                    **          |
| 51   | *>                                                **                                        |
| 52   | *> The control block format is as follows. This structure must                        **    |
| 53   | *> be defined under an 01-level data item of your creation and                        **    |
| 54   | *> should be INITIALIZEd before any items within it are used.                    **         |

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| Line | Statement                                                       |
|------|-----------------------------------------------------------------|
| 55   | *> 05 SCB-Handle-NUM                                            |
| 56   | *> 05 SCB-Mode-CD                                               |
| 57   | *> 88 SCB-Mode-Input-BOOL                                       |
| 58   | *> 88 SCB-Mode-Output-BOOL                                      |
| 59   | *> 88 SCB-Mode-Both-BOOL                                        |
| 60   | *> 05 SCB-Function-CD                                           |
| 61   | *> 88 SCB-Func-CLOSE-BOOL                                       |
| 62   | *> 88 SCB-Func-DELETE-BOOL                                      |
| 63   | *> 88 SCB-Func-OPEN-BOOL                                        |
| 64   | *> 88 SCB-Func-READ-BOOL                                        |
| 65   | *> 88 SCB-Func-READ-Delim-BOOL                                  |
| 66   | *>                                                              |
| 67   | *> 88 SCB-Func-WRITE-BOOL                                       |
| 68   | *> 88 SCB-Func-WRITE-Delim-BOOL                                 |
| 69   | *>                                                              |
| 70   | *> 05 SCB-Delimiter-Mode-CD                                     |
| 71   | *> 88 SCB-Delim-Unix-BOOL                                       |
| 72   | *> 88 SCB-Delim-Windows-BOOL                                    |
| 73   | *> 05 SCB-Offset-NUM                                            |
| 74   | *> 05 SCB-Error-Routine-PTR                                     |
| 75   | *> 05 SCB-Error-Routine-NUM REDEFINES SCB-Error-Routine-PTR     |
| 76   | *>                                                              |
| 77   | *> 05 SCB-Return-CD                                             |
| 78   | *> 05 SCB-Filename-TXT                                          |
| 79   | *>                                                              |
| 80   | *> Such a structure is defined for your use using the copybook  |
| 81   | *> "STREAMIOcb.cpy" (you may also define your own, provided it  |
| 82   | *> conforms to the above layout).                               |
| 83   | *>-----*                                                        |
| 84   | *> SCB-Handle-NUM                                               |
| 85   | *>-----*                                                        |
| 86   | *>                                                              |
| 87   | *> Serves as a file handle to the file once it has been opened  |
| 88   | *> (via the "SCB-Func-OPEN-BOOL" function).                     |
| 89   | *>                                                              |
| 90   | *>-----*                                                        |
| 91   | *> SCB-Mode-CD                                                  |
| 92   | *>-----*                                                        |
| 93   | *>                                                              |
| 94   | *> Prior to calling "STREAMIO" for the first time for a file,   |
| 95   | *> the appropriate subordinate level-88 must be set to TRUE to  |
| 96   | *> select an I/O mode. You may also simply move one of the      |
| 97   | *> string values listed on the level-88 items to "SCB-Mode-CD". |
| 98   | *>                                                              |
| 99   | *>-----*                                                        |
| 100  | *> SCB-Function-CD                                              |
| 101  | *>-----*                                                        |
| 102  | *>                                                              |
| 103  | *> The appropriate subordinate level-88 must be set to TRUE to  |
| 104  | *> select a function you'd like to execute against a file. You  |
| 105  | *> may also simply move one of the string values listed on the  |
| 106  | *> level-88 items to "SCB-Function-CD".                         |
| 107  | *>                                                              |
| 108  | *> Available functions are as follows:                          |

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| Line | Statement                                                                   |
|------|-----------------------------------------------------------------------------|
| 109  | *>          **                                                              |
| 110  | *> SCB-Func-OPEN-BOOL          **                                           |
| 111  | *>          **                                                              |
| 112  | *>      This must be the function specified the first time you          **  |
| 113  | *>      call STREAMIO for any given file. It opens the file &          **   |
| 114  | *>      makes it available for use according to the          **             |
| 115  | *>      "SCB-Mode-CD" specification.          **                            |
| 116  | *>          **                                                              |
| 117  | *>      The filename being opened must be specified in the          **      |
| 118  | *>      "SCB-Filename-TXT" field.          **                               |
| 119  | *>          **                                                              |
| 120  | *>      The SCB-Offset-NUM field will be initialized to ZERO.          **   |
| 121  | *>          **                                                              |
| 122  | *>      If "arg2" is specified in conjunction with this funct-          **  |
| 123  | *>      ion, it will be ignored.          **                                |
| 124  | *>          **                                                              |
| 125  | *> SCB-Func-CLOSE-BOOL          **                                          |
| 126  | *>          **                                                              |
| 127  | *>      This function should be the one specified the LAST time          ** |
| 128  | *>      you call STREAMIO against a specific file. After this          **   |
| 129  | *>      function has been executed, you'll have to re-open the          **  |
| 130  | *>      file if you wish to use it with STREAMIO again.          **         |
| 131  | *>          **                                                              |
| 132  | *>      The SCB-Handle-NUM item will be reset to ZERO.          **          |
| 133  | *>          **                                                              |
| 134  | *>      If "arg2" is specified in conjunction with this funct-          **  |
| 135  | *>      ion, it will be ignored.          **                                |
| 136  | *>          **                                                              |
| 137  | *> SCB-Func-DELETE-BOOL          **                                         |
| 138  | *>          **                                                              |
| 139  | *>      This function will delete the file specified in the          **     |
| 140  | *>      control block (see SCB-Filename-TXT).          **                   |
| 141  | *>          **                                                              |
| 142  | *>      This function should not be performed against a file          **    |
| 143  | *>      that is open.          **                                           |
| 144  | *>          **                                                              |
| 145  | *>      If "arg2" is specified in conjunction with this funct-          **  |
| 146  | *>      ion, it will be ignored.          **                                |
| 147  | *>          **                                                              |
| 148  | *> SCB-Func-READ-BOOL          **                                           |
| 149  | *>          **                                                              |
| 150  | *>      This function invokes a standard CBL_READ_FILE against          **  |
| 151  | *>      the file specified in the control block (see          **            |
| 152  | *>      SCB-Filename-TXT).          **                                      |
| 153  | *>          **                                                              |
| 154  | *>      The buffer into which you wish to read data must be          **     |
| 155  | *>      supplied as "arg2". The size of that buffer, in bytes,          **  |
| 156  | *>      will define the "byte-count" value supplied to the          **      |
| 157  | *>      CBL_READ_FILE subroutine. The buffer data item will be          **  |
| 158  | *>      set to SPACES before the read takes place.          **              |
| 159  | *>          **                                                              |
| 160  | *>      If the file-offset value (SCB-Offset-NUM) is greater          **    |
| 161  | *>      than the size of the file, a "no more data" return code          ** |
| 162  | *>      (01) will be passed back in SCB-Return-CD and the          **       |

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| Line | Statement                                                  |
|------|------------------------------------------------------------|
| 163  | *> buffer will have been set to SPACES.                    |
| 164  | *>                                                         |
| 165  | *> At the conclusion of a successful SCB-Func-READ-BOOL,   |
| 166  | *> the value of SCB-Offset-NUM will have been automati-    |
| 167  | *> cally incremented by the byte-count size of "arg2".     |
| 168  | *>                                                         |
| 169  | *> SCB-Func-WRITE-BOOL                                     |
| 170  | *>                                                         |
| 171  | *> This function invokes a standard CBL_WRITE_FILE against |
| 172  | *> the file specified in the control block (see            |
| 173  | *> SCB-Filename-TXT).                                      |
| 174  | *>                                                         |
| 175  | *> The buffer from which data will be written to the file  |
| 176  | *> must be supplied as "arg2". The size of that buffer,    |
| 177  | *> in bytes, will define the "byte-count" value supplied   |
| 178  | *> CBL_WRITE_FILE subroutine. The buffer data will be      |
| 179  | *> written to the file-offset position defined by the      |
| 180  | *> SCB-Offset-NUM value. You may specify "arg2" either     |
| 181  | *> as an actual alphanumeric data item or as an alpha-     |
| 182  | *> numeric literal.                                        |
| 183  | *>                                                         |
| 184  | *> If the file-offset value (SCB-Offset-NUM) is greater    |
| 185  | *> than the size of the file, a "no more data" return code |
| 186  | *> will be passed back in SCB-Return-CD and the buffer     |
| 187  | *> will have been set to SPACES.                           |
| 188  | *>                                                         |
| 189  | *> At the conclusion of a successful SCB-Func-WRITE-BOOL   |
| 190  | *> operation, the value of SCB-Offset-NUM will have been   |
| 191  | *> automatically incremented by the byte-count size of     |
| 192  | *> "arg2".                                                 |
| 193  | *>                                                         |
| 194  | *> SCB-Func-READ-Delim-BOOL                                |
| 195  | *>                                                         |
| 196  | *> SCB-Func-READ-Delim-BOOL behaves like the SCB-FUNC-     |
| 197  | *> READ function, with the following behavioral dif-       |
| 198  | *> ferences:                                               |
| 199  | *>                                                         |
| 200  | *> 1. When data is read from the file, only that data read |
| 201  | *> up to BUT NOT INCLUDING an end-of-line delimiter        |
| 202  | *> sequence (either a LF or CRLF) will be retained in      |
| 203  | *> the buffer - the remainder of the buffer from the       |
| 204  | *> end-of-line sequence onward will be reset to SPACES.    |
| 205  | *> The file-offset value (SCB-Offset-NUM) will be in-      |
| 206  | *> cremented ONLY by the amount of data transferred up     |
| 207  | *> to AND INCLUDING the end-of-line sequence.              |
| 208  | *>                                                         |
| 209  | *> 2. When data is read from the file and an end-of-line   |
| 210  | *> delimiter sequence (either a LF or a CRLF) cannot be    |
| 211  | *> found within the buffer, the assumption is made that    |
| 212  | *> the record is too long to fit within the buffer. In     |
| 213  | *> these instances, an SCB-Return-CD value of 02 will      |
| 214  | *> be returned and the SCB-Offset-NUM value will be        |
| 215  | *> incremented past the next end-of-line sequence in       |
| 216  | *> the file (this will involve at least one additional     |

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| Line | Statement                                                                    |
|------|------------------------------------------------------------------------------|
| 217  | * > call to CBL_READ_FILE to locate that eol sequence,     **                |
| 218  | * > but any additional such reads will be done internal- **                  |
| 219  | * > ly to STREAMIO and will be entirely transparent to     **                |
| 220  | * > the caller of STREAMIO.                                    **            |
| 221  | * >                                                                          |
| 222  | * > DO NOT USE the Streamio-READ-Delim function if the     **                |
| 223  | * > possibility exists that linefeed (X"0A") or carriage-     **             |
| 224  | * > return (X"0D") characters could exist as actual data     **              |
| 225  | * > characters in the file.                                    **            |
| 226  | * >                                                                          |
| 227  | * > SCB-Func-WRITE-Delim-BOOL                                  **            |
| 228  | * >                                                                          |
| 229  | * >      SCB-Func-WRITE-Delim-BOOL acts like the Streamio-     **            |
| 230  | * > FUNC-WRITE function, with the following difference:     **               |
| 231  | * >                                                                          |
| 232  | * > After the specified data is written to the file, an     **               |
| 233  | * > end-of-line sequence will also be written to the file.     **            |
| 234  | * > The file-offset value (SCB-Value) will be incremented     **             |
| 235  | * > by the byte-count size of the data PLUS the size of the     **           |
| 236  | * > end-of-line sequence. One of two possible end-of-line     **             |
| 237  | * > sequences must be specified using the value of SCB-     **               |
| 238  | * > Delimiter-Mode.                                            **            |
| 239  | * >                                                                          |
| 240  | * >-----*                                                                    |
| 241  | * > SCB-Delimiter-Mode-CD                                    **              |
| 242  | * >-----*                                                                    |
| 243  | * >                                                                          |
| 244  | * >      This data item is needed only when issuing the Streamio-     **     |
| 245  | * > FUNC-WRITE-Delim function. In those circumstances, this     **           |
| 246  | * > item defines what end-of-line delimiter sequence is to be     **         |
| 247  | * > written:                                                    **           |
| 248  | * >                                                                          |
| 249  | * >      If SCB-Delim-Unix-BOOL is true, a linefeed character will     **    |
| 250  | * > be written.                                                    **        |
| 251  | * >                                                                          |
| 252  | * >      If SCB-Delim-Windows-BOOL is true, a carriage-return and     **     |
| 253  | * > linefeed sequence will be written.                            **         |
| 254  | * >                                                                          |
| 255  | * >-----*                                                                    |
| 256  | * > SCB-Offset-NUM                                            **             |
| 257  | * >-----*                                                                    |
| 258  | * >                                                                          |
| 259  | * >      This data item specifies the next relative byte number with-     ** |
| 260  | * > in the file where the next read or write will start.     **              |
| 261  | * >                                                                          |
| 262  | * >      SCB-Offset-NUM is automatically set to 0 (the first byte)     **    |
| 263  | * > when the file is opened, and is automatically incremented as     **      |
| 264  | * > the file is read or written via STREAMIO.                    **          |
| 265  | * >                                                                          |
| 266  | * >      You may also manually set this value as desired before any     **   |
| 267  | * > call to STREAMIO.                                            **          |
| 268  | * >                                                                          |
| 269  | * >-----*                                                                    |
| 270  | * > SCB-Error-Routine-PTR                                    **              |

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| Line | Statement                                                           |
|------|---------------------------------------------------------------------|
| 271  | *>-----**                                                           |
| 272  | *>-----**                                                           |
| 273  | /* To specify a general error-handling routine for handling **      |
| 274  | /* STREAMIO failures, Create the routine and define an entry- **    |
| 275  | /* name for it via the ENTRY statement. Then use the following **   |
| 276  | /* to set that routine up as the error handler: **                  |
| 277  | /*-----**                                                           |
| 278  | /*> SET SCB-Error-Routine-PTR TO ENTRY "entry-name" **              |
| 279  | /*-----**                                                           |
| 280  | /*> To "turn off" the error-routine: **                             |
| 281  | /*-----**                                                           |
| 282  | /*> SET SCB-Error-Routine-PTR TO NULL **                            |
| 283  | /*-----**                                                           |
| 284  | /*> If a fatal error occurs (any error not marked with a ">" in **  |
| 285  | /* the SCB-Return-CD discussion), the error routine you spe- **     |
| 286  | /* cified (if any) will be set up as an exit routine via the **     |
| 287  | /* CBL_EXIT_PROC subroutine; the STREAMIO routine will then is- **  |
| 288  | /* sue a STOP RUN to intentionally trigger your error routine. **   |
| 289  | /* You will not be able to recover your program once your error **  |
| 290  | /* routine triggers. If you wish to be able to recover from **      |
| 291  | /* fatal STREAMIO errors, you should NOT use the SCB-Error- **      |
| 292  | /* Routine feature but instead you should explicitly test the **    |
| 293  | /* SCB-Return-CD value after every call to STREAMIO. **             |
| 294  | /*-----**                                                           |
| 295  | /*> A default error routine is defined by the "STREAMIOError.cpy"** |
| 296  | /*> copybook. **                                                    |
| 297  | /*-----**                                                           |
| 298  | /*-----**                                                           |
| 299  | /*> SCB-Return-CD **                                                |
| 300  | /*-----**                                                           |
| 301  | /*-----**                                                           |
| 302  | /*> The following are the possible SCB-Return-CD values. The **     |
| 303  | /*> ones marked with a ">" will NOT trigger an error-routine, if ** |
| 304  | /*> one is currently registered via SCB-Error-Routine-PTR. **       |
| 305  | /*-----**                                                           |
| 306  | /*> 12 I/O error writing to file **                                 |
| 307  | /*> 11 File does not exist **                                       |
| 308  | /*> 10 File already OPEN or already CLOSEd **                       |
| 309  | /*> > 02 READ-Delim was truncated **                                |
| 310  | /*> > 01 No more data is available from the current **              |
| 311  | /*> SCB-Offset-NUM **                                               |
| 312  | /*> > 00 OK - the operation was successful **                       |
| 313  | /*> -1 Invalid SCB-Function-CD **                                   |
| 314  | /*> -2 Invalid SCB-Mode-CD **                                       |
| 315  | /*> -3 CBL_xxxxx(FILE routine rejected operation **                 |
| 316  | /*> -4 Invalid delimiter mode specified (Not U/W) **                |
| 317  | /*-----**                                                           |
| 318  | /*-----**                                                           |
| 319  | /*> SCB-Filename-TXT **                                             |
| 320  | /*-----**                                                           |
| 321  | /*-----**                                                           |
| 322  | /*> This is the name of the file you wish to access. **             |
| 323  | /*-----**                                                           |
| 324  | /*> If you are planning on reading the file, the file MUST exist ** |

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| Line | Statement                                                       |
|------|-----------------------------------------------------------------|
| 325  | *> at the time the SCB-Func-OPEN-BOOL is executed.              |
| 326  | *>                                                              |
| 327  | *> If you are planning on writing to the file, the file need    |
| 328  | *> exist when the SCB-Func-OPEN-BOOL is issued.                 |
| 329  | *>                                                              |
| 330  | *> In general, the contents of SCB-Filename-TXT should re-      |
| 331  | *> flect the complete path to the file as well as the name of   |
| 332  | *> the file itself, unless the file is contained in whatever    |
| 333  | *> directory is current at the time the SCB-Func-OPEN-BOOL is   |
| 334  | *> executed.                                                    |
| 335  | *>                                                              |
| 336  | *> The following special values may be used for                 |
| 337  | *> SCB-Filename-TXT:                                            |
| 338  | *>                                                              |
| 339  | *> SPACES If the filename is SPACES, a filename will be created |
| 340  | *> automatically for you in whatever directory is de-           |
| 341  | *> fined by the TEMP environment variable. If there IS          |
| 342  | *> no TEMP variable defined, the "/tmp" folder will be          |
| 343  | *> assumed. The filename will be STREAMIO-nnnnnnnn.dat          |
| 344  | *> where "nnnnnnnn" is a random number.                         |
| 345  | *>                                                              |
| 346  | *> . If you specify only a dot (period) as the filename,        |
| 347  | *> the behavior will be the same as with a value of             |
| 348  | *> SPACES except there will be no ".dat" at the end of          |
| 349  | *> the generated filename.                                      |
| 350  | *>                                                              |
| 351  | *> .ext If you specify a filename extension prefixed with a     |
| 352  | *> dot (period), the behavior will be the same as if a          |
| 353  | *> value of SPACES were specified, except that the given        |
| 354  | *> extension will be used instead of ".dat". Note that          |
| 355  | *> if you are using a Unix/Cygwin implementation of             |
| 356  | *> OpenCOBOL and you'd like to specify a hidden file in         |
| 357  | *> the current directory as the SCB-Filename-TXT, you           |
| 358  | *> MUST code the filename as "./.xxxxx" to avoid having         |
| 359  | *> it treated as this special name.                             |
| 360  | *>                                                              |
| 361  | *>*****                                                         |
| 362  | ENVIRONMENT DIVISION.                                           |
| 363  | CONFIGURATION SECTION.                                          |
| 364  | REPOSITORY.                                                     |
| 365  | FUNCTION ALL INTRINSIC.                                         |
| 366  | DATA DIVISION.                                                  |
| 367  | WORKING-STORAGE SECTION.                                        |
| 368  | 01 WS-Access-Mode-CD PIC X(1) COMP-X.                           |
| 369  | 01 WS-Arg-Length-NUM PIC X(4) COMP-X.                           |
| 370  | 01 WS-Buffer-TXT PIC X(256).                                    |
| 371  | 01 WS-Delim-Buffer-TXT PIC X(2).                                |
| 372  | 01 WS-Env-Temp-TXT PIC X(256).                                  |
| 373  | 01 WS-Slash-CHR PIC X(1).                                       |
| 374  | 01 WS-Tally-NUM USAGE BINARY-LONG.                              |
| 375  | 01 WS-8-Digit-NUM PIC 9(8).                                     |
| 376  | 01 WS-256-Byte-TXT PIC X(256).                                  |
| 377  | LINKAGE SECTION.                                                |
| 378  | 01 L-StreamIO-Control-Block-TXT.                                |

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Line Statement

```

=====
379      COPY STREAMIOcb
380          REPLACING LEADING ==SCB--- BY ==L-SCB---.
05 L-SCB-Handle-NUM PIC X(4) COMP-X.
05 L-SCB-Mode-CD PIC X(1).
88 L-SCB-MODE-Input-BOOL VALUE 'I' 'i'.
88 L-SCB-MODE-Output-BOOL VALUE 'O' 'o'.
88 L-SCB-MODE-Both-BOOL VALUE 'B' 'b'.
05 L-SCB-Function-CD PIC X(2).
88 L-SCB-Func-CLOSE-BOOL VALUE 'C' 'c'.
88 L-SCB-Func-DELETE-BOOL VALUE 'D' 'd'.
88 L-SCB-Func-OPEN-BOOL VALUE 'O' 'o'.
88 L-SCB-Func-READ-BOOL VALUE 'R' 'r'.
88 L-SCB-Func-READ-Delim-BOOL VALUE 'RD' 'rd'
  'rD' 'Rd'.
88 L-SCB-Func-WRITE-BOOL VALUE 'W' 'w'.
88 L-SCB-Func-WRITE-Delim-BOOL VALUE 'WD' 'wd'
  'wD' 'Wd'.
05 L-SCB-Delimiter-Mode-CD PIC X(1).
88 L-SCB-DELIM-Unix-BOOL VALUE 'U' 'u'.
88 L-SCB-DELIM-Windows-BOOL VALUE 'W' 'w'.
05 L-SCB-Offset-NUM PIC X(8) COMP-X.
05 L-SCB-Error-Routine-PTR USAGE PROGRAM-POINTER.
05 L-SCB-Error-Routine-NUM REDEFINES L-SCB-Error-Routine-PTR
USAGE BINARY-LONG.
05 L-SCB-Return-CD USAGE BINARY-LONG.
05 L-SCB-Filename-TXT PIC X(256).
01 L-Arg2-TXT          PIC X ANY LENGTH.
382 PROCEDURE DIVISION USING L-StreamIO-Control-Block-TXT,
383                               L-Arg2-TXT.
384 000>Main SECTION.
385     MOVE 00 TO L-SCB-Return-CD
386     EVALUATE TRUE
387       WHEN L-SCB-Func-CLOSE-BOOL
388           PERFORM 030-Validate-Handle-NonZero
389           PERFORM 200-CLOSE
390       WHEN L-SCB-Func-DELETE-BOOL
391           CALL "CBL_DELETE_FILE" USING L-SCB-Filename-TXT
392       WHEN L-SCB-Func-OPEN-BOOL
393           PERFORM 020-Validate-Handle-Zero
394           PERFORM 100-OPEN
395       WHEN L-SCB-Func-READ-BOOL
396           PERFORM 030-Validate-Handle-NonZero
397           PERFORM 400-READ
398       WHEN L-SCB-Func-READ-Delim-BOOL
399           PERFORM 030-Validate-Handle-NonZero
400           PERFORM 500-READ-Delim
401       WHEN L-SCB-Func-WRITE-BOOL
402           PERFORM 030-Validate-Handle-NonZero
403           PERFORM 300-WRITE
404       WHEN L-SCB-Func-WRITE-Delim-BOOL
405           EVALUATE TRUE
406             WHEN L-SCB-Delimiter-Unix-BOOL
407                 PERFORM 030-Validate-Handle-NonZero
408                 PERFORM 300-WRITE

```

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| Line | Statement                                    |
|------|----------------------------------------------|
| 409  | MOVE 1 TO WS-Arg-Length-NUM                  |
| 410  | MOVE X"0A" TO WS-Delim-Buffer-TXT            |
| 411  | WHEN L-SCB-Delim-Windows-BOOL                |
| 412  | PERFORM 030-Validate-Handle-NonZero          |
| 413  | PERFORM 300-WRITE                            |
| 414  | MOVE 2 TO WS-Arg-Length-NUM                  |
| 415  | MOVE X"0D0A" TO WS-Delim-Buffer-TXT          |
| 416  | WHEN OTHER                                   |
| 417  | MOVE -4 TO L-SCB-Return-CD                   |
| 418  | PERFORM 099-ERROR-Return                     |
| 419  | END-EVALUATE                                 |
| 420  | CALL "CBL_WRITE_FILE" USING L-SCB-Handle-NUM |
| 421  | L-SCB-Offset-NUM                             |
| 422  | WS-Arg-Length-NUM                            |
| 423  | 0                                            |
| 424  | WS-Delim-Buffer-TXT                          |
| 425  | PERFORM 040-Check-WRITE-SCB-Return-CD        |
| 426  | ADD WS-Arg-Length-NUM TO L-SCB-Offset-NUM    |
| 427  | WHEN OTHER                                   |
| 428  | MOVE -1 TO L-SCB-Return-CD                   |
| 429  | PERFORM 099-ERROR-Return                     |
| 430  | END-EVALUATE                                 |
| 431  | GOBACK                                       |
| 432  | .                                            |
| 433  | 020-Validate-Handle-Zero SECTION.            |
| 434  | IF L-SCB-Handle-NUM NOT = ZERO               |
| 435  | MOVE 10 TO L-SCB-Return-CD                   |
| 436  | PERFORM 099-ERROR-Return                     |
| 437  | END-IF                                       |
| 438  | .                                            |
| 439  | 030-Validate-Handle-NonZero SECTION.         |
| 440  | IF L-SCB-Handle-NUM = ZERO                   |
| 441  | MOVE 10 TO L-SCB-Return-CD                   |
| 442  | PERFORM 099-ERROR-Return                     |
| 443  | END-IF                                       |
| 444  | .                                            |
| 445  | 040-Check-WRITE-SCB-Return-CD SECTION.       |
| 446  | IF RETURN-CODE < 0                           |
| 447  | MOVE -3 TO L-SCB-Return-CD                   |
| 448  | PERFORM 099-ERROR-Return                     |
| 449  | END-IF                                       |
| 450  | IF RETURN-CODE = 30                          |
| 451  | MOVE 12 TO L-SCB-Return-CD                   |
| 452  | PERFORM 099-ERROR-Return                     |
| 453  | END-IF                                       |
| 454  | MOVE 00 TO L-SCB-Return-CD                   |
| 455  | .                                            |
| 456  | 050-Check-READ-SCB-Return-CD SECTION.        |
| 457  | IF RETURN-CODE < 0                           |
| 458  | MOVE -3 TO L-SCB-Return-CD                   |
| 459  | PERFORM 099-ERROR-Return                     |
| 460  | END-IF                                       |
| 461  | IF RETURN-CODE = 10                          |
| 462  | MOVE 01 TO L-SCB-Return-CD                   |

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| Line | Statement                                             |
|------|-------------------------------------------------------|
| 463  | GOBACK                                                |
| 464  | END-IF                                                |
| 465  | MOVE 00 TO L-SCB-Return-CD                            |
| 466  | .                                                     |
| 467  | 060-Identify-TEMP SECTION.                            |
| 468  | ACCEPT WS-Env-Temp-TXT FROM ENVIRONMENT "TEMP"        |
| 469  | EVALUATE TRUE                                         |
| 470  | WHEN WS-Env-Temp-TXT (1:1) = "/"                      |
| 471  | MOVE "/" TO WS-Slash-CHR                              |
| 472  | WHEN WS-Env-Temp-TXT (2:1) = ":"                      |
| 473  | MOVE "\"" TO WS-Slash-CHR                             |
| 474  | WHEN OTHER                                            |
| 475  | MOVE "/tmp" TO WS-Env-Temp-TXT                        |
| 476  | MOVE "/" TO WS-Slash-CHR                              |
| 477  | END-EVALUATE                                          |
| 478  | .                                                     |
| 479  | 099-ERROR-Return SECTION.                             |
| 480  | IF L-SCB-Error-Routine-NUM NOT = 0                    |
| 481  | CALL "CBL_EXIT_PROC" USING 0, L-SCB-Error-Routine-PTR |
| 482  | STOP RUN                                              |
| 483  | END-IF                                                |
| 484  | GOBACK                                                |
| 485  | .                                                     |
| 486  | 100-OPEN SECTION.                                     |
| 487  | IF (L-SCB-Mode-Input-BOOL OR L-SCB-Mode-Both-BOOL)    |
| 488  | AND (L-SCB-Filename-TXT = SPACES OR LOW-VALUES)       |
| 489  | MOVE 11 TO L-SCB-Return-CD                            |
| 490  | PERFORM 099-ERROR-Return                              |
| 491  | END-IF                                                |
| 492  | EVALUATE TRUE                                         |
| 493  | WHEN L-SCB-Filename-TXT = SPACES OR LOW-VALUES        |
| 494  | PERFORM 060-Identify-TEMP                             |
| 495  | MOVE SPACES TO L-SCB-Filename-TXT                     |
| 496  | COMPUTE                                               |
| 497  | WS-8-Digit-Num =                                      |
| 498  | RANDOM(SECONDS-PAST-MIDNIGHT) * 100000000             |
| 499  | END-COMPUTE                                           |
| 500  | STRING                                                |
| 501  | TRIM(WS-Env-Temp-TXT,.TRAILING)                       |
| 502  | WS-Slash-CHR                                          |
| 503  | "STREAMIO-"                                           |
| 504  | WS-8-Digit-Num                                        |
| 505  | ".dat"                                                |
| 506  | DELIMITED BY SIZE                                     |
| 507  | INTO L-SCB-Filename-TXT                               |
| 508  | WHEN L-SCB-Filename-TXT(1:1) = ".."                   |
| 509  | PERFORM 060-Identify-TEMP                             |
| 510  | IF L-SCB-Filename-TXT(2:1) = SPACE                    |
| 511  | MOVE SPACES TO WS-256-Byte-TXT                        |
| 512  | ELSE                                                  |
| 513  | MOVE L-SCB-Filename-TXT TO WS-256-Byte-TXT            |
| 514  | END-IF                                                |
| 515  | MOVE SPACES TO L-SCB-Filename-TXT                     |
| 516  | COMPUTE WS-8-Digit-Num =                              |

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| Line | Statement                                                    |
|------|--------------------------------------------------------------|
| 517  | RANDOM(SECONDS-PAST-MIDNIGHT) * 100000000                    |
| 518  | STRING                                                       |
| 519  | TRIM(WS-Env-Temp-TXT,TRAILING)                               |
| 520  | WS-Slash-CHR                                                 |
| 521  | "STREAMIO-"                                                  |
| 522  | WS-8-Digit-NUM                                               |
| 523  | TRIM(WS-256-Byte-TXT,TRAILING)                               |
| 524  | DELIMITED BY SIZE                                            |
| 525  | INTO L-SCB-Filename-TXT                                      |
| 526  | END-EVALUATE                                                 |
| 527  | EVALUATE TRUE                                                |
| 528  | WHEN L-SCB-Mode-Input-BOOL                                   |
| 529  | MOVE 1 TO WS-Access-Mode-CD                                  |
| 530  | WHEN L-SCB-Mode-Output-BOOL                                  |
| 531  | MOVE 2 TO WS-Access-Mode-CD                                  |
| 532  | WHEN L-SCB-Mode-Both-BOOL                                    |
| 533  | MOVE 3 TO WS-Access-Mode-CD                                  |
| 534  | WHEN OTHER                                                   |
| 535  | MOVE -2 TO L-SCB-Return-CD                                   |
| 536  | PERFORM 099-ERROR-Return                                     |
| 537  | END-EVALUATE                                                 |
| 538  | CALL "CBL_OPEN_FILE" USING TRIM(L-SCB-Filename-TXT,TRAILING) |
| 539  | WS-Access-Mode-CD                                            |
| 540  | 0                                                            |
| 541  | 0                                                            |
| 542  | L-SCB-Handle-NUM                                             |
| 543  | IF RETURN-CODE = 35                                          |
| 544  | MOVE 11 TO L-SCB-Return-CD                                   |
| 545  | PERFORM 099-ERROR-Return                                     |
| 546  | ENDIF                                                        |
| 547  | IF RETURN-CODE < 0                                           |
| 548  | MOVE -2 TO L-SCB-Return-CD                                   |
| 549  | PERFORM 099-ERROR-Return                                     |
| 550  | ENDIF                                                        |
| 551  | MOVE 00 TO L-SCB-Return-CD                                   |
| 552  | MOVE 0 TO L-SCB-Offset-NUM                                   |
| 553  | .                                                            |
| 554  | 200-CLOSE SECTION.                                           |
| 555  | CALL "CBL_CLOSE_FILE" USING L-SCB-Handle-NUM                 |
| 556  | IF RETURN-CODE < 0                                           |
| 557  | MOVE -2 TO L-SCB-Return-CD                                   |
| 558  | PERFORM 099-ERROR-Return                                     |
| 559  | ENDIF                                                        |
| 560  | MOVE 00 TO L-SCB-Return-CD                                   |
| 561  | MOVE 0 TO L-SCB-Handle-NUM                                   |
| 562  | .                                                            |
| 563  | 300-WRITE SECTION.                                           |
| 564  | CALL "C\$PARAMSIZE" USING 2                                  |
| 565  | MOVE RETURN-CODE TO WS-Arg-Length-NUM                        |
| 566  | CALL "CBL_WRITE_FILE" USING L-SCB-Handle-NUM                 |
| 567  | L-SCB-Offset-NUM                                             |
| 568  | WS-Arg-Length-NUM                                            |
| 569  | 0                                                            |
| 570  | L-Arg2-TXT                                                   |

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| Line | Statement                                                                                     |
|------|-----------------------------------------------------------------------------------------------|
| 571  | PERFORM 040-Check-WRITE-SCB-Return-CD                                                         |
| 572  | ADD WS-Arg-Length-NUM TO L-SCB-Offset-NUM                                                     |
| 573  | .                                                                                             |
| 574  | 400-READ SECTION.                                                                             |
| 575  | CALL "C\$PARAMSIZE" USING 2                                                                   |
| 576  | MOVE RETURN-CODE TO WS-Arg-Length-NUM                                                         |
| 577  | MOVE SPACES TO L-Arg2-TXT(1:WS-Arg-Length-NUM)                                                |
| 578  | CALL "CBL_READ_FILE" USING L-SCB-Handle-NUM                                                   |
| 579  | L-SCB-Offset-NUM                                                                              |
| 580  | WS-Arg-Length-NUM                                                                             |
| 581  | 0                                                                                             |
| 582  | L-Arg2-TXT                                                                                    |
| 583  | PERFORM 050-Check-READ-SCB-Return-CD                                                          |
| 584  | ADD WS-Arg-Length-NUM TO L-SCB-Offset-NUM                                                     |
| 585  | .                                                                                             |
| 586  | 500-READ-Delim SECTION.                                                                       |
| 587  | CALL "C\$PARAMSIZE" USING 2                                                                   |
| 588  | MOVE RETURN-CODE TO WS-Arg-Length-NUM                                                         |
| 589  | MOVE SPACES TO L-Arg2-TXT(1:WS-Arg-Length-NUM)                                                |
| 590  | CALL "CBL_READ_FILE" USING L-SCB-Handle-NUM                                                   |
| 591  | L-SCB-Offset-NUM                                                                              |
| 592  | WS-Arg-Length-NUM                                                                             |
| 593  | 0                                                                                             |
| 594  | L-Arg2-TXT                                                                                    |
| 595  | PERFORM 050-Check-READ-SCB-Return-CD                                                          |
| 596  | MOVE 0 TO WS-Tally-NUM                                                                        |
| 597  | INSPECT L-Arg2-TXT(1:WS-Arg-Length-NUM)                                                       |
| 598  | TALLYING WS-Tally-NUM FOR ALL X"0A"                                                           |
| 599  | IF WS-Tally-NUM = 0 *> No LF found - return truncated data and position past next LF (if any) |
| 600  | IF L-Arg2-TXT(WS-Arg-Length-NUM:1) = X"0D"                                                    |
| 601  | MOVE SPACE TO L-Arg2-TXT(WS-Arg-Length-NUM:1)                                                 |
| 602  | END-IF                                                                                        |
| 603  | ADD WS-Arg-Length-NUM TO L-SCB-Offset-NUM                                                     |
| 604  | MOVE 02 TO L-SCB-Return-CD                                                                    |
| 605  | MOVE 256 TO WS-Arg-Length-NUM                                                                 |
| 606  | PERFORM UNTIL 0 = 1                                                                           |
| 607  | MOVE SPACES TO WS-Buffer-TXT                                                                  |
| 608  | CALL "CBL_READ_FILE" USING L-SCB-Handle-NUM                                                   |
| 609  | L-SCB-Offset-NUM                                                                              |
| 610  | WS-Arg-Length-NUM                                                                             |
| 611  | 0                                                                                             |
| 612  | WS-Buffer-TXT                                                                                 |
| 613  | IF RETURN-CODE < 0                                                                            |
| 614  | MOVE -3 TO L-SCB-Return-CD                                                                    |
| 615  | PERFORM 099-ERROR-Return                                                                      |
| 616  | END-IF                                                                                        |
| 617  | IF RETURN-CODE = 10                                                                           |
| 618  | GOBACK                                                                                        |
| 619  | END-IF                                                                                        |
| 620  | MOVE 0 TO WS-Tally-NUM                                                                        |
| 621  | INSPECT WS-Buffer-TXT                                                                         |
| 622  | TALLYING WS-Tally-NUM FOR ALL X"0A"                                                           |
| 623  | IF WS-Tally-NUM = 0                                                                           |
| 624  | ADD 256 TO L-SCB-Offset-NUM                                                                   |

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Line Statement

```
=====  
625      ELSE  
626          MOVE 0 TO WS-Tally-NUM  
627          INSPECT WS-Buffer-TXT  
628              TALLYING WS-Tally-NUM  
629                  FOR CHARACTERS BEFORE INITIAL X"0A"  
630                  ADD WS-Tally-NUM, 1 TO L-SCB-Offset-NUM  
631                  GOBACK  
632          END-IF  
633      END-PERFORM  
634      ELSE          *> There is (at least) one LF in the buffer  
635          MOVE 0 TO WS-Tally-NUM  
636          INSPECT L-Arg2-TXT(1:WS-Arg-Length-NUM)  
637              TALLYING WS-Tally-NUM  
638                  FOR CHARACTERS BEFORE INITIAL X"0A"  
639                  ADD WS-Tally-NUM, 1 TO L-SCB-Offset-NUM  
640                  IF WS-Tally-NUM > 1  
641                      IF L-Arg2-TXT(WS-Tally-NUM:1) = X"0D"  
642                          COMPUTE WS-Arg-Length-NUM =  
643                              WS-Arg-Length-NUM  
644                              - WS-Tally-NUM  
645                              + 1  
646                  ELSE  
647                      COMPUTE WS-Arg-Length-NUM =  
648                          WS-Arg-Length-NUM  
649                          - WS-Tally-NUM  
650                      ADD 1 TO WS-Tally-NUM  
651                  END-IF  
652                  MOVE SPACES  
653                      TO L-Arg2-TXT(WS-Tally-NUM:WS-Arg-Length-NUM)  
654              ELSE  
655                  MOVE SPACES  
656                  TO L-Arg2-TXT(1:WS-Arg-Length-NUM)  
657          END-IF  
658      END-IF  
659  .
```

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------|-----------------|--------------------------|------|------|------|------|------|------|----------|
| PROGRAM-ID                                                                                                                                                               | Identifier/Register/Function  | Defn | Where Defined   | References (* = Updated) |      |      |      |      |      |      | Page: 14 |
| STREAMIO                                                                                                                                                                 | 000-Main                      | 384  | PROCEDURE       |                          |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | 020-Validate-Handle-Zero      | 433  | PROCEDURE       | 393                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | 030-Validate-Handle-NonZero   | 439  | PROCEDURE       | 388                      | 396  | 399  | 402  | 407  | 412  |      |          |
| STREAMIO                                                                                                                                                                 | 040-Check-WRITE-SCB-Return-CD | 445  | PROCEDURE       | 425                      | 571  |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | 050-Check-READ-SCB-Return-CD  | 456  | PROCEDURE       | 583                      | 595  |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | 060-Identify-TEMP             | 467  | PROCEDURE       | 494                      | 509  |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | 099-ERROR-Return              | 479  | PROCEDURE       | 418                      | 429  | 436  | 442  | 448  | 452  | 459  | 490      |
|                                                                                                                                                                          |                               |      |                 | 536                      | 545  | 549  | 558  | 615  |      |      |          |
| STREAMIO                                                                                                                                                                 | 100-OPEN                      | 486  | PROCEDURE       | 394                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | 200-CLOSE                     | 554  | PROCEDURE       | 389                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | 300-WRITE                     | 563  | PROCEDURE       | 403                      | 408  | 413  |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | 400-READ                      | 574  | PROCEDURE       | 397                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | 500-READ-Delim                | 586  | PROCEDURE       | 400                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-Arg2-TXT                    | 381  | LINKAGE         | 383                      | 570* | 577* | 582* | 589* | 594* | 600  | 601*     |
|                                                                                                                                                                          |                               |      |                 | 641                      | 653* | 656* |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-DELIM-Unix-BOOL         | 380  | [STREAMIOcb ]   | 406                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-DELIM-Windows-BOOL      | 380  | [STREAMIOcb ]   | 411                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Delimiter-Mode-CD       | 380  | [STREAMIOcb ]   |                          |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Error-Routine-NUM       | 380  | [STREAMIOcb ]   | 480                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Error-Routine-PTR       | 380  | [STREAMIOcb ]   | 380                      | 481* |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Filename-TXT            | 380  | [STREAMIOcb ]   | 391*                     | 488  | 493  | 495* | 507* | 508  | 510  | 513      |
|                                                                                                                                                                          |                               |      |                 | 515*                     | 525* | 538* |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Func-CLOSE-BOOL         | 380  | [STREAMIOcb ]   | 387                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Func-DELETE-BOOL        | 380  | [STREAMIOcb ]   | 390                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Func-OPEN-BOOL          | 380  | [STREAMIOcb ]   | 392                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Func-READ-BOOL          | 380  | [STREAMIOcb ]   | 395                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Func-READ-Delim-BOOL    | 380  | [STREAMIOcb ]   | 398                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Func-WRITE-BOOL         | 380  | [STREAMIOcb ]   | 401                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Func-WRITE-Delim-BOOL   | 380  | [STREAMIOcb ]   | 404                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Function-CD             | 380  | [STREAMIOcb ]   |                          |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Handle-NUM              | 380  | [STREAMIOcb ]   | 420*                     | 434  | 440  | 542* | 555* | 561* | 566* | 578*     |
|                                                                                                                                                                          |                               |      |                 | 590*                     | 608* |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-MODE-Both-BOOL          | 380  | [STREAMIOcb ]   | 487                      | 532  |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Mode-CD                 | 380  | [STREAMIOcb ]   |                          |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-MODE-Input-BOOL         | 380  | [STREAMIOcb ]   | 487                      | 528  |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-MODE-Output-BOOL        | 380  | [STREAMIOcb ]   | 530                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Offset-NUM              | 380  | [STREAMIOcb ]   | 421*                     | 426* | 552* | 567* | 572* | 579* | 584* | 591*     |
|                                                                                                                                                                          |                               |      |                 | 603*                     | 609* | 624* | 630* | 639* |      |      |          |
| STREAMIO                                                                                                                                                                 | L-SCB-Return-CD               | 380  | [STREAMIOcb ]   | 385*                     | 417* | 428* | 435* | 441* | 447* | 451* | 454*     |
|                                                                                                                                                                          |                               |      |                 | 458*                     | 462* | 465* | 489* | 535* | 544* | 548* | 551*     |
|                                                                                                                                                                          |                               |      |                 | 557*                     | 560* | 604* | 614* |      |      |      |          |
| STREAMIO                                                                                                                                                                 | L-StreamIO-Control-Block-TXT  | 378  | LINKAGE         | 382                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | RANDOM                        | 498  | PROCEDURE       | 517                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | RETURN-CODE                   | 446  | PROCEDURE       | 450                      | 457  | 461  | 543  | 547  | 556  | 565  |          |
|                                                                                                                                                                          |                               |      |                 | 576                      | 588  | 613  | 617  |      |      |      |          |
| STREAMIO                                                                                                                                                                 | SECONDS-PAST-MIDNIGHT         | 498  | PROCEDURE       | 517                      |      |      |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | TRIM                          | 501  | PROCEDURE       | 519                      | 523  | 538* |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | WS-256-Byte-TXT               | 376  | WORKING-STORAGE | 511*                     | 513* | 523  |      |      |      |      |          |
| STREAMIO                                                                                                                                                                 | WS-8-Digit-NUM                | 375  | WORKING-STORAGE | 497*                     | 504  | 516* | 522  |      |      |      |          |
| STREAMIO                                                                                                                                                                 | WS-Access-Mode-CD             | 368  | WORKING-STORAGE | 529*                     | 531* | 533* | 539* |      |      |      |          |
| STREAMIO                                                                                                                                                                 | WS-Arg-Length-NUM             | 369  | WORKING-STORAGE | 409*                     | 414* | 422* | 426  | 565* | 568* | 572  | 576*     |
|                                                                                                                                                                          |                               |      |                 | 577                      | 580* | 584  | 588* | 589  | 592* | 597  | 600      |
|                                                                                                                                                                          |                               |      |                 | 601                      | 603  | 605* | 610* | 636  | 642* | 643  | 647*     |
|                                                                                                                                                                          |                               |      |                 | 648                      | 653  | 656  |      |      |      |      |          |

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|---------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------|-----------------|--------------------------|------|------------|------|------|-----|------|------|
| PROGRAM-ID                                                                                                                                                    | Identifier/Register/Function | Defn | Where Defined   | References (* = Updated) |      | Page: 15   |      |      |     |      |      |
| STREAMIO                                                                                                                                                      | WS-Buffer-TXT                | 370  | WORKING-STORAGE | 607*                     | 612* |            |      |      |     |      |      |
| STREAMIO                                                                                                                                                      | WS-Delim-Buffer-TXT          | 371  | WORKING-STORAGE | 410*                     | 415* | 424*       |      |      |     |      |      |
| STREAMIO                                                                                                                                                      | WS-Env-Temp-TXT              | 372  | WORKING-STORAGE | 468*                     | 470  | 472        | 475* | 501  | 519 |      |      |
| STREAMIO                                                                                                                                                      | WS-Slash-CHR                 | 373  | WORKING-STORAGE | 471*                     | 473* | 476*       | 502  | 520  |     |      |      |
| STREAMIO                                                                                                                                                      | WS-Tally-NUM                 | 374  | WORKING-STORAGE | 596*                     | 598* | 599        | 620* | 622* | 623 | 626* | 628* |
|                                                                                                                                                               |                              |      |                 | 630                      | 635* | 637*       | 639  | 640  | 641 | 644  | 649  |
|                                                                                                                                                               |                              |      |                 | 650*                     | 653  |            |      |      |     |      |      |

## 11. Glossary of Terms

There are many terms that are used throughout this document (as well as throughout ANY document dealing with the COBOL language) that are used to make discussions of syntax and semantics more concise. The following is a list of such terms and their definitions.

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Alphanumeric Literal</b>         | A string of characters enclosed within a pair of quotation marks ("") or apostrophes (''). See section <a href="#">1.8</a> .                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Collating Sequence</b>           | The sequence in which the characters that are acceptable to a computer are ordered for purposes of all types of sorting, merging, comparing, and processing. GNU COBOL programs may utilize standard character-set collating sequences (such as that defined by the ASCII or EBCDIC charactersets) or programmer-defined custom sequences as specified in the OBJECT-COMPUTER paragraph (section <a href="#">4.1.2</a> ) and defined in the SPECIAL-NAMES paragraph (section <a href="#">4.1.4</a> ).                                           |
| <b>Compilation Group</b>            | The collection of all compilation units being compiled by a single execution of the GNU COBOL compiler.                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Compilation Unit</b>             | A single source file being compiled by the GNU COBOL compiler. A compilation unit may contain one or more <a href="#">programs</a> .                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Division</b>                     | COBOL programs are broken into four major areas, called DIVISIONS. Divisions are used to collect program components oriented toward specific similar goals together in a single place. The COBOL divisions are:                                                                                                                                                                                                                                                                                                                                 |
|                                     | ▶ IDENTIFICATION DIVISION – names the program and, optionally, if it is a subprogram, defines its high-level data initialization policy and/or global availability to other programs compiled in the same compilation group.                                                                                                                                                                                                                                                                                                                    |
|                                     | ▶ ENVIRONMENT DIVISION – defines characteristics of the environment in which the program will be executed, such as files the program will be reading and/or writing, run-time switches that may be used to pass information into the program from the operating system environment and any special options that may be needed in order for the program to properly compile; typically, those special options are used to enable COBOL programs created using some other version of COBOL to be compiled and executed under a different version. |
|                                     | ▶ DATA DIVISION – provides detailed descriptions of the files, data and data structures the program will be working with.                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                                     | ▶ PROCEDURE DIVISION – contains the actual executable program code.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Dynamically-loadable library</b> | The GNU COBOL compiler can create dynamically-loadable library files when compiling <a href="#">subprograms</a> as their own separate <a href="#">compilation groups</a> . On UNIX systems, these will be ".so" files while on Windows systems these will be DLLs. <a href="#">Main programs</a> can be created in this manner also. The "-m" compiler switch is used to create dynamically-loadable libraries.                                                                                                                                 |
| <b>Dynamically-loadable module</b>  | A synonym for <a href="#">Dynamically-loadable library</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Elementary Item</b>              | A data item described as not being further logically subdivided.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Entry-point</b>                  | A spot in the PROCEDURE DIVISION where a program may begin execution when it is executed from the operating system, invoked as a user-defined function or <b>CALLED</b> by another program. Every program has at least one entry-point – known as the <i>primary entry-point</i> – which corresponds to the first executable <a href="#">statement</a> in the PROCEDURE DIVISION following the DECLARATIVES area, if any. Additional entry-points may be defined via the ENTRY statement (see section <a href="#">6.4.14</a> ).                 |
| <b>Entry-point name</b>             | Every <i>entry-point</i> has a name. That name must be unique for all <a href="#">programs</a> that comprise an executable program. Entry-point names are defined using a <a href="#">subroutine's</a> PROGRAM-ID clause (see section 3) or via ENTRY statements coded in the subroutine's PROCEDURE DIVISION (see section <a href="#">6.4.14</a> ).                                                                                                                                                                                            |

|                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Executable file</b>      | The GNU COBOL compiler can create operating-system appropriate files that may be executed directly from the operating system environment. On Windows systems, these will be ".exe" files whereas on UNIX systems they will have no specific extensions. The "-x" compiler switch is used to create executable files. Only <a href="#">main programs</a> should be compiled in this manner.                                                                                                                                                                                                                                                                                                                                        |
| <b>Figurative constants</b> | GNU COBOL, like other COBOL implementations, supports a number of reserved words that may be used to represent a specific <a href="#">literal</a> value. These are known as figurative constants. See section <a href="#">1.9</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Group item</b>           | A group item is an <a href="#">identifier</a> that is broken down into sub-items. For example, a MAILING-ADDRESS might be broken down into STREET-ADDRESS, APARTMENT-NUMBER, CITY, STATE and ZIP-CODE components.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Identifiers</b>          | These are data items a COBOL program will be working with. The vast majority of identifiers are defined by the user (programmer) while a few are pre-defined by the GNU COBOL compiler. Identifiers pre-defined by the compiler are referred to as <a href="#">registers</a> . Other programming languages generally refer to identifiers as "variables".                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Imperative statement</b> | <p>There are two types of GNU COBOL statements that meet this definition:</p> <ol style="list-style-type: none"> <li>1. A non-conditional GNU COBOL <a href="#">statement</a>; i.e. one that performs an unconditional action and lacks any decision-making capabilities (including <b>EXCEPTION</b>, <b>ON SIZE ERROR</b> and <b>AT END</b> clauses), or...</li> <li>2. A conditional GNU COBOL <a href="#">statement</a> properly terminated with the correct "END-xxxx" trailer.</li> </ol> <p>Any <b>PROCEDURE DIVISION</b> <a href="#">statement</a> can be made to be imperative– and therefore may be used in circumstances that only allow imperative <a href="#">statements</a> - under one or the other definition.</p> |
| <b>Intrinsic Function</b>   | <p>A built-in routine that accepts arguments and returns a value; syntactically, these may be used most places where GNU COBOL identifiers are valid.</p> <p>See section <a href="#">6.1.7</a> for documentation on all supported intrinsic functions.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Level number</b>         | <p>A user-defined word expressed as a 1- or 2-digit number that indicates the hierarchical position of a data item or the special properties of a data description entry.</p> <p>Level numbers in the range 1 through 49 indicate the position of a data item in the hierarchical structure of a logical <a href="#">record</a>. Level numbers in the range 1 through 9 can be written either as a single digit or as a zero followed by the significant digit.</p> <p>Level numbers 66, 77, 78 and 88 identify special properties of a data description entry.</p> <p>See sections <a href="#">5.3</a>, <a href="#">5.4</a>, <a href="#">5.5</a> and 0.</p>                                                                      |
| <b>Literal</b>              | A <a href="#">numeric literal</a> or an <a href="#">alphanumeric literal</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Main program</b>         | A GNU COBOL program that is to be executed directly from an operating system or shell event. Main programs are not executed from other programs unless such execution is accomplished via the <b>CALL "SYSTEM"</b> facility.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Numeric literal</b>      | A numeric constant. See section <a href="#">1.8</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Primary Entry-Point</b>  | See <a href="#">entry-point</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Procedure</b>            | All executable code <a href="#">statements</a> within a single PROCEDURE DIVISION paragraph or SECTION.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Procedure name</b>       | A programmer-defined SECTION or paragraph name in the PROCEDURE DIVISION assigned to a <a href="#">procedure</a> . Procedure names serve as a means by which a <a href="#">statement</a> may refer to the <a href="#">statements</a> that follow the procedure name.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Program</b>               | A GNU COBOL main program or subprogram. Subprogram programs may be nested inside of other programs and a main program may be followed by any number of subprogram programs in the same compilation group.                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Qualification</b>         | The process of establishing a unique reference to a data item whose name is duplicated in a program. This takes the form of using the duplicated data name and the name of any of its parent data items, connected by “OF” or “IN” such that the combination of those two data names is unique within the program.                                                                                                                                                                                                                                                           |
| <b>Record</b>                | The most-inclusive, highest level, data item. The <a href="#">level number</a> for a record is 01. A record can be either an <a href="#">elementary item</a> or a <a href="#">group item</a> .                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Registers</b>             | Special data items that are automatically defined for your use by the GNU COBOL compiler. See section <a href="#">6.1.8</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Reserved word</b>         | A COBOL word specified in the list of words that can be used in a COBOL source program, but that must not appear in the program as user-defined words or system names.                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Sentence</b>              | Any number of COBOL <a href="#">statements</a> , followed by a period.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Statement</b>             | A single COBOL instruction. Every statement starts with a <a href="#">verb</a> which defines the overall action the statement will take. Any additional syntax following the <a href="#">verb</a> refines the actions that will be taken.                                                                                                                                                                                                                                                                                                                                    |
| <b>Subprogram</b>            | A <a href="#">user-defined function</a> or a <a href="#">subroutine</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Subroutine</b>            | A program executed from another via a GNU COBOL “CALL” statement (or the equivalent in whatever programming language that other program was written in).                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>User-defined Function</b> | A user-written GNU COBOL subprogram that may be executed in a syntactically-similar manner to that by which the various built-in <a href="#">intrinsic functions</a> are executed.                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>User-defined names</b>    | Either the name of an <a href="#">identifier</a> or a <a href="#">procedure</a> in the program. GNU COBOL limits user-defined names to a maximum of 31 characters taken from the set of numeric digits, upper- and lower-case letters, hyphens and underscores. A user-defined name may neither begin nor end with a hyphen or underscore. User-defined names used as file names may additionally not begin with a digit although - unlike many other programming languages - user-defined names used as <a href="#">identifiers</a> or <a href="#">procedure</a> names may. |
| <b>Verb</b>                  | A single COBOL <a href="#">reserved-word</a> which defines an action a COBOL program will take at execution time. Every COBOL <a href="#">statement</a> begins with a verb. Some verbs perform relatively simple actions ( <b>MOVE</b> , <b>STOP</b> , <b>SET</b> , etc.) while others can perform extremely complex actions ( <b>SEARCH</b> , <b>SORT</b> , <b>MERGE</b> , <b>STRING</b> , <b>UNSTRING</b> , etc.).                                                                                                                                                         |



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