# SQL IQUERY SCRIPT

*The Modern SQL Language for IBM i*

First Ed. Jan 2023

# THINKING IN SQL

As IBM i developers we often tend to think of solutions by considering how we can solve a problem using RPG IV or CL. With SQL iQuery and even with RPG IV and embedded SQL we developers need to starting *Thinking in SQL*™

This means considering a data-centric approach to problem solving. Rather than treat the data as a repository that needs to be read and then processed, think of how to extract the results you need for your endgame. That is, *let the database query engine do the work for you*.

With few exceptions, legacy applications that only process data can be refactored/modernized so that they only use SQL and specifically, SQL iQuery Script. In addition, generating classic Reports for end-users can also be produced using SQL iQuery Script. In fact, iQuery Script is the only way I create reports for an end-user today. I haven't written an RPG print program for report purposes in 10 years.

**Scenario 1:**
The sales executive needs a report showing sales by region and summarized by sales representative within that region. Of course, they want an interactive (classic Inquiry) result as well as a print option to produce the report.

You start building an RPG IV with DDS for the Display file application. After a couple weeks you deliver the application to the end-user. They use it for a week or two and then state, "What I really want is this information in Excel, can you do that?"

**Scenario 2:**
The Purchasing department would like a consolidated report containing the sales for certain items across all distribution centers. This requires that you pull in data from remote IBM i partitions. So, you spend several weeks building CL programs to prompt them for the items and pull in the data from each remote partition/server, create RPG or perhaps OPNQRYF consolidation routines, and build a cool looking DDS-based PRTF Report for them.

After delivering this awesome solution, they ask if they can get it delivered via EMAIL and in Excel format.

## Scenario 3: Thinking in SQL

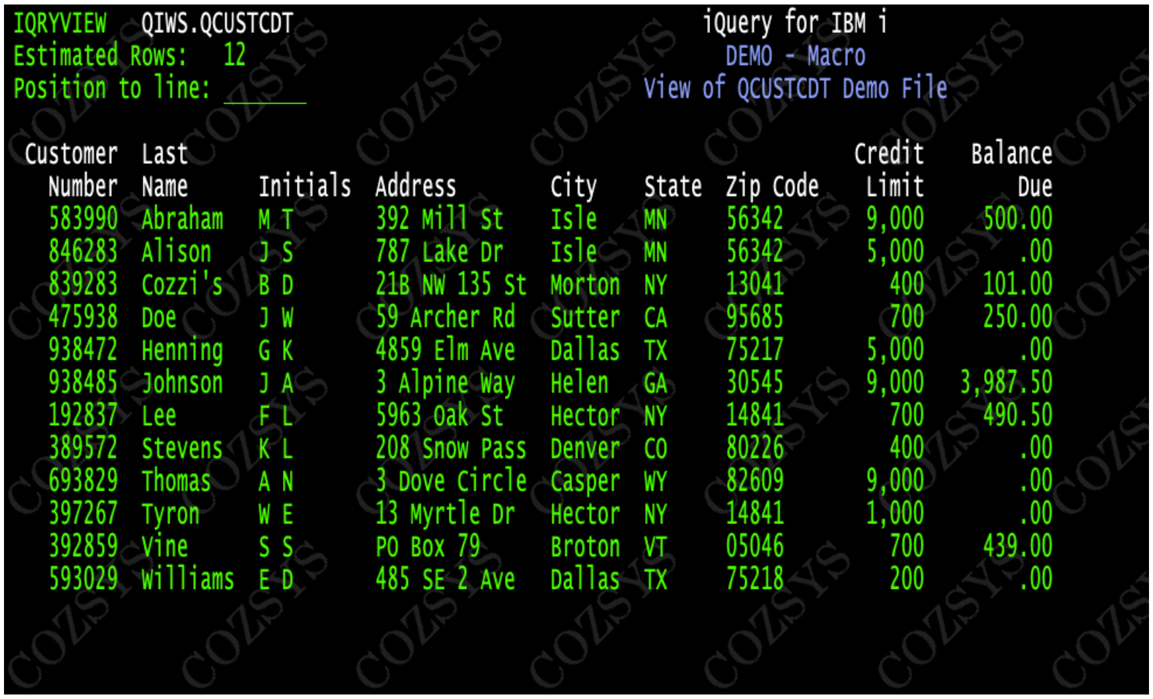
When an end-user has a request for an inquiry program or report, you should anticipate that the end-product requirements will evolve after they use it, or in some cases before you deliver it. If you start the design phase by thinking in SQL you end up with a flexible outcome that can easily adapt to a fluid situation.

For example, in scenario 1, above, if you created the report using SQL iQuery script, when the end-user changed the requirements to Excel output, you could have change the output parameter to OUTPUT(*EXCEL) or embedded it into the iQuery Script using the #DFTOUTPUT EXCEL directive.

# SQL IQUERY SCRIPT USERS GUIDE

This document describes the SQL iQuery Script syntax and development process. It does so from the perspective of an IBM i RPG IV programmer. The reader does not need to be an advanced RPG IV developer, but references to RPG IV are used for context throughout this document.

```
    RUNiQRY 'select * from qiws.qcustcdt'
```



```
IQRYVIEW   QIWS.QCUSTCDT                         iQuery for IBM i
Estimated Rows:    12                              DEMO - Macro
Position to line: _______                       View of QCUSTCDT Demo File

 Customer  Last                                                  Credit    Balance
   Number  Name      Initials  Address        City    State  Zip Code   Limit        Due
   583990  Abraham   M T       392 Mill St    Isle    MN     56342      9,000     500.00
   846283  Alison    J S       787 Lake Dr    Isle    MN     56342      5,000        .00
   839283  Cozzi's   B D       21B NW 135 St  Morton  NY     13041        400     101.00
   475938  Doe       J W       59 Archer Rd   Sutter  CA     95685        700     250.00
   938472  Henning   G K       4859 Elm Ave   Dallas  TX     75217      5,000        .00
   938485  Johnson   J A       3 Alpine Way   Helen   GA     30545      9,000   3,987.50
   192837  Lee       F L       5963 Oak St    Hector  NY     14841        700     490.50
   389572  Stevens   K L       208 Snow Pass  Denver  CO     80226        400        .00
   693829  Thomas    A N       3 Dove Circle  Casper  WY     82609      9,000        .00
   397267  Tyron     W E       13 Myrtle Dr   Hector  NY     14841      1,000        .00
   392859  Vine      S S       PO Box 79      Broton  VT     05046        700     439.00
   593029  Williams  E D       485 SE 2 Ave   Dallas  TX     75218        200        .00
```

**Resources**

SQL iQuery is available from www.SQLiQuery.com or it may be used at no charge on the PUB400.com portal on a current IBM Power server running the latest version of IBM i.

**Uses**

You can process SQL using SQL iQuery through any of the following methods:

- CL Command Entry
- CL Programs
- Source Members ("Scripts")
- Web (CGI interface)
- HLL using our proprietary APIs (rare)

In this book, I will focus on the first three uses and specifically the use of Source Members to create SQL iQuery Scripts. But let's review the first two (Command Entry and CL programs) before continuing.

***Running SQL from Command Entry***

SQL iQuery allows users to run SQL statements from the CL Command Entry screen. To do this the RUNiQRY (Run SQL using iQuery) CL command is provided. This command has all the options needed to process any SQL statement from command entry.

```
    RUNiQRY 'select * from qiws.qcustcdt'
```

In the above example, the SQL SELECT statement is used to query the QCUSTCDT file stored in the QIWS library. This happens to be a demo file shipped with the operating system, so querying it is probably allowed on your system. Note that SQL iQuery is not intended to be used to "compile" SQL/PL source to create SQL Procedures or Functions. You should continue to use the RUNSQLSTM or IBM ACS to create SQL Functions or Procedures.

The output from the above SELECT statement is, by default, routed to the screen. Most users today utilize IBM ACS for 5250 emulation but there are other emulators out there, such as the MochaSoft TN5250 which is widely used.

IBM ACS users typically have both *DS3 and *DS4 modes available to their 5250 sessions. For that reason, SQL iQuery checks the screen capabilities and if *DS4 is supported, the output will use the full 132 characters and 27 rows of the screen.

The advantage of using SQL iQuery over the native RUNSQLSTM CL command is that RUNiQRY supports the SELECT and WITH statements, it can process SQL scripts dynamically; it also directs the output of a SELECT to any of several IFS file formats in addition to standard display and print devices.

For example, using the OUTPUT parameter of the RUNiQRY CL command, you can direct the output to a variety of media format such as print, a data area, Excel, PDF, CSV, JSON, raw text, and more.

### *Running SQL within CL Programs*

SQL iQuery allows users to run SQL statements within CL programs. Again, the RUNiQRY CL command is used to provide this capability. The advantage of using SQL iQuery is that the CL Programmer can "see" the SQL statement that's being run. Alternatively, you can store SQL statements in source file members and run them using SQL iQuery:

```
RUNiQRY SQL('UPDATE QIWS.QCUSTCDT SET CDTLMT = 0 WHERE BALDUE > 0')
```

or

```
RUNiQRY SRCFILE(prodsrc/qsqlsrc) SRCMBR(UPDCSTBAL)
```

With SQL iQuery, CL Programmers can embed the SQL statement directly into the CL program. They can dynamically build the statement with embedded CL variables just like any other CL *CAT operation or specify the entire statement as a literal.

There are advantages, however, when using a Source File member to store the SQL statements you want to run in CL or elsewhere. Source file members can contain simple SQL statements or entire SQL iQuery Scripts. For general single-statement use, however, RUNiQRY gives you the advantage of being able to specify the SQL statement directly.

**Tip**: You can redirect the output of a single record SELECT statement to a data area using SQL iQuery's OUTPUT(*DTAARA) parameter and specifying the data area name on the OUTFILE parameter. This allows you to then pull in that information using the RTVDTAARA CL command.

## SQL Source File Members

As mentioned, SQL statements may be stored in standard source file members and run using the RUNiQRY CL command. We call those source members *SQL iQuery Scripts*. The SQL statements in a source member are run in sequence by the SQL iQuery Script processor. The final statement in the script, however, is passed back to the SQL iQuery engine for processing (i.e., it is returned to the RUNiQRY command for processing).

For example, suppose you have need to run an SQL DELETE or UPDATE statement and then you want a table to be queried with a SELECT statement show the results in an Excel file. You would use an SQL iQuery Script (i.e., source file member) to store and then run those statements.

```
01) DROP TABLE QTEMP.PGMREFS;
02) CL: DSPPGMREF PRODLIB/ORD* OUTPUT(QTEMP/PGMREFS);
03) SELECT WHPNAM,WHFNAM,WHLNAM,WHOTYP,WHFUSG
04)    FROM QTEMP.PGMREFS;
```

The DROP statement and the CL: directive (lines 1 and 2) are processed by SQL iQuery script. The final statement (lines 3 and 4) is passed back to and is processed by the RUNiQRY command as if it were coded as a literal on the RUNiQRY command itself:

```
RUNiQRY SQL( <the last statement> )
```

This last statement, therefore, benefits from the various options specified on the RUNiQRY CL command, such as OUTPUT, EMAIL, Titles, etc.

The only exception to this last statement rule is with nested scripts. In that context, all statements in a nested script source member are run by the SQL iQuery Script processor. Nested SQL iQuery Scripts use the #include directive to identify the external source member to be included in "this" script. More on this later when I cover nested scripts.

SQL iQuery Script is a great way to set up the data, the output media, email recipients, and other attributes.  Here is a simple example:

Source Mbr: MYSTUFF/QSQLSRC(DEMO)

```
01)#COLTOTALS 8, 9
02)#NUMEDIT 8, 9
03)#DFTOUTPUT *EXCEL
04)SELECT CUSNUM    as "Customer            Number",
05)       LSTNAM    as "Last                Name",
06)       INIT      as "Initials",
07)       STREET    as "Address",
08)       CITY      as "City",
09)       STATE     as "State",
10)       DIGITS(ZIPCOD) as "Zip Code",
11)       CDTLMT    as "Credit              Limit",
12)       BALDUE    as "Balance             Due"
13) from qiws.qcustcdt
14) order by lstnam;
```

The final statement is the SELECT statement (line 3). When that SELECT is run, it is passed back to the SQL iQuery processor and is run as if it were passed directly to the RUNiQRY command itself.

Lines 1, 2, and 3 are SQL iQuery Script directives. They cause attributes to be set and the output media to be selected.

Line 1 contains the #COLTOTALS directive. It identifies one or more columns that should be accumulated. This applies to output that is printed or sent to MS Excel. Either the relative column number (as shown in this example) or the actual column name may be specified. Multiple column IDs are separated by a comma. Today, SQL for IBM i supports OLAP functions which were not yet available when SQL iQuery was created, so we built #COLTOTALS into iQuery Script.  One advantage over OLAP is that when OUTPUT(*EXCEL) is used, it embeds the actual Excel sum() function into the sheet (Note: this applies to native iQuery Excel XLS output and is ignored by IBM ACS Excel output options.)

Line 2 contains the #NUMEDIT directive. It identifies one or more columns that should have basic numeric editing applied to them. By default, SQL iQuery avoids thousands notation for numeric output (that is the comma for most countries, and period for others). The #NUMEDIT directive applies a basic numeric edit to the data before it is written to the output media. For example, normally 1234.50 would be written, but when #NUMEDIT identifies that column, the value is written as 1,234.50 instead.

Line 3 contains the #DFTOUTPUT directive. It identifies the output media to be used by default. This means that if the RUNiQRY command is specified with no output parameter, or with the special value OUTPUT(*DFT), then this directive assigns OUTPUT(*EXCEL) as the output media. If, however, the OUTPUT parameter is specified with any value other than *N or *DFT, then #DFTOUTPUT is ignored. Note: There is also an #OUTPUT directive that forces the output media to whatever is specified on that directive, ignoring the RUNiQRY OUTPUT parameter entirely.

## *Source Members*

Source members are used for SQL iQuery Scripts which can contain any number or statements or "lines of code". Source members can be any length (width). SQL iQuery Scripts are not limited to 79 columns. Note that SEU has a hard limit of 240 bytes for source file record length.

When creating source files, I tend to create them with a 112-byte record length (100-byte source data) or max them out at the 240-byte SEU limit (228-byte source data) instead of the legacy 92-byte CRTSRCPF command default.

```
    CRTSRCPF FILE(MYSRC/QSQLSRC) RCDLEN(112)
```

SQL iQuery Script source members can be edited with any of the tools available today such as SEU, RDi, and Microsoft Visual Studio CODE using the *CODE for i* plug-in. Unlike SEU, the other editors do not have a line-length limitation. Also, if you set the SEU Type (source type) to SQL, RDi and VS CODE render the source code using SQL syntax highlighting.

***Column Headings***

A quick note on column headings of your output. There are four column (i.e., database field) labels or headings associated with each column. DDS COLHDG which contain three 20-byte column headings; DDS TEXT which contain a 50-byte text description, DDS ALIAS which contains up to 30-bytes of a "long" column name, and the actual column name itself. This can be assigned using SQL DDL as well.

Db2 for i SQL uses the IBM i DDS Column Headings. The COLHDG keyword in DDS is used to declare the column headings used by various tools such as Query/400, SQL iQuery, STRSQL, ACS RUNSQL, and QM Query. Using the SQL DDL *LABEL ON COLUMN* statement you can set the column heading text. In addition, when a SELECT statement is run, when you include a correlational name via the "AS" clause for a column, that correlational name is used as column heading.

Each of the 3-lines of column headings may be specified on the AS clause by spacing then out in 20-byte strings. For example, the Customer Number (CUSNUM) heading could be specified as:

```
LABEL ON COLUMN QIWS.QCUSTCDT (CUSNUM as 'Customer            Number');
```

In the IBM i DDS source code, this would be specified as:

```
A            CUSNUM         6S 0       COLHDG('Customer' 'Number')
```

In a dynamic SQL SELECT statement it would be specified as:

```
SELECT CUSNUM    as "Customer            Number", ...
```

Each of the 3 column heading lines occupies 20 bytes in the database object. Only 2 of the 3 headings are illustrated above. To specify headings using a runtime SQL SELECT statement, you specify a single string of up to 60 bytes, with each 20-bytes containing one of the three column heading components. However, unlike LABEL ON and the COLHDG keyword, in this context double-quotes are used instead of apostrophes. Here's a more complete SELECT statement that uses the AS clause to set the Column Headings:

```
   --                *........1........2........3........4
SELECT CUSNUM    as "Customer            Number",
       LSTNAM    as "Last                Name"
  FROM QIWS.QCUSTCDT ORDER BY CUSNUM;
```

SQL iQuery inserts the column headings into the result set for SELECT statements where possible. They are used for output to the screen/display, print, Excel, CSV and even JSON. Other SQL tools, such as the legacy STRSQL and IBM ACS RUNSQL Scripts (GUI) also use this information for column headings.

**SQL iQuery Scripting**

The demo source member illustrated earlier is a good example of a simple SQL iQuery Script.

SQL iQuery Script has a full set of conditional logic controls as well as being an SQL processor. That is, it has IF/ELSE/DO control statements that work similar to their corresponding RPG IV opcodes. In fact, iQuery Script logic controls are a sort of hybrid of RPG IV and SQL. That is in addition to traditional condition testing, SQL User Defined Functions (UDF) may be used on conditional statements. For example, you can code the following:

```
01)If EXISTS (Select * from QIWS.QCUSTCDT WHERE BALDUE > 0);
02)  Foreach select cusnum, lstnam, state, baldue
03)              INTO :custNo, :lastName, :State, :BalDue
04)           FROM QIWS.QCUSTCDT
05)           WHERE BALDUE > 0;
06)    If (&STATE = 'NY');
07)      #MSG Balance Due found for Customer &CUSTNO in New York
08)    elseif (&STATE = 'CA');
09)      #MSG Balance Due found for customer &CUSTNO in California
10)    else;
11)     #MSG Balance Due customer &CUSTNO found in &STATE
12)    endif;
13)   endFor;
14)Endif;
```

In this example, line 1 checks if any rows exist in the QCUSTCDT file that have a balance due. If so, it proceeds to the next statement (line 2) which has the FOREACH command. Otherwise, it jumps to the ENDIF statement on line 14. Obviously I could have avoided this "IF EXISTS" statement, but wanted to include it for illustration purposes.

The FOREACH opcode (lines 2 to 5) processes each row of the SQL SELECT statement using a *cursor*. It's all transparent to the programmer, making it easier to code.

Each row that's fetched is stored in the host variables specified on the INTO clause, just like RPG IV. You can use the standard SQL host variable prefix of the colon (as illustrated here) or the SQL iQuery Script variable prefix of the ampersand (similar to CL variables). Both work in this context. Outside of the INTO clause, the ampersand (&) symbol is required to identify variables. See *Session Variables* later in this section.

The #MSG directive on lines 7, 9 and 11 are SQL iQuery Script directives that write text directly to the joblog of the job running the script. If you were to run this script from the Command Entry display, the output would look similar to the following:

```
iQScript: COZTEST/QSQLSRC(CUSTBALDUE)
Balance Due found for Customer 839283 in New York
Balance Due customer 392859 found in VT
Balance Due customer 938485 found in GA
Balance Due found for customer 475938 in California
Balance Due found for Customer 192837 in New York
Balance Due customer 583990 found in MN
```

The first line is an iQuery Script-generated message that indicates the name of the source file and member being processed. This is logged whenever a SQL iQuery Script source member is loaded. It comes in handy when debugging scripts or checking joblogs.

The joblog output shown above is the result of the #MSG directives. In the SQL iQuery Script, everything to the right of the #MSG directive is written to the joblog as an INFO message. Note that #MSG, #SNDMSG and #JOBLOG are synonyms and may be used based on your preference.

SQL iQuery Script ignores upper/lower case that is not quoted. The names of Script commands, directives, opcodes, logic conditional statements along with variable names may be specified in upper/lower case, which is ignored.

## *Session Variables*

SQL iQuery Script supports fields or *variables* to store data similar to other languages. These variables are formally named *Session Variables.* Session Variable names may be up to 30 characters in length, must start with the Ampersand symbol (&) and be followed at least one alphabetic character. That is &A is valid, but &8 is invalid. Subsequent characters in the name may consist of A-Z, 0-1, and the underscore (_) symbol. The first character must be A-Z, the last character may not be an underscore.

The Session Variable naming rules are:

-  Upper/lower case is ignored.
-  They must begin with an Ampersand followed by at least 1 letter (A-Z).
-  Position 2 and beyond of the name may be A-Z, 0-9 or the underscore.
-  The final character of the name may not be an underscore.
    - OK: &HELLO_WORLD
    - **INVALID**: &HELLOWORD_

#DEFINE Directive

Session Variable are implicitly defined "on the fly" similar to how the JavaScript language declares variable. You may define them when you need them or in advance using the #DEFINE directive.

```
#define &varName 'value';
#define &var2 = 'Hello World'
#define &var3 = 12.59
&counter = 0;
```

The #define command declares the variable. The variable name may be followed by its initial value. If the variable already exists, its current value is replaced with the value specified on the #define command. An equals-sign is optional on the #define directive. The semicolon terminator is also optional. The following are all valid #define directives:

```
#define &ITEM_No1 12345
#define &ITEM_No2 = 12345
#define &ITEM_No3 '12345';
```

#DEFAULT Directive

The #DEFAULT directive is similar to #define with one important difference: If the session variable already exists, the #default statement is ignored. This is useful when passing in Session Variables on the SETVAR parameter of the RUNiQRY command, or when using nested SQL iQuery Scripts.

```
#define &CustNo = 5250;
#msg CustNo = &CUSTNO
#default &CUSTNO = 3741;  -- Ignored since &CUSTNO is already defined
#msg CustNo = &CUSTNO
```

The results of the above script produce the following messages in the joblog:

```
CustNo = 5250
CustNo = 5250
```

The #default directive checked to see if &CUSTNO existed. Since the #define was previously used to declare &CUSTNO, the #default directive does not assign its value to the session variable. The output messages show the &CUSTNO session variable is unchanged after the #default directive is processed.

The EVAL opcode may also be used to declare and assign a value to a Session Variable. If the value doesn't exist, it is automatically created.

```
EVAL &CUSTNO = 12345;
```

The above statement assigns the value 12345 to the &CUSTNO session variable. Beginning with SQL iQuery version 7, the EVAL opcode name is optional. The following is also a valid assignment statement:

```
&CUSTNO = 12345;
```

Note: unlike the #declare, #define, #default directives, the EVAL opcode requires an equals sign and terminating semicolon. This is because the EVAL opcode along with all SQL iQuery Script opcodes are multi-line enabled. A semicolon is used to terminate these opcode statements similar to how it is done in RPG IV free format.

There are two additional methods to define Session Variables and assign a value to them:

1. Specify the SETVAR parameter on the RUNiQRY command.
2. Target the Session Variable using the INTO clause of a SELECT or VALUES statement.

The SETVAR parameter is often used with the #default command. If a Session Variable name is not specified on the SETVAR parameter of RUNiQRY, a #default directive may be used to assign a value to that Session Variable. If a Session Variable name is specified on the SETVAR parameter, then its #default is ignored.

Session Variables may contain numeric or character data. They may also contain the contents of an IFS stream file. For example, you can read an entire IFS stream file into a single Session Variable using the GETFILE built-in function.

```
eval &notes = getFile('/home/corp/daily_msg.txt');
```

This loads the DAILY_MSG.TXT file's content into the &NOTES session variable. GETFILE() is very useful when using SQL iQuery email capabilities or when using SQL iQuery for Web. It not only reads the file, but it also merges any embedded SQL iQuery Session Variable names. That is, it converts embedded Session Variable names to their content during the load process.

While there is no practical limit to the size of the data stored in a Session Variable, internally each variable's memory management is limited to just under 2 gigabytes.

### *Predefined Session Variables*

The following predefined Session Variables are automatically created and assigned a value after each SQL statement is run within an SQL iQuery Script.

&SQLSTATE - Automatically set to the last SQL statement's SQL State. You may use this variable wherever you would normally use the SQL State host variable in RPG or other high-level languages.

&SQLCODE – Automatically set to the last SQL statement's SQL Code. You may use this variable wherever you would normally use the SQL State host variable in RPG or other high-level languages.

&SQLMSG - Automatically set to the last SQL statement's SQL message text (if any). Many SQL STATE codes do not have associated message text, so this Session Variable is often empty.

### *Undefining Session Variables*

To destroy an existing Session Variable, the #undef or #undefine directive may be used. This directive immediately removes the Session Variable from the internal storage collection, destroys its content and frees its memory.

```
#undef &VARNAME
```

In the above statement, the &VARNAME Session Variable is deleted from SQL iQuery Script storage. That session variable name no longer exists.

## Interpretive Language

SQL iQuery Script is an interpreted language. Each line of code is read, parsed, and processed dynamically at runtime, including all SQL statements. You may insert Session Variables into the script anywhere in a statement. The variable name is replaced with its content at runtime.

When used with directives or iQuery Script commands or conditional logic, you use the session variable name just like any other programming language. That is quoting a session variable name is very rarely required. Once except is when it contains an edited date value such as 2023-06-21. In that case you should quote the session variable on a conditional statement.

When a session variable is used within an SQL statement, consider whether the expansion of that variable into your content would cause a syntax error when unquoted vs quoted. Use that decision to determine if the value should be quoted. Consider the following:

```
01) #define &FOOD = 'SANDWICH'
02) #define &ORDER = 0;
03) #default &REGID = 'CHICAGO'
04)
05) Select ordid, product
06)        INTO &ORDER, &FOOD
07)     FROM &regid.prodData.OnlineOrders
08)     WHERE transID = &TRANSID
09)     LIMIT 1;
10)
11) IF (&FOOD = 'PIZZA');
12)    Update &regid.prodData.orders SET
13)                  ITEM = '12',
14)                  DESC = '&FOOD'
15)            WHERE ORDID = &ORDER;
16) endIf;
```

Note the use and the quoting of session variables in the above example. On line 6, the INTO clause is actually reading the data into the identified session variables so obviously quoting the session variable in this context is not permitted.

Lines 7 and line 12 use the &REGID variable as a qualifier for a 3-part object name. Again, in this context quoting is not permitted.

Line 14 on the other hand, contains character field name being updated with the content of the &FOOD session variable. Since &FOOD contains text data, it must be enclosed in quotes on line 14 or you would experience a runtime syntax error.

When a session variable contains numeric content and it is used in an SQL statement with a numeric column, it does not need to be quoted. For example.

```
#define &CUSTID = 5250
Select * from prodData.Sales
     WHERE custNo = &CustNo;
```

In the above example, the Session Variable &CUSTNO is expanded to 5250 so the WHERE clause looks like this at runtime:

```
WHERE custNo = 5250;
```

This is valid syntax, so the programmer avoids quoted the &CUSTNO variable in this context.

Using quoted session variable names on SQL iQuery Script conditional statements (IF/ELSEIF/FOR/WHILE) is supported, but normally unnecessary.

One great example where you wouldn't use the quotes in an SQL statement is when a part of that statement is extracted from a Session Variable. The 3-level database names or 3-tier names is a good example of that. While in SQL/PL and standard SQL on the IBM i platform, the database name must be hard coded into the SQL statement itself, SQL iQuery Script allows programmers to set that part of the statement as a Session Variable and have it resolved at runtime. For example:

```
#default &RMT = 'CHICAGO'
select * from &RMT.qiws.QCUSTCDT;
```

This would expand to:

```
select * from CHICAGO.qiws.QCUSTCDT;
```

In the above example, the session variable &RMT is used to identify the database (IBM i partition) to query. In this case, at runtime the content of &RMT is translated to CHICAGO and added to the SELECT statement shown above.

Most SQL iQuery Script Users utilize Session Variables on the WHERE clause of a SELECT statement. But they are not limited to the WHERE clause; they can be used anywhere in the SQL statement to embed portions of the statement at runtime. For example, the actual file name on a FROM clause may be passed to the statement within a Session Variable, similar to the following:

```
#define &filename = 'ORDHIST'
SELECT * FROM myData.&FileName order by ACCTNO;
```

At runtime, the SQL iQuery Script engine produces the following statement:

```
SELECT * FROM myData.ORDHIST order by ACCTNO;
```

This provides a much simpler way to build a statement dynamically.

As an interpreted language, each statement is expanded by translating each session variable name to its *value* at runtime. This allows programmers to build complex SQL statements that contain runtime components, without the challenges and ugliness of a lengthy and vexing concatenation statement.

In the context of Conditional statements, when the statement requires a quoted value, then at runtime, SQL iQuery Script will attempt to quote the session variable's content, otherwise it will appear as an unquoted value. Here are two examples:

```
01)#define &REGION = 'CHICAGO'
02)#define &CODE = 2
03)If (&REGION = 'PHOENIX');
04)IF (&CODE > 0);
```

Line 3 produces a quoted runtime result of: IF ('CHICAGO' = 'PHOENIX') while line 4 produces an unquoted result of: IF (2 > 0).

SQL iQuery Script is context-aware; in most situations it works the way you want it to work. But when in doubt, you can always quote the session variable name in a conditional statement, just to be sure. SQL iQuery Script will not quote a Session Variable that is already enclosing quotes.

# CONVERTING QM QUERY AND QUERY/400 QUERIES TO SQL IQUERY

If you have a library of Query/400 queries, you can use the IBM-supplied RTVQMQRY CL command to convert those existing queries to SQL statements. To do that, use the RUNQRMQRY with the name of the Query and the source member where the generated SQL statement should appear. For example:

```
RTVQMQRY QMQRY(BOBSLIB/MYREPORT) SRCFILE(BOBSRC/QSQLSRC) ALWQRYDFN(*YES)
```

This will produce a source member named MYREPORT that contains Query headers and an SQL SELECT statement that reproduces your results with some omissions.

```
01)H QM4 05 Q 01 E V W E R 01 03 23/01/05 07:56
02)V 1001 050 Customer Balance Due Report
03)V 5001 004 *HEX
04)SELECT
05)  ALL       CUSNUM, LSTNAM, INIT, STREET, CITY, STATE,
06)            ZIPCOD, CDTLMT, CHGCOD,
07)            (BALDUE), CDTDUE
08)  FROM      QIWS/QCUSTCDT T01
09)  WHERE     BALDUE > 0
```

SQL iQuery can directly read and process this source code, unchanged. It uses the embedded Report Title (line 2) and then processes the SQL SELECT statement on lines 4 to 8.

Note the unusual parens around the BALDUE column in the SELECT clause. This is an indication that some type of function was used on that column. You will need to go into the Query/400 environment and see what that function was because the RTVQMQRY command does not return it.

The only way to know what this parenthetical expression was, is to look at the printed query definition. Sadly, that means launching WKRQRY and issuing a Print Definition on the query itself.  Once you do that, scroll down to the Report column formatting and summary functions, and look for anything marked under the "Summary Functions" column:

```
1=SUM(), 2 = AVG(), 3=MIN(), 4=MAX(), and 5=COUNT()
```

In my example, the value is 1 next to the BALDUE column. Since this is not a summary report, that is each record is included where a balance due is greater than 0, I need to use the SQL iQuery #COLTOTALS directive instead of the SQL SUM function. I insert that directive into the source member as follows (line 4):

```
01) H QM4 05 Q 01 E V W E R 01 03 23/01/05 07:56
02) V 1001 050 Customer Balance Due Report
03) V 5001 004 *HEX
04) #COLTOTALS 10
05) SELECT
06)   ALL       CUSNUM, LSTNAM, INIT, STREET, CITY, STATE,
07)             ZIPCOD, CDTLMT, CHGCOD,
08)             (BALDUE), CDTDUE
09)   FROM      QIWS/QCUSTCDT T01
10)   WHERE     BALDUE > 0
```

Line 4, above, contains #COLTOTALS 10. This is an SQL iQuery Script directive or *command* that identifies the relative column number to be accumulated. The BALDUE and CRTDUE columns would appear in printed output with BALDUE column total shown below it; and excerpt of this output appears below:

```
 BALDUE    CDTDUE
 101.00       .00
 439.00       .00
3987.50    300.00
 250.00    100.00
 490.50  -1234.50
 500.00       .00
5768.00  ***
```

While #COLTOTALS supports both relative column number (10 in this example) as well as the column name (e.g. #COLTOTALS BALDUE) I prefer to use the relative column number since the name of columns is often obscured or lost while processing an SQL statement. For example, if BALDUE had something like a column heading on it, (i.e., the AS clause) then it is no longer known as BALDUE. Likewise, if you cast a column to another length or type, it loses its original name.

You quickly learn to replace the "V 1001" header lines generated by RTVQMQRY with the #Hx directives. For example, lines 1 and 3 are not important, but line 2 contains the "V 1001" value which is the Report Heading. In the above script, lines 1 and 2 can be deleted and line 3 can be replaced with the #H1 directive. That would mean the header is the only line needed, and is replaced with #H1 as follows:

```
#H1 Customer Balance Due Report
```

Now the SQL iQuery Script version of that Query/400 source looks like the following:

```
#H1 Customer Balance Due Report
#COLTOTALS 10
SELECT
         CUSNUM, LSTNAM, INIT, STREET, CITY, STATE,
         ZIPCOD, CDTLMT, CHGCOD,
         BALDUE, CDTDUE
  FROM   QIWS/QCUSTCDT T01
  WHERE  BALDUE > 0;
```

You'll note that I've removed the ALL clause from the SELECT as it is redundant and often confuses users, I've also removed the parens from around the BALDUE column. Lastly I've added a semi-colon to terminate the statement.

# SQL IQUERY SCRIPT

The basic SQL iQuery Script source member is structured with 1 to 3 sections. Advanced scripts have more sections, include other source members, and communicate with the Web Browser through the integrated CGI interface. But an SQL iQuery Script typically has either of the following two structures:

**Basic Script:**

> *SQL Statement 1;*
> *SQL Statement 2;*
> *SQL Statement 3;*

**Classic Script:**

> *Output Headers*
>
> *Declare Session Variables*
>
> *Conditional Logic*
>
> *SQL Statements...*
>
> *Final Statement*

The point of the above illustrations are to show that an SQL iQuery Script may contain just SQL statement(s) or it can be an entire application. You can even avoid doing any SQL statements entirely and instead, write stuff to the joblog, run CL commands, and retrieve system-related information (sysvals, serial number, etc.). For example, you may want to test a formula or a regular expression using SQL iQuery Script and write the results to the joblog for review.

Let's look at examples of each type of SQL iQuery Script.

**Basic iQuery Script**

If you have an elaborate SQL statement (perhaps one that spans many source lines) you may want to keep it in a source member so it can be easily run. This is the simplest form of an SQL iQuery Script. You simply store that SQL statement in the source member, and then when you need it, run it using RUNiQRY as follows:

```
RUNiQRY SRCFILE(mysrc/qSQLSRC) SRCMBR(CUSTLIST)
```

This runs the SQL statement(s) stored in the CUSTLIST source member. If you want to print the results instead of viewing them on the display, add the OUTPUT(*PRINT) parameter to the above RUNiQRY command.

## Classic Script

While an SQL iQuery Script can be a little as one line/one statement, most scripts have multiple lines of code, including #Hx directives, Session Variables, and conditional logic. All of that is normally followed by an SQL statement that produces the desired result. That final statement may be virtually any SQL statement, but it is typically the SELECT statement.

### *Output Headers*

SQL iQuery supports custom report headings. These can be thought of as Report Titles and may be specified using the #Hx directive or specified on one of the title parameters of the RUNiQRY command itself. I tend to use the #Hx directives exclusively.

```
#Hx <output title text char(50)>
```

Each #Hx directive may contain up to 50 characters of text. The text should not be quoted, but if it is, those quotes will appear in the heading result. Everything through the end of the line or the first 50 characters is used. #Hx statement do not need to be specified in sequence as the x in #Hx identifies the sequence of the heading line.

Here is an example:

```
01)#H1 Cozzi Productions, Inc.
02)#h2 New York Regional Report
03)#default &REGION 'NY'
04)Select * from qiws.qcustcdt WHERE STATE = '&REGION';
```

Lines 1 and 2 use the #Hx header commands to indicate the text that appears on lines 1 and 2 of the output. Headers are used for many output media types. The display/interactive output supports up to 3 header lines (i.e., #H1 #H2 and #H3) while other output types such as *PRINT, *PDF, *EXCEL also support a fourth header line (#H4) giving you extra headers when needed.

### *Declaring Session Variables*

Session Variables may be declared or deleted. There two directives that may be used to explicitly define a Session Variable and another that may be used to delete or "undefine" a session variable. In addition, Session Variables may be declared on the SETVAR parameter of the RUNiQRY command or implicitly defined using an EVAL opcode, a SELECT INTO or the VALUE INTO statements.

Session variables may be declared within the SQL iQuery Script or passed to the script via the SETVAR parameter of the RUNiQRY command. When passed in on SETVAR, a session variable has the same characteristics as using the #define directive in the SQL iQuery Script.

In SQL iQuery Script, the 3 directives that are used to declare or destroy a Session Variable are:

- #define – Define a Session Variable, optionally assign it a value.
- #default – If the Session Variable does not exist, define it and assign it a value.
- #undef – Undefine or *delete* a Session Variable from memory.

Note that when a session variable is passed to a script via the SETVAR parameter of the RUNiQRY command, if a #define directive is specified for the same variable name, the #define directive takes priority over the SETVAR and replaces that Session Variable. When you need the SETVAR value to be used when specified but still need a default for a Session Variable when it isn't passed via SETVAR, use the #default directive.

For more information see the table of Directives later in this document.

### *Conditional Logic*

SQL iQuery Scripts has a basic set of conditional logic opcodes. They allow you to control the flow of the script. Conditional statements may be nested and may control the execution of SQL statements, such as INSERT, UPDATE, SELECT, etc. Conditional statements must be terminated with a semicolon, similar to RPG IV.

As with most programming languages, conditional statements may span multiple source lines when necessary; the statement continues until a semicolon terminator character is detected.  Note that there are # directive versions of many of these opcodes. The #directive versions may be used to conditionally build SQL statements at runtime. More on this feature, later.

| **OpCode** | **Description** |
|---|---|
| IF &lt;condition&gt; | Standard conditional statement. Supports all SQL syntax that may appear on a standard SQL WHERE clause. For example:<br>IF (SUBSTR(&PRODUCT,3,4) = 'DEFG');<br>All conditional statements must be terminated with a semicolon. |
| IF EXISTS (select statement...); | The IF EXISTS *select-stmt* test can be used with a nested SELECT statement to determine if any rows exist before continuing.<br>IF EXISTS (SELECT ... );<br> -- conditioned code goes here<br>endif; |
| If EXIST &lt;object&gt; objtype; | The IF EXISTS library/object *objtype; test can be used to check if an IBM i object or member exists.<br>To check for object existance:<br>IF EXIST libname/objname *objtype;<br>To test if a member exists in a file:<br>IF EXIST srclib/srcfName(mbrName) *MBR; |
| ELSEIF | A combination of ELSE and IF. When the prior IF or ELSEIF condition is false, the next ELSEIF is tested. This continues until an ELSEIF condition is true or the corresponding ENDIF is encountered. |
| ELSE | When the above ELSEIF or IF (when no ELSEIF conditions are specified) fails, the one-and-only final ELSE statement receives control and any statements following it are performed until the corresponding ENDIF statement is encounter. |
| DO<br><br>FOR | Classic "for" loop that auto-increments a counter. It has syntax similar to RPG IV. The opcode is FOR or DO (either can be used).<br>FOR &i = 1 to 10;<br>  -- statements go here<br>endfor;<br>Users may use the DO opcode as a synonym the FOR opcode. |
| WHILE | Classic "do while" loop. Performs the code while the condition is met.<br>WHILE (&COUNT &lt; &LIMIT);<br> -- your while-loop code goes here<br>endwhile; |

| OpCode | Description |
|---|---|
| FOREACH<br>FOR EACH | Processes each resultSet row of an embedded SELECT statement, returning each row's data to the Session Variables on the INTO clause. Once EOF is reached, the FOREACH loop terminates and closes the SQL Cursor.<br>FOREACH select cusnum,baldue<br>       INTO :CustNo, :Due<br>      FROM QIWS.QCUSTCDT<br>       WHERE STATE = 'NY';<br>   If (&Due > 0);<br>    #MSG Customer &CUSTNO has a balance due of &Due<br> endIf;<br>endfor; |
| LEAVE<br>BREAK | The LEAVE or BREAK opcodes exit the current Loop (FOR, DO, FOREACH, WHILE) immediately and jump to the line after the corresponding ENDDO/ENDFOR/ENDWHILE statement. |
| ITER<br>ITERATE<br>CONTINUE | Logic is passed to the top of the current loop block. |
| END IF<br>END FOR<br>END DO<br>END WHILE | Each conditional statement must be closed with a corresponding ENDxxx statement. Note that the END opcode syntax is flexible in that it supports both the RPG IV style and SQL/PL style. That is, both of the following syntax formats are supported: END IF;  or  ENDIF; |

The IF statement supports the EXISTS extension, as mentioned. It allows the IF EXISTS opcode to be include an SQL select statement that returns true when records/rows are found that match the SELECT's WHERE clause or false when no records/rows are returned. The SELECT statement must be enclosed in parentheses.

```
    if exists (select * from qiws.qcustcdt where BALDUE > 0);
```

You may also specify it with the NOT operator:

```
    if NOT exists (select * from qiws.qcustcdt where BALDUE > 0);
```

In addition, IF EXISTS may be used to test for the existence of an IBM i object. To do that, simply specify the qualified object name followed by the IBM i object type. For example:

```
    if exists qiws.qcustcdt *file;
```

The IF NOT EXISTS may also be used, for example:

```
if NOT exists qiws/qcustcdt *file;
```

You can see from the previous example that either qualifier-symbol for object names may be used. That is both *lib/object* and *lib.object* are supported.

When a multi-member file is being checked, you can specify it as illustrated above, or you can include the member's name to verify that a specific member exists in the file. The member exists syntax is illustrated below on line 1:

```
01) IF NOT EXISTS devsrc/qsqlsrc(THX1138) *MBR;
02)      CL: addpfm devsrc/qsqlsrc MBR(THX1138) SRCTYPE(SQL);
03) endif;
```

I particularly enjoy using IF EXISTS to check the existence of data areas which I use as flow control or to enable features I've coded into the script itself. For example, I can test to see if the data area named IQDEBUG exists in QGPL, and then route the code path as desired.

```
If exists qgpl/IQDEBUG *DTAARA;
   #MSG Debug Mode Detected. Dumping Session Variables
   #dumpVars Dev Mode
endif;
```

In the above example, I check if the data area IQDEBUG exists in the QGPL library. If I omitted the library, *LIBL is used. If the data area exists, I write a message to the joblog and then dump out all existing Session Variable names and their contents. The #DUMPVARS directive writes the name and content of all session variables to the joblog.

***SQL Statements***

Intermixed with conditional logic or as stand-alone statements, virtually any SQL statement may be used within the SQL iQuery Script. This includes but is not limited to: SELECT INTO, VALUES INTO, INSERT, UPDATE, DELETE, DROP, CREATE, DECLARE GLOBAL TEMPORARY TABLE, MERGE and so on. The statements are processed by first translating any embedded Session Variables into their corresponding values, then they are sent to the SQL CLI engine for processing using native IBM i interfaces.

The only session variables that are not translated are those on the INTO clause of a SELECT or VALUES statement. Their value is assigned by the SQL statement itself.

***Blocked SQL Statements***

SQL iQuery provides a security mechanism to block certain SQL commands. This is accomplished by creating data areas in a library on the library list. If the specific data area exists, then that SQL statement is blocked for all users.

| Data Area | Blocked Statement |
|---|---|
| **IQ_UPDATE** | UPDATE |
| **IQ_INSERT** | INSERT |
| **IQ_DELETE** | DELETE |
| **IQ_MERGE** | MERGE |
| **IQ_MODIFY** | INSERT UPDATE DELETE MERGE |
| **IQ_DROP** | DROP |
| **IQ_WITH** | WITH (CTE statements) |

To create one or more of these data areas, insure that *PUBLIC cannot delete or rename the objects. Here is an example of the CRTDTAARA:

```
    CRTDTAARA DTAARA(QGPL/IQ_DROP) TYPE(*CHAR) AUT(*USE)
```

***Final Statement***

When the final statement in an SQL iQuery Script is any SQL statement, normally it is a SELECT or VALUES statement but can be any SQL statement, that statement is passed back to the RUNiQRY program for processing. That is, the SQL iQuery Script processor does not run that final statement, but instead, assembles it by embedded any Session Variables and processing any conditional statements. Then the statement is sent back to the RUNiQRY program. That final statement may not include an INTO clause.

**SQL iQuery Script Components**

SQL iQuery Script not only supports session variables, but it also supports:

- Figurative constants
- Directives
- Opcodes
- Built-in Functions

Each of these are explain in the following sections.

### *Figurative Constants*

As with any programming language SQL iQuery Script includes a set of predefined values, which we call Figurative Constants. There are a number of SQL iQuery figurative constants, including:

| Constant | Name | Description |
|---|---|---|
| *DATE | Current System Date | The current date in job date format. To alter the format of this result, use the CHGJOB DATFMT() command. |
| *TIME | Current Time | |
| *DAY | Current Day of the Week | The full day of the week name, e.g., Sunday, Monday, etc. |
| *SRCMBR | iQuery Script source member name | The name of the source member where the *SRCMBR appears. |
| *SYSNAME | The Partition ID *system name*. | The system name or partition ID. This is materialized using the MATMATR MI instruction, but is the same name returned by the RTVNETA CL command. |
| *SRLNBR | The Partition Serial Number | The IBM i Partition serial number. The MATMATR MI instruction is used to extract this data, however it is the same info returned by the QSRLNBR system value. |
| *USRPRF or *USER | User profile | The IBM i user profile of the user that launched the SQL iQuery Script. |
| *CURUSR | Current User profile | The current user profile under which the job is running |
| *GRPPRF | Group Profile | The Group User Profile under which the job is running. |
| *JOB_NAME | Qualified 3-part job name | The job identifier as a 3-part qualified job name. *nnnnnn/uuuuuuuuuu/jjjjjjjjjj* |
| *JOBNAME | The 10 character name component of the job name associated with the job running the SQL iQuery script. | The job name component of the job identifier. |
| *JOBUSER | The 10 character user profile associated with the job running the SQL iQuery script. | The user profile that started the job. |
| *JOBNBR | The 6-character job number associated with the job running the SQL iQuery script. | The, up to, 6-digit job number of the job. |
| *JOBDATE | The job date | The job date returned in CYYMMDD format. Note the job date is modified when the CHGJOB DATE(...) command is run. Otherwise, it remains unchanged regardless of the duration of the job. |
| *CCSID | Job CCSID | The job's CCSID under which the job is running. |

| Constant | Name | Description |
|---|---|---|
| *DFTCCSID | The Job's default CCSID | The default CCSID if the job is running under a "no CCSID" configuration. For example, the job's CCSID is 65535. |
| *SYSCCSID | The value of the QCCSID System value | The system value QCCSID value. |
| *HOMEDIR | User's home folder | The home directory associated with the user profile running the script. Note that simply because a User Profile contains a home directory value, there is no guarantee that the home director exists. |
| *PRODLIB | SQL iQuery installation Library name | The 10-character library name were SQL iQuery was installed. Normally this is IQUERY and cannot be changed. |
| *VxRyMz<br>*VxRy | | Flags that indicate if the currently running IBM i version is at least at the level specified. For example, if you are running V7R4, then *V7R1 *V7R2 *V7R3 and *V7R4 return true, but *V7R5 returns false.<br>e.g.,<br>if defined(*V7R3);<br>  ...<br>endif; |
| *WEBUSER | Remote User for CGI/Web Brower user. | When running SQL iQuery for Web, this constant is converted to the user profile who signed into the web browser through the secured interface (if any). |

These figurative constants may be specified anywhere a regular Session Variable is allowed; except they **may NOT be used as part of an SQL statement**.

If a figurative constant value needs to be used in an SQL statement, assign its value to a Session Variable, and then use that session variable in the SQL statement.

In the context of the *VxRy and *VxRyMz constants, when used on conditional statements, wrap them in the defined() or isDefined() built-in functions to provide a true/false conditional test. For example:

```
IF defined(*V7R4);
```

***SQL iQuery Script Directives***

There a several non-conditional, non-SQL operators which we call iQuery Script Directives. They have also been referred to as *hashtag directives* or *hashtag commands* by our users, so either term is acceptable. You've already read about #H1, #define and a few others. Directives occupy a single line of code, typically, and perform one task, such as assigning the output media, setting up the headings, or controlling certain attributes.

There are several directives, those related to programing SQL iQuery Scripts are included in the table below. There are many others that are covered in context as you progress through this document.

| Directive | Parameters | Description |
|---|---|---|
| #define | Variable name<br>Value | Declare a variable and assign a value to that variable.<br>#define &count 1<br>NOTE: #Declare may be used as a synonym of the #define directive. |
| #default | Variable name<br>Default value | If a variable does not exist, declare the variable, and assign it the specified *default* value. If it does exist, ignore the statement.<br>#define &limit 100 |
| #sysval | Variable name<br>System Value | Retrieve system value.<br>#sysval &DATFMT = QDATFMT<br>Note that the GETSYSVAL() built-in function was also introduced in iQuery V5 and may be used in place of the #sysval directive. |
| #Hx | Title text | Declare output title line.<br>#H1 to #H3 are supported by all output formats, #H4 to #H9 are also supported by Excel output. |
| #sndmsg | Message text | Send an INFO message to the joblog |
| #sndsts | Message text | Send a *STATUS message to the *EXT message queue. |
| #snddiag | Message text | Send a *DIAG message to the job’s message queue. |

| Directive | Parameters | Description |
|---|---|---|
| #dumpVars | Title | Writes the name of each Session Variable along with its contents to the joblog as an *INFO message. The optional title text may be specified to help indicate where the dumpvars statement occurred. Note the command has two spellings: #DUMPVAR or #DUMPVARS |

Directives have the following syntax:

```
    #XXXXXXXXXX  <value>
```

The *value* or parameters vary based on the Directive being used. For example: #H1 supports 1 parameter (the header text), while #default supports 2 parameters: the session variable name and its initial value.

In the rare case where you need more space for the value specified for a Directive, you may specify a trailing back slash symbol \ and the SQL iQuery Script processor continues the directive onto the next line, swallowing the backslash itself. The first non-blank character on the subsequent line is inserted where the backslash was located. For example:

```
    #msg Sometimes a message can exceed the length of the source line. \
    When it does, adding a backslash to the end will continue that \
    Statement onto the next line.
```

***SQL iQuery Script Built-in Functions***

There are a number of built-in functions available. These can be used on assignment or conditional statements. They help with typical programming tasks such as locating or transforming data in a variable or retrieving system information. Most are inline functions, but some perform runtime routines and return a value.

| Built-in | Description |
|---|---|
| sst( *value, start, len* ) | The classic Substring function. The SST function extracts a substring value and passes it to the resulting parser. If you use the native SQL SUBSTR function instead, then it itself is passed to the parser and not processed by SQL iQuery Script. |
| findfirstOf( *'character list', variable* )<br>firstOf<br>find_first_of | Returns the location of the first position in the 2nd parameter of any of the characters specified on the first parameter. e.g., &Pos = findFirstOf(', -:', &partNo); |

| Built-in | Description |
|---|---|
| findfirstNotOf(*'character list', variable* )<br>firstNotOf<br>find_first_not_of | Returns the location of the first position in the 2nd parameter that does not match at least one of the characters specified on the first parameter.<br>e.g. &start = findFirstNotOf(' *', &partNo); |
| getCookie( *'cookie name'* ) | Retrieve a Web/CGI Cookie of the name specified. The entire value of the cookie is retrieved. |
| getCWD()<br>getCurDir() | Retrieve the current directory for the job. The result is the IFS path that the job is using as the *current working directory*. |
| getHomeDir() | Retrieve the current user's home folder/directory. |
| trimRight( *'value', length or character* ) | Trims the value or Session Variable contents based on the 2nd parameter.<br>If parameter 2 contains one or more quoted characters, then those characters are removed from the right-end of the Session variable.<br>If parameter 2 contains a numeric value (length) the Session Variable content is truncated to that length.<br>If parameter 2 is not specified (omitted) then blanks are assumed and the Session Variable's content has any trailing blanks removed. |
| trimLeft( *'value', 'chacter(s)'* ) | Trim the leading (left side) characters (specified on the 2nd parameter) from the value specified on the first parameter. If only one parameter is specified, then blanks are removed. |
| usrspc( *qualified_user_space, start, length )* | Retrieve data from the qualified User Space (*USRSPC) name (first parm). The start positions (parameter 2) and optional length (parameter 3) may be specified to refine the location of the data be retrieved. If the start is omitted the entire user space content is retrieved. If the length is omitted, then the data returned is from the start location through the end of the user space.<br>The user space object name is specified as:<br>*library/userSpace* |
| getsysval(*'system value'*) | Retrieve System Value. The system value specified on the first parameter is returned. |
| getsrlnbr*()* | Retrieve the system serial number |
| getenv*('env variable')* | Retrieve a Job-level Environment Variable's value |
| getsysenv('*env variable'*) | Retrieve a System-level Environment Variable's value. |
| msgid*( msgid, msgfile, msgdata, 1 \| 2)* | Retrieve message text (MSGID) returns the 1st or 2nd-level message text for the specified MSGID. It inserts the message data (3rd parameter) into the result. If no message data is needed but the 2nd-level text is desired, pass a quoted string/blank for the 3rd parameter and 2 for the fourth parameter.<br>The message ID is a 7-position quoted message ID.<br>The message file (MSGFILE) parameter is a qualified or unqualified *MSGF object name, such as 'QSYS/QCPFMSG' or simply 'QCPFMSG'.<br>`&warning = msgid('CPF3741','qcpfmsg');` |

| **Built-in** | **Description** |
|---|---|
| getfile*('ifs stream file name')* | Read contents of IFS file, substituting any embedded Session Variables. The getfile() function reads an IFS file and scans it for any embedded Session Variables. If it detects any it replaces those session variable names with the content of the session variable. This is helpful for things like email/mail-merge applications or HTML loading where you want to populate the HTML "template" with certain data. |
| Fkey*( keyID )* | Checks the environment to see if the corresponding Fn key was pressed to return control to the Script. This is used by SQL iQuery Script Prompting only and does not function with other interfaces. |
| toAscii*( value )* | Converts the value from the job CCSID to CCSID 1208 and returns it to the target session variable. |
| toEBCDIC*( value )* | Converts the value from ASCII to the job's CCSID, such as 37 for North America. The conversion is based on the CCSID of the JOB when SQL iQuery was started. |
| dtaara( *qualified_data_area, start, length )* | Retrieve data from the qualified Data Area. The first parameter is the data area name (qualified or unqualified) followed by (2nd parameter) the starting position within the data area and the number of bytes to retrieve (3rd parameter).<br>If the start is omitted the entire data area is retrieved. If the length is omitted, then the data returned is from the start location through the end of the data area. |
| CompNoCase( *value1, value2* ) | Compares the two parameter values using case-insensitive logic. Returns true of a match is detected, otherwise it returns false. |
| scan( *pattern, searched-value* )<br>scani( *pattern, searched-value* )<br>find( *pattern, searched-value* )<br>findi( *pattern, searched-value* ) | The scan and find functions scan parameter 2 for the value specified on parameter 1 and return the location if found, or 0 if not found.<br>The SCANI and FINDI function do the same thing but using case-insensitive logic. |
| chkLiblE( '*library1 library 2...*', *1 \| 0*) | The CHKLIBLE function scans the library list of the job for the library/libraries specified and if found, returns a non-zero value.<br>When parameter 2 is specified as 1, (find all) and multiple library names are specified on parameter 1, then all of the library names must exist or 0 is returned. |
| strlen( *variable* ) | The STRLEN function returns the length of the content of the Session Variable specified as its one and only parameter. The content length omits trailing blanks on the right-side. |
| isDDE( *variable* ) | After a successful SELECT INTO, a host variable may have had a Decimal Data Error (DDE). Use ISDDE to check if that field received a DDE by the SQL engine. |
| isNULL( *variable* ) | After a successful SELECT INTO, a host variable may have been set to NULL by the SQL engine. Use ISNULL to determine if that host variable was set to NULL. |

| **Built-in** | **Description** |
|---|---|
| split( *variable, 'split-characters'* ) | The SPLIT function scans the value (1st parameter) for any of the split-characters (2nd parameter) and returns the data up to that point. It then reduces the value size by removing the retrieved content. A subsequent SPLIT to the same session variable will return the next value and so on. Use this function to spilt-apart or *parse* the contents of the variable that contains a delimited list of values.<br>Here's an example the splits up a 3-part job name:<br>`#define &userJob = *JOB_NAME;`<br>`while (strlen(&userJob) > 0);`<br>` &token = split(&userJob, '/');`<br>` #MSG &TOKEN`<br>`endwhile;`<br>`return;` |
| elems( *variable* ) | The ELEM or ELEMS function counts the number of array elements in a Session Variable Array (SVA). SVAs are created when a SELECT INTO results in multiple resultSet rows being returned at once. For example, if the FOR 5 ROWS ONLY or the LIMIT 5 is used, then the target host variables will receive up to 5 values from the resultSet. That causes each of the Session Variables of the INTO clause to be converted into Session Variable Arrays. The individual array elements may be accessed using standard C/C++ array syntax: &varArr[ *index* ] where *index* is a literal or another session variable. |
| toUpper( *variable* )<br>toLower( *variable* ) | The TOUPPER and TOLOWER functions returns the converted contents of the session variable (parameter 1) to all upper or all lower case. The input variable (parameter 1) is not altered by these functions.<br>e.g., IF (toLower(&part) = 'sdm'); |
| xLate( *'from-characters', 'to-characters', variable* ) | The XLATE function is similar to the RPGIV %XLATE built-in function; it translates each character of the session variable in parameter 3 by scanning parameter 3 for any of the list of characters specified on parameter 1, and converting them to the character in the corresponding position in parameter 2. |
| encodeXML( *variable* ) | The ENCODEXML function escapes each of the 5 XML reserved symbolic characters to the HTML escape pattern. For example, the & (ampersand) symbol is translated to &amp;<br>The 5 symbols required by XML to be escaped, include:<br>1. `& => &amp;`<br>2. `" => &quot;`<br>3. `' => &apos;`<br>4. `< => &lt;`<br>5. `> => &gt;` |
| encodeURL( *variable* ) | The ENCODEURL function escapes any symbol in the *variable* (parameter 1) that is required to be escaped. It escapes these characters by converting them to Hex and adding the percent sign (%) prefix. If a blank is encountered, it is converted to a plus sign. |

| **Built-in** | **Description** |
|---|---|
| editCode( *variable, edit-code* )<br>editC( *variable, edit-code* ) | The EDITCODE and EDITC functions edit a numeric value specified on the first parameter using the single-character edit code specified on the second parameter. For example:<br>`#define &Credit = -1024.25`<br>`Eval &eCredit = editc(&credit, 'J');`<br>`Results in &ECREDIT = '1,024.25-'` |
| editWord( *variable, edit-mask* )<br>editW( *variable, edit-mask* ) | The EDITWORD and EDITW functions edit the numeric value using the edit mask specified on the 2nd parameter.<br>`#define &SALES = 1200.50`<br>`&eSales = editw(&sales, '$ ,  0,    .  -');`<br>`Results in &ESALES = $1,200.50-` |
| isEmpty( *variable* )<br>isNotEmpty( *variable* ) | The ISEMPTY function returns true if the session variable specified on parameter 1 either does not exist or exists and contains no data or contains only blanks ("is empty").<br>The ISNOTEMPTY function returns true if the session variable exists and contains data. |
| isBatch() | Returns true if the SQL iQuery Script is being run as a batch job on the system. |
| isInter()<br>isInteract() | Returns true if the SQL iQuery Script is being run in an Interactive job. |
| isWeb() | Returns true if the SQL iQuery Script is being run as an HTTP job from a CGI call from a web browser or similar. |
| isBrowser() | Returns the HTTP User Agent that evoked the SQL iQuery script as a CGI job. The web browser information is returned. Use this function to copy that information into a session variable or to scan for specific browser Authors, such as WebKit, Microsoft, etc. |
| isNum( *variable* ) | Returns true if the session variable contains only numeric values, 0 to 9, the decimal notation, the status (i.e., the minus sign) and the *thousands* separator. |
| isDigits( *variable* ) | Returns true if the session variable contains all numeric digits 0 to 9 only. |
| isAlpha( *variable* ) | Returns true if the session variable contains only alphabetic characters: A-Z or a-z |
| isChar( *variable* ) | Returns true if the session variable contains any alphabetic characters, numbers (0 to 9) or blanks. If any symbols are detected, such as % # @, etc. it returns false. |
| isAlphaNum( *variable* ) | Returns true if the session variable contains any alphabetic characters or any digits (0 to 9) |
| toHex( *variable* ) | Returns the 2-character hexadecimal representation for each single character in the session variable (parameter 1). For example:<br>`Eval &hexVal = toHex('12345');`<br>`Results in &HEXVAL = 'F1F2F3F4F5'` |
| checkObjType( *variable* ) | Returns true if the IBM i object type in parameter 1 is a valid object type. It does this by attempting to convert the symbolic/external object type, such as *FILE or *PGM, to the internal MI object type. If that conversion fails, the object type is considered invalid and returns false. This provides the best support to future-proof your code. |

| Built-in | Description |
|---|---|
| chkObjExists( *object, object-type* ) | Returns true if the IBM i object (parameter 1) of the type specified on parameter 2 exists. For example, to check if the object QCUSTCDT exists use this statement: `IF chkObjExist('qiws/qcustcdt',*FILE);` To check to see if a specific source member in a file exists, use *MBR as the object type and enclose the member name in parens: `IF chkObjExist('coztools/qrpglesrc(cpytocsv)',*MBR);` |
| cpybytes( *target var, source var* ) | The CPYBYTES function copies the content of the source variable (parameter 2) to the target variable (parameter 1) directly. Normally a simple eval/assignment is used to copy session variables. However, when a complex session variable, such as an array or LOB (when it contains the content of an IFS file), then it is sometimes easier to use the CPYBYTES function to replicate the variable entirely. |

In addition to this list of built-in functions, all available scalar SQL built-in functions as well an any add-on scalar SQL functions may be used in SQL iQuery control statements. They may not be used on the EVAL assignment statement but may be used on VALUES INTO instead of the EVAL opcode.  For example, the licensed program named *SQL Tools* (2COZ-ST2) ships with an EOMDATE scalar function that returns the end of month date. It can be used directly on an IF statement, as follows:

```
01) IF (current_date = sqlTools.EOMdate());
02)   Include prodlib/qsqlsrc(monthEnd);
03) else;
04)   Include prodlib/qsqlsrc(daily);
05) endif;
```

Line 1 illustrates the scalar function EOMDATE (an *SQL Tools* function). If the current date is equal to the end-of-month date, then the MONTHEND SQL iQuery Script source member is included. If it isn't month-end, then the DAILY source member is included.

## SQL iQuery Script Commands

SQL iQuery Script support several commands or *opcodes* to perform various tasks. Commands are terminated with a semicolon and may span multiple lines.

| **Command** | **Description** |
|---|---|
| EVAL &var = *value or expression* | The EVAL opcode is the classic assignment statement in SQL iQuery Script. The left side of the equals sign is the target variable, while the right-side contains either another variable, a literal/string, or any mathematical expression such a &A * &B, or any SQL scalar function.<br>The EVAL opcode itself is optional as of SQL iQuery version 7.<br>In some conditions the SQL VALUES INTO statement may be better suited than the built-in EVAL opcode, but that's a decision for the specific circumstances. |
| return; | The RETURN opcode returns to the "caller". That is it ends the current SQL iQuery script and returns to the prior script (when using nested scripts) or returns to the RUNiQRY command processing program. Effectively ending the current script immediately. |
| ftp <ftp command> <parameters>; | The FTP opcode can be used to setup a list of objects/files to be sent via FTP and then send those objects. The maximum number of source lines generated to an FTP script cannot exceed 32760.<br>The parameters are standard FTP commands and their parameter values. For example, to create a directory on a target system, you might specify:<br>`FTP MK /home/query;`<br>To send a file:<br>`FTP CD /home/query;`<br>`FTP PUT /home/workfolder/mydata.txt;`<br>More on this topic is coming in a future document.<br>Then to run the script:<br>`FTP connect CHICAGO FTPUSER 'rosebud';`<br>`FTP RUN;`<br>More on this topic is coming in a future document update. |
| CONNECT to <rmt> user <user> using <pwd>; | The classic SQL CONNECT TO statement is integrated into iQuery script. Specify it as you would any other CONNECT TO. Note that to reset the connection you use CONNECT RESET; |
| savestmf <ifs file>, *variable*, ccsid; | Saves the session variable content to the IFS file. If the IFS file does not exist, it is created using the CCSID parameter's CCSID. If no CCSID parameter is specified it defaults to CCSID(1208). If the IFS file already exists, it is cleared, then the session variable's content replaces any existing data. Use the APPENDSTMF command to add data to an existing IFS file. |
| appendStmf <ifs file>, *variable*, ccsid; | Writes the content of the session variable to the end of an existing stream file. If the stream file does not exist, it is created. |
| writeStmf <ifs file>, *variable*, ccsid; | Writes the content of the session variable to the stream file. If the stream file exits, the data is added to the end of the file. If the file does not exist, it is created first, and then the data is written to it. |
| PRINT BEFORE( column, data...) | Write the data, starting in the column specified, above the output resultSet. Valid for print and Excel output only. |
| PRINT AFTER( column, data...) | Write the data, starting in the column specified, below the output resultSet. Valid for print and Excel output only. |

| Command | Description |
|---|---|
| Print BEFORE \| AFTER (*start-column, argument1, arg2...*); | The PRINT command may be used to write addition text information before or after the Result Set. It is often used to add additional information after the list of rows that a SELECT statement returns. Use the PRINT command followed by the AFTER() or the BEFORE() keyword. Then within the parens, specify the starting column in the result followed by the text to be added. Note that this was originally created for EXCEL-based output, but now also works with printed output. `PRINT after(3,'Confidential. Do not distribute');` This prints the text after the result set, starting in column 3 (column C in Excel). See PRINT Command elsewhere in the document for more information and additional examples. |

### *The PRINT Command*

The PRINT command provides supports to include additional text in the output. Originally written to provide a way to embed information after the resultset rows in EXCEL output, it was expanded to work with printed output as well.

**Syntax**:

```
PRINT after( <starting-column>, output-text,output-text2...);
```

The PRINT command supports the AFTER or BEFORE keywords. When BEFORE is used the text appears before (above) the result set, when AFTER is used, the text appears below (after) the result set.

Parameter 1 must contain a number greater than 0 that represents the starting EXCEL column into which the text specified on parameter 2 is written.

Parameter 2 and beyond contain quoted text strings that are written to the output starting at the column specified in parameter 1. Each time a parameter marker is encountered (parameter marker is a comma) the text in the next parameter is written out to the subsequent column. For example, below the works, RED, WHITE and BLUE are written to columns 3, 4 and 5 respectively:

```
PRINT AFTER(3,'RED','WHITE','BLUE');
```

In place of text parameters, you may also specify an EXCEL-based Style for the text. The STYLE keyword is used to accomplish this. For example. Suppose you wanted the output text to be BLUE instead of the default color. The STYLE keyword along with the Excel formatting code may be used as follows:

```
PRINT AFTER(3, style( color: blue), 'Hello World');
```

The *style* keyword accepts MS Excel style attributes using a format substantially similar to that of HTML CSS. That is the Attribute name followed by a colon followed by the attribute. Multiple attributes are separated from one another with a comma.

```
    PRINT AFTER(3, style( color:blue, rotate: 45,fontsize:18), 'Hello World');
```

It is up to the user to know the Excel styles and their syntax. Embedding an incorrect style or using the wrong style format will result in Excel issuing an error and potentially failing to open the Spreadsheet. Be sure to test the scripts before providing end-users with the results.

# CODING EXAMPLES

When creating an SQL iQuery Script, you frequently need to test the result of the prior SQL statement. SQL iQuery Script supports the &SQLSTATE session variable. It can be used to test the SQL state after each SQL statement. For example, if you wanted to extract the operating system's technology refresh level, you might query the GROUP_PTF_INFO View that is located in the QSYS2 library:

```
01)  -- Get IBM i Technology Refresh Level into &TR
02)SELECT  PTF_GROUP_LEVEL
03) INTO :TR
04)FROM QSYS2.GROUP_PTF_INFO
05) WHERE PTF_GROUP_DESCRIPTION = 'TECHNOLOGY REFRESH'
06)     AND PTF_GROUP_STATUS = 'INSTALLED'
07)ORDER BY PTF_GROUP_TARGET_RELEASE DESC,PTF_GROUP_LEVEL DESC
08)LIMIT 1;
09)
10)if (&SQLState >= '02000' or isEmpty(&TR));
11)  eval &TR = 0;
12)endif;
13)#msg TR Level &TR
```

The SQL SELECT statement that begins on line 2 and continues through 8 attempts to retrieve the IBM i operation system *technology refresh* level. On line 10, &SQLSTATE is checked for the infamous '02000' state. If &SQLSTATE is 02000 or higher, then the assumption is that no TR level was retrieved, and the &TR session variable is set to 0.

The next step in this script is to check that the OS release level and &TR level are at least at level 9 (for V7R3) or 3 (for V7R4) variable for something useful. In our case, we want to check the TR level of the system before attempt to include the PROTECTION_STATUS column from the SYSDISKSTAT View. IBM added PROTECTION_STATUS late in V7R4 and backported it to V7R3. To check that, an #IF statement directly inserted into the SELECT query and controls the inclusion of the PROTECTION_STATUS column, as follows:

```
14)SELECT ASP_NUMBER as   "ASP",
15)        UNITNBR    as   "Drive               Number",
16)        DISK_TYPE  as   "Disk                Unit Type",
17)        DISK_MODEL as   "Disk                Model",
18)        CASE WHEN UNIT_TYPE = 1 THEN 'SSD'
19)             WHEN UNIT_TYPE = 0 THEN 'HDD'
20)             ELSE '???' END
21)                   as   "Drive Type          HDD/SSD",
22)        UNITMCAP   as   "Drive               Capacity",
23)        UNITSPACE  as   "Drive               Free Space",
24)        PERCENTUSE as   "Percentage          Used",
25)
26)#IF defined(*V7R5) or \
27)    (defined(*V7R3) and &TR >= 9) or \
28)    (defined(*V7R4) and &TR >= 3)
29)        PROTECTION_STATUS
30)#else
31)        'Feature NOT Avail'
32)#endif
33)                   as   "Status",
34)        CASE WHEN MIRRORPS is NULL THEN 'NOT Mirrored'
35)             WHEN MIRRORPS = '0'   THEN 'Inactive'
36)             WHEN MIRRORPS = '1'   THEN 'Mirrored'
37)             END   as   "Mirrored",
38)        CASE WHEN MIRRORUS is NULL THEN ' '
39)             WHEN MIRRORUS = '1'   THEN 'Paired'
40)             WHEN MIRRORUS = '2'   THEN 'Syncing'
41)             WHEN MIRRORUS = '3'   THEN 'Suspended'
42)        END        AS   "Mirrored            Status"
43) FROM QSYS2.SYSDISKSTAT;
```

Line 13 begins the SELECT query of the SYSDISKSTAT View (see line 41). Then on line 25 the #IF statement is used to test for the IBM i operation system being on V7R3 TR9, V7R4 TR3 or V7R5 or later. If it is not, then a constant of "Feature Not Avail" is produced instead of the drive protection status.

Remember the # (pound sign, which has a contemporary nomenclature of *hashtag*) alters the IF condition so it can be directly embedded in an SQL statement. When and #IF statement is embedded like this, it is used to include or omit portions of the SQL statement. Without the hashtag prefix, the SQL iQuery Script processor would concatenate the IF statement with the SQL statement and produce a syntax error.

Let's look closer at that embedded #IF condition portion of the above script.

```
01)#IF defined(*V7R5) or \
02)    (defined(*V7R3) and &TR >= 9) or \
03)    (defined(*V7R4) and &TR >= 3)
04)        PROTECTION_STATUS
05)#else
06)        'Feature NOT Avail'
07)#endif
```

Line 1 uses the DEFINED() built-in function to check if the figurative constant *V7R5 is defined. If it is, then IBM i V7R5 or later is installed, and we're good. Note that since this condition need a bit more space, I've continued it to lines 2 and 3 using the trailing backslash, as mentioned earlier.

If *V7R5 is not defined, then it checks for *V7R3 at TR9 or later, or for *V7R4 and TR3 or later. If either condition is met, then the PROTECTION_STATUS column is included in the resultSet. If none of the conditions are met, then the literal 'Feature NOT Avail' is inserted instead of the PROTECTION_STATUS column.

**Note**: SQL Tools QDISK View and DISK_LIST Table function return the Protection_Status column starting with V7R2. They may be used as an alternative to the IBM-supplied SYSDISKSTAT View.

Before running the SQL SELECT statement that produces the DISK Drive Status Report, you may want to include header information and change some output attributes. To do that, we could add the following 4 lines of code to the previous SQL iQuery Script.

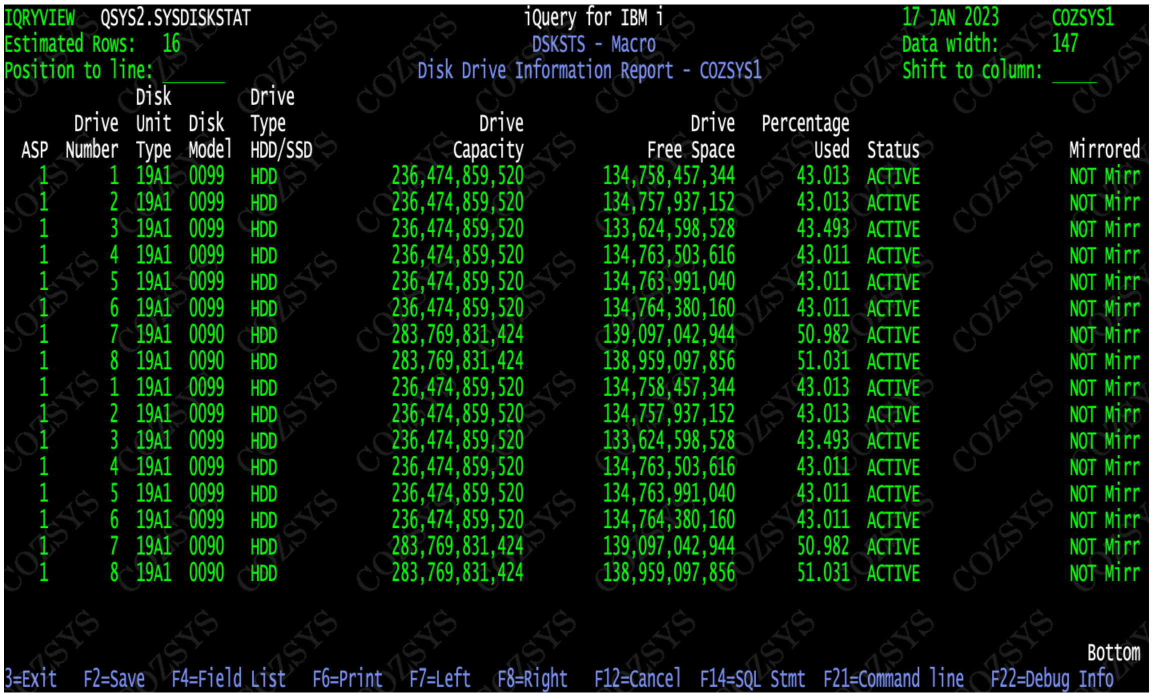
```
01)#H1 My Company Corp.
02)#H2 *MACRO - Script
03)#H3 Disk Drive Status Report
04)#colEdit  6,7
```

Lines 1, 2, and 3 add Report header lines to the output. Output formats that do not support headings will ignore the #Hx directives.

- #H1 is the company name – a convention most SQL iQuery Customers have adopted.
- #H2 contains the figurative constant *MACRO that inserts the Source File Member name into the heading.
- #H3 contains the report title.

Line 4 uses the #COLEDIT (edit numeric columns) directive to identify the columns that should have standardized numeric editing applied. In this example, the Disk Capacity and Space Available are identified as columns 6 and 7 respectively. You could have also used the column names, but that can be confusing since SQL will use the correlation name as the column name in most situations.

The results of this query would look something like the following:



```
IQRYVIEW   QSYS2.SYSDISKSTAT                    iQuery for IBM i                       17 JAN 2023      COZSYS1
Estimated Rows:   16                            DSKSTS - Macro                         Data width:      147
Position to line: ______                  Disk Drive Information Report - COZSYS1      Shift to column: ____
              Disk        Drive
        Drive Unit  Disk  Type                   Drive            Drive  Percentage
 ASP   Number Type  Model HDD/SSD              Capacity      Free Space       Used  Status             Mirrored
   1        1 19A1  0099  HDD           236,474,859,520 134,758,457,344     43.013  ACTIVE             NOT Mirr
   1        2 19A1  0099  HDD           236,474,859,520 134,757,937,152     43.013  ACTIVE             NOT Mirr
   1        3 19A1  0099  HDD           236,474,859,520 133,624,598,528     43.493  ACTIVE             NOT Mirr
   1        4 19A1  0099  HDD           236,474,859,520 134,763,503,616     43.011  ACTIVE             NOT Mirr
   1        5 19A1  0099  HDD           236,474,859,520 134,763,991,040     43.011  ACTIVE             NOT Mirr
   1        6 19A1  0099  HDD           236,474,859,520 134,764,380,160     43.011  ACTIVE             NOT Mirr
   1        7 19A1  0090  HDD           283,769,831,424 139,097,042,944     50.982  ACTIVE             NOT Mirr
   1        8 19A1  0090  HDD           283,769,831,424 138,959,097,856     51.031  ACTIVE             NOT Mirr
   1        1 19A1  0099  HDD           236,474,859,520 134,758,457,344     43.013  ACTIVE             NOT Mirr
   1        2 19A1  0099  HDD           236,474,859,520 134,757,937,152     43.013  ACTIVE             NOT Mirr
   1        3 19A1  0099  HDD           236,474,859,520 133,624,598,528     43.493  ACTIVE             NOT Mirr
   1        4 19A1  0099  HDD           236,474,859,520 134,763,503,616     43.011  ACTIVE             NOT Mirr
   1        5 19A1  0099  HDD           236,474,859,520 134,763,991,040     43.011  ACTIVE             NOT Mirr
   1        6 19A1  0099  HDD           236,474,859,520 134,764,380,160     43.011  ACTIVE             NOT Mirr
   1        7 19A1  0090  HDD           283,769,831,424 139,097,042,944     50.982  ACTIVE             NOT Mirr
   1        8 19A1  0090  HDD           283,769,831,424 138,959,097,856     51.031  ACTIVE             NOT Mirr

                                                                                                         Bottom
3=Exit   F2=Save   F4=Field List   F6=Print   F7=Left   F8=Right   F12=Cancel  F14=SQL Stmt  F21=Command line  F22=Debug Info
```