

spitbol – copyright notice

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*
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*
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spitbol – notes to implementors

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*
*   m a c r o   s p i t b o l       v e r s i o n   3 . 7
*   -----
*
*   date of release   -   16 april 2009
*
*   permission to use spitbol may be negotiated with
*   professor robert b. k. dewar.
*   sites which have obtained such permission may not pass
*   on copies of the spitbol system or parts of it except
*   by agreement with dewar.
*
*   version 3.7 was maintained by
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*
*   versions 2.6 through 3.4 were maintained by
*       dr. a. p. mccann
*       department of computer studies
*       university of leeds
*       leeds ls2 9jt
*       england.
*
*   from 1979 through early 1983 a number of fixes and
*   enhancements were made by steve duff and robert goldberg.
*
*   to assist implementors a revision history based on
*   version 2.7 is being maintained.
*
```

spitbol – revision history

```

*      r e v i s i o n   h i s t o r y
*      -----
*
*      version 3.6a to 3.7 (november 1, 1991, mark b. emmer)
*      -----
*
*      bugs fixed
*      -----
*
*      b3.701  add btkwv and refined test at cdgvl+9 to prevent
*              variable names alphabet, lcase, ucase from being
*              pre-evaluated because of their associated
*              constant keywords.  the code
*                  alphabet = "abc"; output = size(alphabet)
*              returned zero because of pre-evaluation.
*      b3.702  delay binding to function block of fourth
*              argument to trace function.  this permits the
*              trace function to be invoked before the 4th
*              argument function is defined.  accomplished by
*              storing a vrbk pointer in trfnc, and fetching
*              its vrfnc entry later, in trxeq.
*      b3.703  references to keywords with constant pattern
*              values (&arb, &bal, etc.) did not work.  a wtb
*              instruction had been omitted at acs14+2.
*      b3.704  if a program employed the code function to
*              redefine a label that was the entry location of
*              a user-defined function, the function would
*              continue to jump to its old function body.  pfcd
*              in pfblk was pointing directly to the target code
*              block, instead of doing so indirectly through the
*              vrbk for the entry label.
*      b3.705  the test that required a label to be defined
*              before it could be used as the entry of a user-
*              defined function has been removed.  functions
*              may be defined even if the label is yet
*              undefined.
*      b3.706  after a compilation error in the code function,
*              the eval function produces spurious errors.  the
*              code offset cwcof was not being reset to the
*              beginning of code block.  add line at err04+1 to
*              accomplish this reset.
*      b3.707  inconsistant tests with mxlen corrected.  several
*              places were testing with bge instead of bgt,
*              resulting in such anomalies as the statement
*                  &maxlngth = &maxlngth
*              failing.  since mxlen is guaranteed to be
*              strictly less than dnamb, it is permissible to
*              create objects of size mxlen.  bge changed to
*              bgt at locations
*                  s$arr+14, sar07+8, alobf+3, asg14+8, gtar6+10.
*      b3.708  exit(command string) was not loading ptr to fcb
*              chain into wb.  corrected at sext1.

```

* b3.709 change patst to return non-string error for null
 * argument. previously, break(), any(), etc., were
 * succeeding, contrary to the language definition.
 * b3.710 convert function with null second argument
 * crashed system by calling flstg with wa=0. added
 * test at s\$cnv, moved error 74 to separate erb at
 * scv29.
 * b3.711 leq(,) crashed system. lcomp did not obey
 * minimal assumption that cmc opcode will always
 * be called with wa .gt. 0. added test at lcmp1.
 * b3.712 modified line at sdf07+4 to use register wa
 * instead of wb. this corrects problem of define
 * function with local variable list that begins
 * with comma- define("f(x),l1,l2")
 * b3.713 erroneous plc on uninitialised r\$cim in listr.
 * b3.714 erroneous call to flstg possible with null string
 * at sdat1.
 * b3.715 when copy function used with table argument, fix
 * problem at cop07. when copying first teblk on a
 * chain, the pseudo-previous block pointer in xr
 * is pushed on the stack prior to calling alloc.
 * this is not a valid block pointer, as it points
 * within the tbbk. if the subsequent alloc
 * invokes gbcol, the heap becomes scrambled.
 * recoded to save pointer to start of block, plus
 * offset in wb.
 * b3.716 at iop01, if gtvar triggered garbage collection
 * via alast, trap block in wc was not collected.
 * save wc on stack to make it collectable across
 * gtvar call.
 * b3.717 at asg10, allow case of variable with more than
 * one trblk, as happens with the following stmt -
 * output(.output, .output, filename).
 * b3.718 at senf1, trblk chain search was reloading chain
 * head, causing infinite loop if the desired trblk
 * was not the first on chain. system crashed with
 * trace(.v1) output(.v2,.v1,file).
 * b3.719 prototype strings (define, load, data, etc.) were
 * allowing blank characters, producing bogus
 * variable names.
 * b3.720 the fact that ioxcb destroyed register wc was not
 * documented. b\$efc conversion of file argument
 * never worked because wc and xt were destroyed by
 * call to ioxcb.
 * b3.721 ioput left a trblk attached to filearg1 if sysio
 * failed. subsequent use of this filearg1 variable
 * in another i/o call would crash system.
 * b3.722 add chk at evlp1 to catch recursive pattern error.
 * b3.723 allow -line to work properly within code function
 * by setting cmpln directly in cnc44. if file name
 * absent, decrement scnpt to rescan terminator.
 * b3.724 when mxlen exceeds start of dynamic memory, round
 * it up to multiple of word size prior to storing

* in dnamb at ini06.

* b3.725 provide right padding of zero characters to any

* string returned by an external function.

* b3.726 reset flptr at bpf17 for undefined function

* when evalx is evaluating an expression.

* b3.727 modify code after read5 for outer nesting of

* an execute-time compile of -include statement.

* create a substring of remainder of original

* code function argument string and return as

* result of readr function

* b3.728 the definition of the aov opcode is corrected.

* formerly the definition specified that the branch

* was to be taken if the result of the addition

* exceeded cfp\$m, implying a test for overflow

* from signed addition.

* however, address arithmetic must be unsigned to

* allow for systems where the high order address

* bit is set. therefore, the test must be for

* carry out of the high order bit, if the result

* would exceed cfp\$l.

* b3.729 a label trace on the entry label for a function

* was undetected, resulting in a transfer to

* b\$trt and subsequent crash. see bpf08 for fix.

* b3.730 pop first argument to substr if it is a buffer.

* b3.731 pattern replacement with buffer subject returned

* null string instead of new subject value.

* changed to behave as if subject was a string.

* b3.732 if convert function was called with a buffer

* first argument and "buffer" second argument,

* it would convert the buffer to a string, and

* then back to a buffer. this has be corrected

* to simply return the first argument as the

* function result.

* b3.733 detect external function returning a null string

* unconverted result at bef12, and jump to exnul.

* b3.734 fix problem at ins04 when inserting zero length

* string into buffer. defend against invoking

* mvc with a zero value in wa, which will cause

* some implementations to wrap the counter.

* b3.735 add overflow test for cos and sin to detect

* out-of-range argument.

* b3.736 fixed problem introduced with b3.727 not

* restoring r\$cim, scnpt and scnll after creating

* substring.

* b3.737 fixed tfind to place default value in newly

* allocated teblk.

* b3.738 added bl\$p0 to p\$nth entry point. the expression

* datatype(convert("", "pattern")) would crash when

* the dtype function uses the non-existent type

* word preceding p\$nth.

* b3.739 bug at gtn35 in the case of overflow during cvm.

* wb can be destroyed by cvm on some platforms.

* b3.740 protect scontinue from usage in other than error

```

*          320 case.
*
* b3.741 protect continue from usage following error
*          evaluating complex failure goto.
*
*
* changes
* -----
*
* c3.701 add .culk conditional to include &lcase, &ucase.
* c3.702 add -line nn "filename" control card.
* c3.703 move .cnld conditional up in routine dffnc to
*          omit all tests for b$efc.
* c3.704 add conditional .cicc to ignore unrecognized
*          control cards.
* c3.705 add conditional .cnsc to omit string to numeric
*          conversion in sort. the presence of this
*          conversion mode produces a sort result that is
*          dependent upon the order of input data.
*          for example, given input data "2", 5, "10",
*          string comparison yields "10" lt "2", but string
*          to integer conversion yields "2" lt 5 lt "10".
* c3.706 add seventh return from syshs that allows callee
*          to return a string pointer and length. this is
*          done to eliminate the need for the caller to have
*          an scblk big enough to accommodate long strings.
* c3.707 add eighth return from syshs to force copy of
*          block pointed to by xr.
* c3.708 made -copy a synonym for -include.
* c3.709 add conditional .cbyt for statistics displayed
*          in bytes rather than words.
* c3.710 dump null valued variables when dump = 3. core
*          dump produced for dump = 4.
* c3.711 restrict minimum value to which keyword maxlngh
*          can be set to 1,024 via new variable mnlcn.
* c3.712 add conditional symbol .cmth for extended math
*          functions- atan, chop, cos, exp, ln, sin, sqrt,
*          tan. x**y and remdr(x,y) are extended to include
*          reals.
* c3.713 add bit to syspp to set -print upon entry
* c3.714 add conditional .csfn to track source file name
*          associated with each code block.
* c3.715 add conditional .cinc for -include control card
*          feature. the format of the card is
*          -include "filename"
*          include control cards may be used during both the
*          initial compile and execute-time compile. the
*          filename is saved in a table, and redundant
*          includes of that file are ignored.
* c3.716 add conditional .csln to include source line
*          number in code blocks. release current ccblk
*          after initial compile.
* c3.717 changed rilen to 258 (from 120) to provide
*          uniform input line length when reading from

```



```

*          terminal or input.
*
* c3.718  add additional exit to iofcb to distinguish
*          argument not convertible to string and argument
*          file not open.
*
* c3.719  add fourth and fifth arguments to host function.
*
* c3.720  add &compare keyword to control string
*          comparisons.
*
* c3.721  setup pfdmp at iniy0 in case osint forced
*          &profile non-zero.
*
* c3.722  add conditional symbol .caex to include up arrow
*          as synonym for exponentiation.
*
* c3.723  add conditional .ccmc and external function syscm
*          to provide string comparison using collation
*          sequence other than strict ordering of character
*          codes (international compares).
*
* c3.724  add conditional .cpol and external function syspl
*          to provide interactive control of spitbol
*          execution.
*
* c3.725  add conditional symbol .cera and external
*          function sysea to provide advice of compilation
*          and runtime errors to osint.
*
* c3.726  add cmpln, rdcln, rdnlm to track source line
*          number.
*
* c3.727  converted error messages to upper/lower case.
*
* c3.728  add conditional .cgbc to external routine sysgc.
*          called at the start and end of garbage collection
*          to perform any needed notification to operating
*          system or user.
*
* c3.729  modified last line of s$set from exnul to exint
*          so seek can return final file position after
*          seek.
*
* c3.730  place mov xr,(xs) at s$rmnd+4 to allow real second
*          arg to remdr.
*
* c3.731  remove redundant bge xr,=cfp$u,scn07 at scn06+4
*
* c3.732  change definition of cmc and trc such that only
*          xl must be cleared after operation. note, this
*          change was subsequently voided. cmc and trc must
*          clear both xl and xr, because utility routines
*          may preserve xl or xr on the stack, and the stack
*          is collectable by gbcol.
*
* c3.733  remove most branches to exits and exixr.
*          instead, jump directly to next code word.
*
* c3.734  add error 260 for array too large in gtarr.
*
* c3.735  add conditional .cs32 to initialize stlim to
*          2147483647.
*
* c3.736  add second argument to exit function, allowing
*          user to specify file name of load module being
*          written. if omitted, osint will provide a
*          default name.
*
* c3.737  add conditional .cspr to include spare locations
*          in working area. these may be used in later bug
*          fixes without changing the size of the working
*          storage and obsoleting modules created by exit().

```

```

*      subsuently removed in c3.767.
*
* c3.738 add r$cts to remember last string used to build
*        bit column in patst.
*
* c3.739 change flstg to type e procedure instead of r.
*
* c3.740 standardize on big-endian systems.  at the
*        implementors choice, the zgb opcode can also
*        perform a byte swap if necessary to achieve big-
*        endian byte ordering.  this is done so that
*        systems with similar word lengths will produce
*        the same hash code for strings, and hence the
*        same ordering for table entries.  the hashes
*        procedure has an additional zgb added to reorder
*        the length word.
*
* c3.741 add conditional .csou to cause assignments to
*        output and terminal variables to be processed
*        through calls to sysou rather than through
*        listing buffer.  done to eliminate short record
*        lengths enforced by buffer size.  a code of 0 or
*        1 is passed to sysou instead of an fcblk.
*
* c3.742 increased iniln, inils, rilen to 1024.
*
* c3.743 add bit to syspp to set noerrors mode.
*
* c3.744 add .ccmk conditional to include keyword compare
*        even if syscm is not being included.  done to
*        provide identical data regions in systems that
*        implement syscm and those which do not, so that
*        save files can be exchanged in the next release.
*
* c3.745 add wc return parameter to sysil to allow
*        interface to inform spitbol if file about to be
*        read is a binary file.  if so, no blank trimming
*        occurs.
*
* c3.746 fold load function argument types to upper case.
*
* c3.747 add .cexp conditional to have sysex pop its
*        arguments.
*
* c3.748 in stopr, do not attempt to display file name and
*        line number if stopping because of stack overflow
*        during garbage collection.  pointers to file name
*        table and code block are wrong.
*
* c3.749 add bit to syspp to set case folding mode.
*
* c3.750 add additional return from sysld if insufficient
*        memory to load/call external function.
*
* c3.751 add additional returns from sysex if insufficient
*        memory or bad argument type.
*
* c3.752 ignore leading and trailing blanks in arguments
*        within prototype strings to clear, data, define
*        and load.
*
* c3.753 test for fatal error at err04 and abort if so.
*        force termination on stack overflow by setting
*        errft to 4 in stack overflow section.
*
* c3.754 recode copy loop at srt14 to exchange usage of
*        registers xl and xr.  this permits use of the
*        mvw order instead of the explicit loop coding
*        previously employed.
*
* c3.755 add .ceng conditional to include routines needed

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*      by text processing engine. add routines enevs and
*      engts for use by engine or debugger. copy xr to
*      xl around call to syspl to allow syspl to
*      trigger garbage collection.
*      c3.756 add &file, &lastfile, &line, &lastline keywords.
*      for now, line and lastline are maintained in the
*      same manner as stno and lastno, which adds over-
*      head to the statement initialization code. a
*      possible change is to create a stmln procedure
*      that maps statement numbers to line numbers.
*      one simple strategy would be to sweep code blocks
*      in memory looking for the statement number and
*      extracting the line number from that code block.
*      such a procedure would also allow line numbers
*      (and file names) to be added to statement profile
*      reports.
*      c3.757 change sort to fail instead of producing error
*      message if argument table is null. change sorta
*      to return failure. add another return to gtarr
*      to distinguish null table from bad argument.
*      c3.758 create procedure prtmm to display memory usage
*      statistics, and call it when producing end-of-
*      run stats.
*      c3.759 add label scontinue to allow setexit to resume
*      execution exactly where it was interrupted.
*      c3.760 add snobol4 backspace function and conditional
*      .cbasp.
*      c3.761 add additional arguments to sysgc to assist
*      virtual memory managers.
*      c3.762 the method of converting a table to an array has
*      been revised. previously, table elements were
*      copied to the result array in the order they were
*      encountered along the various hash chains. this
*      appeared to the user as a random ordering. how-
*      ever, spitbol/370 as well as sil snobol4 ordered
*      array elements according to their time of entry
*      into the table. user programs that relied upon
*      this behavior malfunctioned when ported to macro
*      spitbol.
*      to remedy this, the conversion is performed in
*      three steps:
*      1. convert table to an array placing the address
*         of each teblk in the array instead of the key
*         and value.
*      2. sort the array of addresses. this orders ele-
*         ments by time of creation (ascending address).
*      3. scan the array, replacing addresses with the
*         key and value from the referenced teblk.
*      the affected portions of the program are at s$cnv
*      and in gtarr, which now accepts an additional
*      argument specifying whether to place key/values
*      in the array or teblk addresses.
*      c3.763 if case-folding is active, fold the function name

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```

*           provided to the load() function before passing it
*           to sysld.
*
* c3.764 add sediment algorithm to garbage collector,
*           conditioned on .csed.
*
* c3.765 add optimization to discard null statements and
*           statements which just have a constant subject
*           (see code at cmp12).
*
* c3.766 rearranged order of initial objects in static
*           memory so that hash table is the last of the four
*           object created by initialization code.  this is
*           done so that the print buffer, gts work area, and
*           &alphabet keywords do not need to be saved in
*           any save file created by osint.  added routine to
*           initialize these structures.
*
* c3.767 removed .cspr conditional and spare locations.
*
* c3.768 added .crel conditional and extensive routines
*           (reloc et. al.) to perform relocation of data
*           in working section, static region, and dynamic
*           region after reload of a saved memory image.
*           routines relaj, relcr, and reloc are invoked
*           by osint after reloading a save file.
*           it is now possible to reload such an image even
*           if the spitbol compiler and its data structures
*           are reloaded to other addresses.  the working
*           section has been extensively rearranged to
*           accommodate the reloc procedure.
*
* c3.769 zero r$ccb (interim ccblk ptr) in collect,
*           convert, eval, and exit functions to release
*           unneeded ccblk memory.
*
* c3.770 add exit(4) and exit(-4) to allow execution to
*           continue after writing save file or load module.
*           revised sysxi interface to detect continuation
*           after performance of exit(4) or exit(-4) action.
*
* c3.771 change filnm to preserve registers.
*
* c3.772 addition of .cncr and syscr (real to string
*           system routine option).
*
* c3.773 modified replace function to optimize usage
*           when second argument is &alphabet.  in this case,
*           the third argument can be used as the translate
*           table directly.
*
* c3.774 modified conditionals for buffers and reals so
*           that their respective block codes are always
*           present, even if these data types are conditioned
*           out.  this provides consistent block code
*           numbering for external functions.
*
* c3.775 modified alobf to test string length against
*           kvmxl instead of mxlen.  also, alobf was testing
*           total size of bfblk, instead of just string len.
*
* c3.776 move utility routines source up to lie between
*           predefined snobol functions (s$xxx) routines and
*           utility procedures.  this was done to assist
*           translation on platforms such as apple macintosh
*           that use 15-bit offsets to store error exits (ppm

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*      branches).  offsets to labels like exfal were
*      just too far away.  similarly, functions tfind,
*      tmake, and vmake are located out of alphabetic
*      order to satisfy the macintosh's limited range
*      for subroutine calls.  move built-in labels
*      beyond the block and pattern routines to get it
*      within 32k of the error routines.
*      c3.777  at scn46, allow colon, right paren and right
*      bracket to terminate = operator with default
*      null operand.
*      c3.778  added .ctet conditional for table entry trace.
*      c3.779  introduce cfp$l, the largest unsigned value
*      that may be stored in a one-word integer.  this
*      is done to accommodate machines where memory
*      addresses have the high-order address bit set.
*      c3.780  perform replace in place if first arg is buffer.
*      c3.781  perform reverse in place if first arg is buffer.
*      c3.782  change sysou to accept buffer as well as string
*      to be output.  change code at asg11 to prevent
*      conversion of buffer to string.
*      c3.783  optimize pos and rpos when it is the first node
*      of a pattern and has either an integer or simple
*      expression variable argument.  if unanchored mode
*      and the cursor is zero, it is advanced directly
*      to the desired cursor position.
*      c3.784  perform trim function in place if arg is buffer.
*      c3.785  add gtstb procedure to get a string or buffer
*      argument for replace, reverse, size, trim, etc.
*      c3.786  change leq, lgt, etc. to perform comparisons
*      without converting buffer arguments to strings.
*      this is done by changing lcomp to accept buffer
*      argument(s).  this also affects sort function,
*      which will compare two buffers as strings.
*      c3.787  change gtnum to use characters in buffer without
*      conversion to a string.  this implies that acomp
*      will perform arithmetic comparisons of buffers
*      without converting to strings first.
*      c3.788  perform comparisons of strings and buffers in
*      sortc.
*      c3.789  change insbf to allow insertion of a buffer into
*      a buffer without first converting it to a string.
*      note that this only works when the two buffers
*      are not the same.
*      c3.790  documentation change:  note that all of the block
*      move opcodes should have wa .gt. 0.  not all
*      implementations avoid moving objects when wa is
*      zero.
*      c3.791  change ident to provide buffer/buffer and
*      buffer/string comparisons, to accommodate users
*      who perform ident(buf) to check for null string
*      in buffer.
*      c3.792  added fullscan keyword initialized to one.  user
*      may set to any non-zero value, will receive an

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*          error message if attempts to set to zero, since
*          quickscan mode is not supported.
* c3.793  rewrote statement startup code at stmgo to only
*          perform checking of profiling, stcount tracing,
*          and statement counting if necessary.
* c3.794  add additional exit to sysfc and ioput to signal
*          that i/o channel (fcbk) is already in use.
*          added error message numbers 289 and 290.
* c3.795  added optional integer argument to date function
*          to specify format of date string returned by
*          sysdt.

```

version 3.6 to 3.6a (oct 83)

changes

```

* c3.617  add .cnlf. if defined, then arguments to external
*          functions may be declared to have type file.
*          such arguments must have been used as second
*          arg to input() or output() and a pointer to the
*          fcb is passed to the external function.

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version 3.5 to 3.6 (jun 83)

```

*          codes used to identify authors are (sgd) for duff,
*          (reg) for goldberg, and (lds) for shields.

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bugs fixed

```

* b3.601  (sgd) to fix multiple trap block problem in assign
* b3.602  (sgd) patch in gtarr to fix null convert.
* b3.603  (sgd) inserted missing wtb after sysmm calls.
* b3.604  (sgd) use string length in hashes.
* b3.605  (sgd) fixed serious parser problem
*          relating to (x y) on line being viewed as pattern
*          match. fixed by addition of new cmtyp value
*          c$cnf (concatenation - not pattern match).
* b3.606  (sgd) fixed exit(n) respecification code
*          to properly observe header semantics on return.
* b3.607  (sgd) bypass prtpg call at initialization
*          following compilation if no output generated.
*          this prevents output files consisting of the
*          headers and a few blank lines when there is no
*          source listing and no compilation stats.
*          also fix timsx initialization in same code.
* b3.608  (sgd) b$efc code did not check for
*          unconverted result returning null string.
* b3.609  (sgd) load pfvbl field in retn for

```

```

*           return tracing. this was causing bug on return
*           traces that tried to access the variable name.
*   b3.610   (sgd) fixed problem relating to compilation of
*           goto fields containing small integers
*           (in const sec).
*   b3.611   (reg) prevent clear() from clobbering protected
*           variables at label sclr5.
*   b3.612   (reg) fixed gtexp from accepting trailing
*           semicolon or colon. this is not a legal way
*           to end an expression.
*   b3.613   (reg) fixed difficulties with listings during
*           execution when no listing generated during
*           compilation. -list to code() caused bomb.
*           fix is to reset r$ttl and r$stl to nulls not 0
*           after compilation.
*           (listr and listt expect nulls)
*           when listing and statistics routed to different
*           file than execution output, error message is sent
*           to execution output (and gets separated from
*           ... in statement ... msg). labo1 calls sysax and
*           stopr does not call sysax if entered from labo1.
*   b3.614   (lds) fix misuse of wc just after asg10.
*   b3.615   (lds) add comment pointing out suspicious code
*           after tfn02
*   b3.616   (lds) fix inconsistent declaration of sorth.
*   b3.617   (lds) insert missing conditional tests on cnbf.
*   b3.618   (lds) fix some violations of minimal language
*           that had slipped past some translators.
*   b3.619   (lds) correct error introduced in fixing b3.614.

```

```

*      changes
*      -----
*
*
*      c3.601  (sgd) addition of .cnci and sysci (int to string
*              system routine option)
*      c3.602  (reg) changed iniln and inils to 258
*      c3.603  (sgd) merged in profiler patches, repaired code.
*      c3.604  (sgd) added buffer type and symbol cnbf
*      c3.605  (sgd) added char function.  char(n) returns nth
*              character of host machine character set.
*      c3.606  (reg) added cfp$u to ease translation on smaller
*              systems - conditional .cucf
*      c3.607  (reg) added lower case support, conditional .culc
*      c3.608  (reg) added set i/o function, conditional .cust
*      c3.609  (reg) conditionalized page eject after call to
*              sysbx and added another before call to sysbx,
*              so that, if desired by the implementor,
*              standard output will reflect assignments made
*              by executing program only.
*              conditional .cuej controls - if defined then
*              eject is before call to sysbx.
*      c3.610  (lds) introduce .ctmd to support system that
*              reports elapsed time in deciseconds instead of
*              milliseconds.
*      c3.611  (lds) provide place for .def or .und for each
*              conditional option, so that settings can be
*              changed without changing line numbers.
*              current settings are for 808x translation.
*      c3.612  (lds) obey (new) restriction that operand in
*              conditional branch instruction cannot have form
*              (x)+ in order to simplify translations for which
*              postincrement not readily available.
*      c3.613  (reg,lds) add op
*              flc wreg
*              that folds character in wreg to upper case.
*              this op is used only if .culc is defined.
*              this change also involves addition of keyword
*              &case which when nonzero (the initial setting)
*              causes the case folding just described to be
*              done.
*      c3.614  (lds) add option .cs16 to permit initialization
*              of statement limit values to 32767 for 16 bit
*              machines.
*      c3.615  (lds) permit return point and entry point
*              addresses to be distinguished by their parity
*              instead of by lying within a certain range
*              of values.  introduce conditional symbols
*              .crpp return points have odd parity
*              .cepp entry points have odd parity
*      c3.616  (lds) introduce new minimal opcodes to branch
*              according to parity,
*              bev opn,plbl branch if address even

```



```
*      bod  opn,plbl  branch if address odd
*      an address is even if it is a multiple of cfp$b.
```

```
*      documentation revisions
*      -----
*
*      d3.601  (lds) bring minimal machine description up to
*              date
*
```

```

*      version 3.4 to 3.5 (feb 79)
*      -----
*
*
*      bugs fixed
*      -----
*
*      b3.401 prtst should be declared as an r type procedure.
*      b3.402 timing error if spitbol fails in dump.
*      b3.403 error in handling omitted args of operators.
*      b3.404 too many lines put on first page of listing.
*      b3.405 leading unary operator in eval erroneously needed
*      preceding blank.
*      b3.406 identifying name in dump of array or table values
*      was omitted.
*      b3.407 eval unable to return a deferred expression.
*      b3.408 illegal if setexit code branches to return.
*      b3.409 illegal on detaching input, output, terminal.
*
*      changes
*      -----
*
*      c3.401 -sequ and -nose control cards removed.
*      c3.402 option provided to suppress system identification
*      on listing.
*      c3.403 description of sysbx slightly revised.
*      c3.404 permissible to modify scblk length before taking
*      error returns from sysin, sysrd, sysri.
*      c3.405 conditional .cnld may be defined to omit load().
*      c3.406 conditional .cnex may be defined to omit exit().
*      c3.407 table now accepts a third argument specifying
*      default initial lookup value.
*      c3.408 routines sort, rsort for sorting arrays and table
*      introduced. specification is as in sitbol.
*      routines may be omitted by defining .cnsr .
*      c3.409 error in code(), eval() call now causes statement
*      failure but errtext keyword is still set.
*      c3.410 arg to code() may contain embedded control cards
*      and comment delimited by a semicolon.
*
*      documentation revisions
*      -----
*
*      d3.401 purpose of restriction 2 in minimal section -6-
*      (operations on char values), erroneously stated
*      to be for cmc, rather than for ceq, cne.
*      descriptions of above opcodes revised.
*      d3.402 description of ent clarified.
*      d3.403 descriptions of several opcodes revised to remove
*      technically invalid literals e.g. =0 , *1.
*      d3.405 restricted use of letter z in minimal clarified.
*      d3.406 divide by zero explicitly mentioned in relation
*      to overflow setting.

```

```

*      version 3.3 to 3.4 (oct 78)
*      -----
*
*      bugs fixed
*      -----
*
*      b3.301  illegal for erroneous eval() arg.
*      b3.302  address arithmetic overflow in alloc and alocs.
*      b3.303  -eject and -space ignored -nolist option.
*      b3.304  erroneous argument scan in load().
*      b3.305  erroneous plc on uninitialised r$cim in nexts.
*      b3.306  ldi used instead of mti after prv07.
*      b3.307  misuse of rmi at erra2.
*      b3.308  misuse of mti in hashs.
*      b3.309  bug in -sequ card sequence number checking.
*      b3.310  stack overflow error message not always printed.
*      b3.311  corrupt prototype print for traced arrays.
*      b3.312  pattern first arg in dupl caused error.
*      b3.313  omitted csc in s$rpd, erroneous csc in convert.
*      b3.314  misplaced btw in exbld.
*      b3.315  incorrect code in hashs.
*      b3.316  failure of load to scan integer arg.
*      b3.317  table access with negative integer arg. failed.
*      b3.318  error in returning result of loaded function.
*      b3.319  =e$srs used after ini01 instead of *e$srs.
*      b3.320  err used instead of erb after systu
*      b3.321  label could start with disallowed character.
*      b3.322  continue after setexit had bad heuristic.

```

```

*
*
*   changes
*   -----
*
*   c3.301 sysax and .csax introduced - see sysax
*           in procedures section.
*   c3.302 variable mxlen introduced. contains the maximum
*           size of a spitbol object and is not changeable
*           after initialisation. may be defaulted or set
*           explicitly by sysmx.
*   c3.303 syshs returns revised - see syshs.
*   c3.304 new minimal opcode aov to fix b3.302.
*   c3.305 inhibit stlimit check if stlimit made negative.
*   c3.306 cfp$m is required to be of form 2**n - 1.
*   c3.307 dupl made to conform to sil snobol4 standard.
*   c3.308 lch and sch actions more closely defined.
*   c3.309 batch initialisation code omitted if conditional
*           assembly symbol .cnbt (no batch) defined.
*   c3.310 (wa) contains argument count in sysex call.
*   c3.311 sysfc may request allocation of static fcblk.
*   c3.312 if ia,wc overlap, restriction put on dumping/
*           restoring these registers.
*   c3.313 new listing option intermediate between compact
*           and extended provided (see syspp).
*   c3.314 revision of sysxi interface to permit options for
*           load module standard o/p file (see sysxi,syspp).
*   c3.315 last arg of substr may be omitted - treated
*           as remainder of string.

```

```

*      version 3.2 to 3.3 (jan 78)
*      -----
*
*      bugs fixed
*      -----
*
*      b3.201  array reference and external function load
*              routines illegally accessed information
*              beyond the stack front.
*              similar fault in unanchored pattern matching.
*      b3.202  dump(1) produced dump(2) type output.
*      b3.203  wtb conversion omitted in code following
*              ini01, ini02, exbld.
*      b3.204  incorrect fail return from tfind in arref.
*      b3.205  endfile did not detach i/o associated variables.
*      b3.206  -space with omitted arg. failed
*      b3.207  looped if dump keyword non-zero after stack
*              overflow in garbage collect failure.
*      b3.208  failure in reading numbers with trailing blanks.
*
*      changes
*      -----
*
*      the extensive changes made here mostly result from a
*      snobol4 implementors meeting held at new york university
*      in august 1977. they are aimed at
*          (1) having spitbol conform to certain snobol4
*              language standards  and
*          (2) producing a stable definition of minimal by
*              carrying out a few essential revisions in the light
*              of experience in its use.
*
*      changes to spitbol
*      -----
*
*      c3.201  default values for keywords trim and anchor are
*              zero. on systems where records are customarily
*              handled without trailing blanks, there is no
*              obligation to supply such blanks.
*      c3.202  default value of -inxx control card is -in72.

```

* c3.203 the second argument of input and output is
 * permitted to be an integer as in snobol4.
 * in addition input(), output() now give a snobol4
 * statement failure if sysio uses the file not
 * found return.
 * the third argument has a recommended format and
 * to override its default delimiter (,) a
 * conditional assembly symbol, .ciod, is used.
 * interfaces to sysef,sysej,syfc,sysio,sysrw
 * are revised.
 * wc may now be used to return from sysio, a max
 * record length.

* c3.204 a new configuration parameter cfp\$f (scblk offset
 * is introduced. cfp\$u is removed.

* c3.205 implementation and version identification is
 * required - see sysid.

* c3.206 routine sysmx returns the maximum length of
 * spitbol objects (strings arrays etc). this
 * information is not now needed at time of entry to
 * spitbol and hence wc should be zero on entry.

* c3.207 a conditional parameter .cnra permits assembly
 * of a more compact version with no real
 * arithmetic code.

* c3.208 terminal is a new pre-associated variable
 * capable of performing input and output to an
 * online terminal.
 * sysri is a new routine used in the implementation
 * of this. see also syspp.

* c3.209 the environment parameters e\$--- are now
 * provided by the minimal translator using the
 * revised equ * format (see c3.229 and start
 * of spitbol definitions section - some reordering
 * of symbols has occurred).

* c3.210 the interface of sysxi has been slightly revised.
 * unavailability of i/o channels after exit(1),
 * exit(-1) is documented together with additional
 * error return usage for sysin,sysou,syspr,sysrd.

* c3.211 spitbol error codes have been frozen - see c3.230

* c3.212 the utility routines arref etc. are now
 * introduced by rtn statements.

* c3.213 sysrl (record length for std input file) is
 * removed. since implementation of a general -inxxx
 * control card and an ability to specify max record
 * length using the third argument of input, sysrl
 * has become redundant.

* c3.214 sysej and sysxi are now passed a chain linking
 * all fcblks in use.

* c3.215 a special ending code in sysej is used when
 * attempts to use standard output channel fail.

* c3.216 restriction c3.233 observed so simplifying
 * optimised translation of ent with omitted val.

```

*
* changes to minimal
* -----
*
* c3.220 minimal opcodes dec, dim, inc, and bmp
*         are withdrawn and replaced by the more consistent
*         set dca, dcv, ica, icv.
* c3.221 chs has been replaced by the more generally
*         useful zgb (still likely to be a no-op for most
*         implementations however).
* c3.222 the set of character comparisons has been
*         reduced to ceq and cne to ease implementation
*         problems.
* c3.223 opcode irz is removed and dvi, rmi orders are
*         redefined to conform to more common usage.
* c3.224 new opcodes ssl and sss are defined. their use
*         permits return links for n type procedures to be
*         placed on a local stack if desired.
* c3.225 opcode mnz complements zer. it moves a non-zero
*         flag to its destination.
* c3.226 for some machines it is preferable for the stack
*         to build up rather than down. to permit this
*         without need for massive changes in minimal and
*         recoding of existing programs, a scheme has been
*         devised in which an additional register name, xt,
*         is used as a synonym for xl when this register
*         is involved in stack manipulation- see section 4.
* c3.227 section 0 of a minimal program is renamed the
*         procedure section. it now contains, in addition
*         to exp, specifications of internal procedures
*         and routines by means of the inp and inr opcodes.
* c3.228 the literal operand formats =int and *int have
*         been withdrawn. =dlbl and *dlbl must be used in
*         their stead.
* c3.229 the format
*         label equ *nn
*         used to specify values supplied by the minimal
*         translator for char. codes etc. is replaced by
*         label equ *
*         where the order in which the definitions are
*         supplied by the translator should match the
*         order of occurrence in the definitions section.
* c3.230 the format of err,erb opcodes is changed to
*         require a numeric operand.
* c3.231 the rtn opcode is used to introduce routines
*         (which are quite distinct from procedures).
* c3.232 conditional assembly directives may be nested.
* c3.233 minor restriction placed on the omission of
*         val with the ent opcode.

```



```

*      version 3.1 to 3.2 (aug 77)
*      -----
*
*      bugs fixed
*      -----
*
*      b3.101  astonishing this was unnoticed for three years.
*              bad code for snobol4 integer divide, /, gave
*              wrong result for operands of opposite signs.
*              implementations have either wrongly translated
*              dvi and got correct result or correctly
*              translated dvi and got wrong result - leeds had
*              one of each. see also c3.106.
*              test program no. 1 now extended to check /
*              more thoroughly.
*      b3.102  garbage collection bug in scan
*
*      changes
*      -----
*
*      c3.101  option to use additional characters ch$ht,ch$vt
*              (horizontal and vertical tab) with same syntactic
*              significance as ch$bl (blank).
*      c3.102  option to use a set of shifted case alphabetic
*              characters ch$$a ... ch$$$$.
*      c3.103  conditional assembly features are introduced into
*              minimal on account of the above.
*              see minimal documentation section for details
*              of above changes.
*      c3.104  lch and sch may use an x register first
*              operand as alternative to a w register.
*      c3.105  spitbol statement numbers in the listing may
*              optionally be padded to 6 or 8 chars instead of 5
*              by defining conditional assembly symbols
*              .csn6 or .csn8 .
*      c3.106  to fix bug 3.101. at moderate cost,
*              opcode irz (branch if integer divide remainder
*              zero) introduced.
*      c3.107  to handle possible machine dependency in string
*              hashing, chs (complete hashing of string) opcode
*              is introduced. probably a no-op on most machines
*              - not on the dec10.
*      c3.108  procedures patin,tfind,trace have been
*              modified to conform to the minimal standard
*              call and return regime.
*      c3.109  sysfc interface revised slightly to permit
*              osint to return a pointer to a privately
*              allocated fcbk which spitbol will return on
*              subsequent i/o - see sysfc doc.
*      c3.110  to remove inconsistencies in calling sequences,
*              all sys routines having access to a possible
*              fcbk have fcbk ptr or zero in reg. wa on entry.
*              change affects sysef, sysen, sysil, sysin,

```

```
*      sysou, sysrw.  
*      c3.111 syspp bit allocated to provide  
*      -noexec option on entry to spitbol.
```

*
* documentation revisions
* -----
*
* d3.101 need to preserve registers in syspi, syspr,
* sysrd calls was overstated.

```

*      version 3.0 to 3.1 (mar 77)
*      -----
*
*      bugs fixed
*      -----
*
*      b3.001  replace() could fail during pre-evaluation.
*              spitbol now signals an error for null or
*              unequally long 2nd and 3rd arguments.
*      b3.002  negative second arguments to dupl, lpad, rpad
*              caused spitbol to signal an error. now causes
*              return of null string or first arg respectively.
*      b3.003  brn-s used instead of ppm-s in s$sub.
*      b3.004  err used instead of erb after cmp30.
*      b3.005  b$pf, s$cnv, s$def, arith and arref kept
*              information illegally above the stack top.
*      b3.006  pre-evaluation of constant parts of
*              complex gotos was erroneous.
*      b3.007  incorrect handling of labels compiled by code().
*      b3.008  the single use of trc (in s$rpl) was not in
*              accord with its definition. some translations of
*              trc may need revision now that the use
*              has been brought into line with definition.
*
*      changes
*      -----
*
*      a debate on a few weaknesses in minimal design has
*      been resolved by introducing 4 new opcodes.
*
*      c3.001  new minimal opcodes bmp and dim introduced
*              to augment inc and dec which are applicable
*              only to addresses.
*      c3.002  the opcode szc (store zero characters) had
*              a restricted applicability. it has been
*              replaced by the more general zer (zeroise).
*      c3.003  fcblks may be optionally allocated as xrblk-s or
*              xnblk-s - see sysfc for vital information.
*      c3.004  control card processing has been recoded.
*              -inxxx allows specification of standard input
*              file record lengths other than 72 or 80, see also
*              sysrl. -sequ is ignored unless -in80 is in effect
*      c3.005  to enable efficient buffering of chars on
*              machines without char. handling orders, the
*              csc (complete store characters) instruction
*              is introduced. current implementations can
*              translate it as a no-op if it is of no benefit.
*      c3.006  integers 0,1,2 are treated specially.
*              icblks in static are used instead of
*              allocating space in dynamic.

```

```

*
* version 2.7 (june 76) to 3.0 (jan 77)
* -----
*
* bugs fixed
* -----
*
* b2.701 goes illegal if timed out during processing of
*         dump() call.
* b2.702 goes illegal if spitbol error detected in args of
*         code() or eval(). bug fixed so that user now gets
*         a spitbol error report (trappable by setexit)
*         before statement failure.
* b2.703 goes illegal in some circumstances when
*         multiple compilation errors occur in a statement
* b2.704 goes illegal if garbage collector runs out of
*         stack space.
* b2.705 control card processing incorrect for cdc 6400.
* b2.706 incorrect handling of multiple occurrences of
*         chars in replace 2nd and 3rd args.
* b2.707 stack overflow in pre-evaluation of replace in
*         cdc 6400 version.
* b2.708 an explicit call of sysmw was coded in s$dat
*         instead of the mvw opcode.
* b2.709 call of garbage collector whilst dumping
*         caused havoc.
* b2.710 size restriction on spitbol objects (size must be
*         numerically less than lowest dynamic address)
*         was not enforced, with potential for catastrophe.
* b2.711 deferred expressions involving alternation or
*         negation were incorrectly translated.
* b2.712 listing of a compilation error at the end of a
*         long line could cause compiler to go illegal.
* b2.713 incorrect -nofail code with success goto.

```

```

*
*
* changes
* -----
*
* (it is not anticipated that major revisions on this
* scale will be frequent).
*
* c2.701 default value of anchor keyword is set to 1. this
* conflicts with snobol4 practice but is a
* preferable default for most applications.
* c2.702 if errtype is out of range the string in keyword
* errtext is printed as the error message.
* c2.703 if stlimit is exceeded, up to 10 more statements
* may be obeyed to permit setexit trap to gain
* control.
* c2.704 the concept of an interactive channel is
* introduced for implementations where an online
* terminal may be used for spitbol. the standard
* print file may be specified as interactive in
* which case shorter title lines are output.
* alternatively copies of compilation and
* execution errors only may be sent to this channel
* c2.705 printing of compilation statistics may be
* suppressed.
* c2.706 printing of execution statistics may be
* suppressed.
* c2.707 extended or compact listing format may be
* selected.
* c2.708 an initial -nolist option may be specified
* before compilation starts.
* c2.709 to specify choices implied by c2.704 to c2.708
* syspp interface is revised and syspi is defined.
* c2.710 compilation and execution time statistics
* messages have been shortened.
* c2.711 the exit function as in sitbol is introduced
* to permit saving load modules - see sysxi, s$ext.
* c2.712 diagnostic routines sysgb and sysgd have been
* removed. they were useful in the early debugging
* days but have fallen into disuse now.
* c2.713 szc may have an operand of type opn instead of
* type opw
* c2.714 input/output association interface has been
* revised. sysif,sysof have been consolidated into
* the new system routine, sysio, and the
* specification of sysfc has been slightly changed.
* c2.715 configuration parameter mxlen has been withdrawn
* and the maximum size of a spitbol object which
* was formerly fixed at spitbol compile time by
* reference to it may now be specified as a run
* time option by placing a value in wc before entry
* to spitbol. (see comment on dynamic area in
* basic information section).

```

* c2.716 a function, host, is introduced which yields
* information about the host machine - see syshs
* and s\$hst.

```

*
* documentation revisions
* -----
*
* d2.701 the description of mvc has been revised to
*        reflect the fact that some spitbol code sequences
*        rely on mvc not destroying wb. minor changes
*        have been made to mwb and mvw descriptions to
*        emphasise similarities in the implicit loops of
*        these orders.
* d2.702 descriptions of dvi and rmi have been clarified.
* d2.703 implementation of rsx,lsx,ceq,cge,cgt,chi,clo,clt
*        is optional at present since they are currently
*        unused. their use in later versions is not
*        excluded.
* d2.704 impossibility of using stack for return links of
*        n type procedures is emphasised.
* d2.705 notation (xl),(wc) etc in language description is
*        clarified.
* d2.706 documentation of sysfc, sysio has been improved.
* d2.707 opcode descriptions are cross referenced from
*        the alphabetical opcode list.
* d2.708 general description of compiler has been moved to
*        the start of the compiler proper.
* d2.709 definitions of environment parameters have been
*        put near the front of the definitions section.

```


minimal – machine independent macro assembly lang.

```

*
* the following sections describe the implementation
* language originally developed for spitbol but now more
* widely used. minimal is an assembly language
* for an idealized machine. the following describes the
* basic characteristics of this machine.
*
* section 1 - configuration parameters
*
* there are several parameters which may vary with the
* target machine. the macro-program is independent of the
* actual definitions of these parameters.
*
* the definitions of these parameters are supplied by
* the translation program to match the target machine.
*
* cfp$a          number of distinct characters in
*                internal alphabet in the range
*                64 le cfp$a le mxlen.
*
* cfp$b          number of bytes in a word where a
*                byte is the amount of storage
*                addressed by the least significant
*                address bit.
*
* cfp$c          number of characters which can
*                be stored in a single word.
*
* cfp$f          byte offset from start of a string
*                block to the first character.
*                depends both on target machine and
*                string data structure. see plc, psc
*
* cfp$i          number of words in a signed
*                integer constant
*
* cfp$l          the largest unsigned integer
*                of form  $2^{*n} - 1$  which can be
*                stored in a single word. n will
*                often be cfp$n but need not be.
*
* cfp$m          the largest positive signed integer
*                of form  $2^{*n} - 1$  which can be
*                stored in a single word. n will
*                often be cfp$n-1 but need not be.
*
* cfp$n          number of bits which can be stored
*                in a one word bit string.
*
* cfp$r          number of words in a real constant
*
* cfp$s          number of significant digits to
*                be output in conversion of a real

```

<pre> * if .cncr else * * * fi * if .cucf * * * fi * </pre>	<pre> quantity. the integer consisting of this number of 9s must not be too large to fit in the integer accum. realistic upper bound on alphabet. number of digits in real exponent </pre>
---	---

```

*
* section 2 - memory
*
* memory is organized into words which each contain cfp$b
* bytes. for word machines cfp$b, which is a configuration
* parameter, may be one in which case words and bytes are
* identical. to each word corresponds an address which is
* a non-negative quantity which is a multiple of cfp$b.
* data is organized into words as follows.
*
* 1) a signed integer value occupies cfp$i consecutive
* words (cfp$i is a configuration parameter).
* the range may include more negative numbers than
* positive (e.g. the twos complement representation).
*
* 2) a signed real value occupies cfp$r consecutive
* words. (cfp$r is a configuration parameter).
*
* 3) cfp$c characters may be stored in a single word
* (cfp$c is a configuration parameter).
*
* 4) a bit string containing cfp$n bits can be stored in
* a single word (cfp$n is a configuration parameter).
*
* 5) a word can contain a unsigned integer value in
* the range (0 le n le cfp$l). these integer values
* may represent addresses of other words and some of
* the instructions use this fact to provide indexing
* and indirection facilities.
*
* 6) program instructions occupy words in an undefined
* manner. depending on the actual implementation,
* instructions may occupy several words, or part of
* a word, or even be split over word boundaries.
*
* the following regions of memory are available to the
* program. each region consists of a series of words with
* consecutive addresses.
*
* 1) constant section          assembled constants
* 2) working storage section   assembled work areas
* 3) program section           assembled instructions
* 4) stack area                allocated stack area
* 5) data area                 allocated data area

```

```

*
* section 3 - registers
*
* there are three index registers called xr,xl,xs. in
* addition xl may sometimes be referred to by the alias
* of xt - see section 4. any of the above registers
* may hold a positive unsigned integer in the range
* (0 ≤ n ≤ cfp$1). when the index register is used for
* indexing purposes, this must be an appropriate address.
* xs is special in that it is used to point to the top
* item of a stack in memory. the stack may build up or
* down in memory.since it is required that xs points to the
* stack top but access to items below the top is permitted,
* registers xs and xt may be used with suitable offsets
* to index stacked items. only xs and xt may be used for
* this purpose since the direction of the offset is
* target machine dependent. xt is a synonym for xl
* which therefore cannot be used in code sequences
* referencing xt.
*
* the stack is used for s-r linkage and temporary
* data storage for which the stack arrangement is suitable.
* xr,xl can also contain a character pointer in conjunction
* with the character instructions (see description of plc).

```

```

*
*   there are three work registers called wa,wb,wc which
*   can contain any data item which can be stored in a
*   single memory word. in fact, the work registers are just
*   like memory locations except that they have no addresses
*   and are referenced in a special way by the instructions.
*
*   note that registers wa,wb have special uses in connection
*   with the cvd, cvm, mvc, mvw, mwb, cmc, trc instructions.
*
*   register wc may overlap the integer accumulator (ia) in
*   some implementations. thus any operation changing the
*   value in wc leaves (ia) undefined and vice versa
*   except as noted in the following restriction on simple
*   dump/restore operations.
*
*       restriction
*       -----
*
*   if ia and wc overlap then
*       sti  iasav
*       ldi  iasav
*   does not change wc, and
*       mov  wc,wcsav
*       mov  wcsav,wc
*   does not change ia.
*
*
*
*   there is an integer accumulator (ia) which is capable of
*   holding a signed integer value (cfp$i words long).
*   register wc may overlap the integer accumulator (ia) in
*   some implementations. thus any operation changing the
*   value in wc leaves (ia) undefined and vice versa
*   except as noted in the above restriction on simple
*   dump/restore operations.
*
*
*
*   there is a single real accumulator (ra) which can hold
*   any real value and is completely separate from any of
*   the other registers or program accessible locations.
*
*
*
*   the code pointer register (cp) is a special index
*   register for use in implementations of interpreters.
*   it is used to contain a pseudo-code pointer and can
*   only be affected by icp, lcp, scp and lcw instructions.

```

```

*      section 4 - the stack
*
*      the following notes are to guide both implementors of
*      systems written in minimal and minimal programmers in
*      dealing with stack manipulation. implementation of a
*      downwards building stack is easiest and in general is
*      to be preferred, in which case it is merely necessary to
*      consider xt as an alternative name for xl.
*
*      the minimal virtual machine includes a stack and has
*      operand formats -(xs) and (xs)+ for pushing and popping
*      items with an implication that the stack builds down in
*      memory (a d-stack). however on some target machines it is
*      better for the stack to build up (a u-stack).
*      a stack addressed only by push and pop operations can
*      build in either direction with no complication but
*      such a pure scheme of stack access proves restrictive.
*      hence it is permitted to access buried items using an
*      integer offset past the index register pointing to the
*      stack top. on target machines this offset will be
*      positive/negative for d-stacks/u-stacks and this must
*      be allowed for in the translation.
*      a further restriction is that at no time may an item be
*      placed above the stack top. for some operations this
*      makes it convenient to advance the stack pointer and then
*      address items below it using a second index register.
*      the problem of signed offsets past such a register then
*      arises. to distinguish stack offsets, which in some
*      implementations may be negative, from non-stack offsets
*      which are invariably positive, xt, an alias or
*      synonym for xl is used. for a u-stack implementation, the
*      minimal translator should negate the sign of offsets
*      applied to both (xs) and (xt).
*      programmers should note that since xt is not a
*      separate register, xl should not be used in code where
*      xt is referenced. other modifications needed in u-stack
*      translations are in the add, sub, ica, dca opcodes
*      applied to xs, xt. for example
*
*      minimal          d-stack trans.  u-stack trans.
*
*      mov  wa,-(xs)      sbi  xs,1      adi  xs,1
*                        sto  wa,(xs)     sto  wa,(xs)
*      mov  (xt)+,wc      lod  wc,(xl)    lod  wc,(xl)
*                        adi  xl,1        sbi  xl,1
*      add  =seven,xs     adi  xs,7       sbi  xs,7
*      mov  2(xt),wa      lod  wa,2(xl)   lod  wa,-2(xl)
*      ica  xs            adi  xs,1       sbi  xs,1
*
*      note that forms such as
*      mov  -(xs),wa
*      add  wa,(xs)+
*      are illegal, since they assume information storage

```

* above the stack top.


```

*      section 5 - internal character set
*
*      the internal character set is represented by a set of
*      contiguous codes from 0 to cfp$a-1. the codes for the
*      digits 0-9 must be contiguous and in sequence. other
*      than this, there are no restraints.
*
*      the following symbols are automatically defined to have
*      the value of the corresponding internal character code.
*
*      ch$1a          letter a
*      ch$1b          letter b
*      .              .
*      ch$1$          letter z
*
*      ch$d0          digit 0
*      .              .
*      ch$d9          digit 9
*
*      ch$am          ampersand
*      ch$as          asterisk
*      ch$at          at
*      ch$bb          left bracket
*      ch$bl          blank
*      ch$br          vertical bar
*      ch$cl          colon
*      ch$cm          comma
*      ch$dl          dollar sign
*      ch$dt          dot (period)
*      ch$dq          double quote
*      ch$eq          equal sign
*      ch$ex          exclamation mark
*      ch$mn          minus
*      ch$nm          number sign
*      ch$nt          not
*      ch$pc          percent
*      ch$pl          plus
*      ch$pp          left paren
*      ch$rb          right bracket
*      ch$rp          right paren
*      ch$qu          question mark
*      ch$sl          slash
*      ch$sm          semi-colon
*      ch$sq          single quote
*      ch$un          underline
*
*      the following optional symbols are incorporated
*      by defining the conditional assembly symbol named.
*
*      26 shifted letters incorporated by defining .casl
*
*      ch$$a          shifted a
*      ch$$b          shifted b

```

*	.	.
*	ch\$\$\$	shifted z
*		
*	ch\$ht	horizontal tab - define .caht
*	ch\$vt	vertical tab - define .cavt
*	ch\$ey	up arrow - define .caex

```

*
* section 6 - conditional assembly features
*
* some features of the interpreter are applicable to only
* certain target machines. they may be incorporated or
* omitted by use of conditional assembly. the full
* form of a condition is -
* .if    conditional assembly symbol    (cas)
* .then
*      minimal statements1    (ms1)
* .else
*      minimal statements2    (ms2)
* .fi
* the following rules apply
* 1.  the directives .if, .then, .else, .fi must
*     start in column 1.
* 2.  the conditional assembly symbol must start with a
*     dot in column 8 followed by 4 letters or digits e.g.
*     .ca$1
* 3.  .then is redundant and may be omitted if wished.
* 4.  ms1, ms2 are arbitrary sequences of minimal
*     statements either of which may be null or may
*     contain further conditions.
* 5.  if ms2 is omitted, .else may also be omitted.
* 6.  .fi is required.
* 7.  conditions may be nested to a depth determined
*     by the translator (not less than 20, say).
*
* selection of the alternatives ms1, ms2 is by means of the
* define and undefine directives of form -
* .def    cas
* .undef cas
* which obey rules 1. and 2. above and may occur at any
* point in a minimal program, including within a condition.
* multiply defining a symbol is an error.
* undefining a symbol which is not defined is not an error.
*
* the effect is that if a symbol is currently defined,
* then in any condition depending on it, ms1 will be
* processed and ms2 omitted. conversely if it is undefined,
* ms1 will be omitted and ms2 processed.
*
* nesting of conditions is such that conditions
* in a section not selected for processing must not be
* evaluated. nested conditions must remember their
* environment whilst being processed. effectively this
* implies use of a scheme based on a stack with .if, .fi
* matching by the condition processor of the translator.

```

```

*
* section 7 - operand formats
*
* the following section describes the various possibilities
* for operands of instructions and assembly operations.
*
* 01  int          unsigned integer le cfp$l
* 02  dlbl         symbol defined in definitions sec
* 03  wlbl         label in working storage section
* 04  clbl         label in constant section
* 05  elbl         program section entry label
* 06  plbl         program section label (non-entry)
* 07  x            one of the three index registers
* 08  w            one of the three work registers
* 09  (x)          location indexed by x
* 10  (x)+         like (x) but post increment x
* 11  -(x)         like (x) but predecrement x
* 12  int(x)       location int words beyond addr in x
* 13  dlbl(x)      location dlbl words past addr in x
* 14  clbl(x)      location (x) bytes beyond clbl
* 15  wlbl(x)      location (x) bytes beyond wlbl
* 16  integer      signed integer (dic)
* 17  real         signed real (drc)
* 18  =dlbl        location containing dac dlbl
* 19  *dlbl        location containing dac cfp$b*dlbl
* 20  =wblbl       location containing dac wlbl
* 21  =clbl        location containing dac clbl
* 22  =elbl        location containing dac elbl
* 23  pnam         procedure label (on prc instruc)
* 24  eqop         operand for equ instruction
* 25  ptyp         procedure type (see prc)
* 26  text         arbitrary text (erb,err,t1l)
* 27  dtext        delimited text string (d1c)
*
* the numbers in the above list are used in subsequent
* description and in some of the minimal translators.

```

```

*
* operand formats (continued)
*
* the following special symbols refer to a collection of
* the listed possibilities
*
* val  01,02                predefined value
*
*     val is used to refer to a predefined one word
*     integer value in the range 0 le n le cfp$l.
*
* reg  07,08                register
*
*     reg is used to describe an operand which can be
*     any of the registers (xl,xr,xs,xt,wa,wb,wc). such
*     an operand can hold a one word integer (address).
*
* opc  09,10,11            character
*
*     opc is used to designate a specific character
*     operand for use in the lch and sch instructions.
*     the index register referenced must be either xr or
*     xl (not xs,xt). see section on character operations.
*
* ops  03,04,09,12,13,14,15    memory reference
*
*     ops is used to describe an operand which is in
*     memory. the operand may be one or more words long
*     depending on the data type. in the case of multiword
*     operands, the address given is the first word.
*
* opw  as for ops + 08,10,11    full word
*
*     opw is used to refer to an operand whose capacity is
*     that of a full memory word. opw includes all the
*     possibilities for ops (the referenced word is used)
*     plus the use of one of the three work registers
*     (wa,wb,wc). in addition, the formats (x)+ and -(x)
*     allow indexed operations in which the index register
*     is popped by one word after the reference (x)+,
*     or pushed by one word before the reference -(x)
*     these latter two formats provide a facility for
*     manipulation of stacks. the format does not imply
*     a particular direction in which stacks must build -
*     it is used for compactness. note that there is a
*     restriction which disallows an instruction to use
*     an index register in one of these formats
*     in some other manner in the same instruction.
*     e.g.  mov  xl,(xl)+  is illegal.
*     the formats -(x) and (x)+ may also be used in
*     pre-decrementation, post-incrementation to access
*     the adjacent character of a string.

```

```

*
* operand formats (continued)
*
* opn  as for opw + 07          one word integer
*
*     opn is used to represent an operand location which
*     can contain a one word integer (e.g. an address).
*     this includes all the possibilities for opw plus
*     the use of one of the index registers (xl,xr,xt,
*     xs). the range of integer values is 0 le n le cfp$1.
*
* opv  as for opn + 18-22      one word integer value
*
*     opv is used for an operand which can yield a one
*     word integer value (e.g. an address). it includes
*     all the possibilities for opn (the current value of
*     the location is used) plus the use of literals. note
*     that although the literal formats are described in
*     terms of a reference to a location containing an
*     address constant, this location may not actually
*     exist in some implementations since only the value
*     is required. a restriction is placed on literals
*     which may consist only of defined symbols and
*     certain labels. consequently small integers to be
*     used as literals must be pre-defined, a discipline
*     aiding program maintenance and revision.
*
* addr 01,02,03,04,05          address
*
*     addr is used to describe an explicit address value
*     (one word integer value) for use with dac.
*
*
* *****
* *   in the following descriptions the usage --   *
* *   (xl),(xr), ... ,(ia)                         *
* *   in the descriptive text signifies the         +
* *   contents of the stated register.             *
* *****

```

```

*
* section 8 - list of instruction mnemonics
*
* the following list includes all instruction and
* assembly operation mnemonics in alphabetical order.
* the mnemonics are preceded by a number identifying
* the following section where the instruction is described.
* a star (*) is appended to the mnemonic if the last
* operand may optionally be omitted.
* see section -15- for details of statement format and
* comment conventions.
*
* 2.1 add opv,opn      add address
* 4.2 adi ops          add integer
* 5.3 adr ops          add real
* 7.1 anb opw,w        and bit string
* 2.17 aov opv,opn,plbl add address, fail if overflow
* 5.16 atn             arctangent of real accum
* 2.16 bct w,plbl      branch and count
* 2.5 beq opn,opv,plbl branch if address equal
* 2.18 bev opn,plbl    branch if address even
* 2.8 bge opn,opv,plbl branch if address greater or equal
* 2.7 bgt opn,opv,plbl branch if address greater
* 2.12 bhi opn,opv,plbl branch if address high
* 2.10 ble opn,opv,plbl branch if address less or equal
* 2.11 blo opn,opv,plbl branch if address low
* 2.9 blt opn,opv,plbl branch if address less than
* 2.6 bne opn,opv,plbl branch if address not equal
* 2.13 bnz opn,plbl    branch if address non-zero
* 2.19 bod opn,plbl    branch if address odd
* 1.2 brn plbl         branch unconditional
* 1.7 bri opn          branch indirect
* 1.3 bsw* x,val,plbl  branch on switch value
* 8.2 btw reg          convert bytes to words
* 2.14 bze opn,plbl    branch if address zero
* 6.6 ceq opw,opw,plbl branch if characters equal
* 10.1 chk            check stack overflow
* 5.17 chp            integer portion of real accum
* 7.4 cmb w           complement bit string
* 6.8 cmc plbl,plbl   compare character strings
* 6.7 cne opw,opw,plbl branch if characters not equal
* 6.5 csc x           complete store characters
* 5.18 cos            cosine of real accum
* 8.8 ctb w,val       convert character count to bytes
* 8.7 ctw w,val       convert character count to words
* 8.10 cvd            convert by division
* 8.9 cvm plbl        convert by multiplication
* 11.1 dac addr       define address constant
* 11.5 dbc val        define bit string constant
* 2.4 dca opn         decrement address by one word
* 1.17 dcv opn        decrement value by one
* 11.2 dic integer    define integer constant

```

```

*
*      alphabetical list of mnemonics (continued)
*
*      11.3 drc  real      define real constant
*      11.4 dtc  dtext    define text (character) constant
*      4.5  dvi  ops      divide integer
*      5.6  dvr  ops      divide real
*      13.1 ejc                eject assembly listing
*      14.2 end                end of assembly
*      1.13 enp               define end of procedure
*      1.6  ent* val          define entry point
*      12.1 equ  eqop        define symbolic value
*      1.15 erb  int,text    assemble error code and branch
*      1.14 err  int,text    assemble error code
*      1.5  esw                end of switch list for bsw
*      5.19 etx                e to the power in the real accum
*      1.12 exi* int         exit from procedure
*      12.2 exp               define external procedure
*      6.10 flc  w            fold character to upper case
*      2.3  ica  opn          increment address by one word
*      3.4  icp                increment code pointer
*      1.16 icv  opn          increment value by one
*      4.11 ieq  plbl         jump if integer zero
*      1.4  iff  val,plbl     specify branch for bsw
*      4.12 ige  plbl         jump if integer non-negative
*      4.13 igt  plbl         jump if integer positive
*      4.14 ile  plbl         jump if integer negative or zero
*      4.15 ilt  plbl         jump if integer negative
*      4.16 ine  plbl         jump if integer non-zero
*      4.9  ino  plbl         jump if no integer overflow
*      12.3 inp  ptyp,int     internal procedure
*      12.4 inr                internal routine
*      4.10 iov  plbl         jump if integer overflow
*      8.5  itr                convert integer to real
*      1.9  jsr  pnam         call procedure
*      6.3  lch  reg,opc      load character
*      2.15 lct  w,opv        load counter for loop
*      3.1  lcp  reg          load code pointer register
*      3.3  lcw  reg          load next code word
*      4.1  ldi  ops          load integer
*      5.1  ldr  ops          load real
*      1.8  lei  x            load entry point id
*      5.20 lnf                natural logorithm of real accum
*      7.6  lsh  w,val        left shift bit string
*      7.8  lsx  w,(x)        left shift indexed
*      9.4  mcb                move characterswords backwards
*      8.4  mfi* opn,plbl     convert (ia) to address value
*      4.3  mli  ops          multiply integer
*      5.5  mlr  ops          multiply real
*      1.19 mnz  opn          move non-zero
*      1.1  mov  opv,opn      move
*      8.3  mti  opn          move address value to (ia)
*      9.1  mvc                move characters

```


*	9.2	mvw	move words
*	9.3	mwb	move words backwards
*	4.8	ngi	negate integer

```

*
* alphabetical list of mnemonics (continued)
*
* 5.9 ngr                negate real
* 7.9 nzb w,plbl        jump if not all zero bits
* 7.2 orb opw,w         or bit strings
* 6.1 plc* x,opv        prepare to load characters
* 1.10 ppm* plbl        provide procedure exit parameter
* 1.11 prc ptyp,val     define start of procedure
* 6.2 psc* x,opv        prepare to store characters
* 5.10 req plbl         jump if real zero
* 5.11 rge plbl         jump if real positive or zero
* 5.12 rgt plbl         jump if real positive
* 5.13 rle plbl         jump if real negative or zero
* 5.14 rlt plbl         jump if real negative
* 4.6 rmi ops           remainder integer
* 5.15 rne plbl         jump if real non-zero
* 5.8 rno plbl          jump if no real overflow
* 5.7 rov plbl          jump if real overflow
* 7.5 rsh w,val         right shift bit string
* 7.7 rsx w,(x)         right shift indexed
* 8.6 rti* plbl         convert real to integer
* 1.22 rtn              define start of routine
* 4.4 sbi ops           subtract integer
* 5.4 sbr ops           subtract reals
* 6.4 sch reg,opc       store character
* 3.2 scp reg           store code pointer
* 14.1 sec              define start of assembly section
* 5.21 sin              sine of real accum
* 5.22 sqr              square root of real accum
* 1.20 ssl opw          subroutine stack load
* 1.21 sss opw          subroutine stack store
* 4.7 sti ops           store integer
* 5.2 str ops           store real
* 2.2 sub opv,opn       subtract address
* 5.23 tan              tangent of real accum
* 6.9 trc              translate character string
* 13.2 ttl text         supply assembly title
* 8.1 wtb reg           convert words to bytes
* 7.3 xob opw,w         exclusive or bit strings
* 1.18 zer opn          zeroise integer location
* 7.11 zgb opn          zeroise garbage bits
* 7.10 zrb w,plbl       jump if all zero bits

```

```

*
* section 9 - minimal instructions
*
* the following descriptions assume the definitions -
*
* zeroe equ 0
* unity equ 1
*
* -1- basic instruction set
*
* 1.1 mov opv,opn      move one word value
*
*      mov causes the value of operand opv to be set as
*      the new contents of operand location opn. in the
*      case where opn is not an index register, any value
*      which can normally occupy a memory word (including
*      a part of a multiword real or integer value)
*      can be transferred using mov. if the target location
*      opn is an index register, then opv must specify an
*      appropriate one word value or operand containing
*      such an appropriate value.
*
* 1.2 brn plbl          unconditional branch
*
*      brn causes control to be passed to the indicated
*      label in the program section.
*
* 1.3 bsw x,val,plbl    branch on switch value
* 1.4 iff val,plbl      provide branch for switch
*      iff val,plbl      ...
*      ...
* 1.5 esw                end of branch switch table
*
*      bsw,iff,esw provide a capability for a switched
*      branch similar to a fortran computed goto. the
*      val on the bsw instruction is the maximum number
*      of branches. the value in x ranges from zero up to
*      but not including this maximum. each iff provides a
*      branch. val must be less than that given on the bsw
*      and control goes to plbl if the value in x matches.
*      if the value in x does not correspond to any of the
*      iff entries, then control passes to the plbl on the
*      bsw. this plbl operand may be omitted if there are
*      no values missing from the list.
*
*      iff and esw may only be used in this context.
*      execution of bsw may destroy the contents of x.
*      the iff entries may be in any order and since
*      a translator may thus need to store and sort them,
*      the comment field is restricted in length (sec 11).

```

```

*
* -1- basic instructions (continued)
*
* 1.6 ent val          define program entry point
*
*     the symbol appearing in the label field is defined
*     to be a program entry point which can subsequently
*     be used in conjunction with the bri instruction,
*     which provides the only means of entering the
*     code. it is illegal to fall into code
*     identified by an entry point. the
*     entry symbol is assigned an address which need not
*     be a multiple of cfp$b but which must be in the
*     range 0 le cfp$l and the address must not lie within
*     the address range of the allocated data area.
*     furthermore, addresses of successive entry points
*     must be assigned in some ascending sequence so
*     that the address comparison instructions can be
*     used to test the order in which two entry points
*     occur. the symbol val gives an identifying value
*     to the entry point which can be accessed with the
*     lei instruction.
*
*     note - subject to the restriction below, val may
*     be omitted if no such identification is needed i.e.
*     if no lei references the entry point. for this
*     case, a translation optimisation is possible in
*     which no memory need be reserved for a null
*     identification which is never to be referenced, but
*     only provided this is done so as not to interfere
*     with the strictly ascending sequence of entry point
*     addresses. to simplify this optimisation for all
*     implementors, the following restriction is observed
*         val may only be omitted if the entry point is
*         separated from a following entry point by a
*         non-null minimal code sequence.
*     entry point addresses are accessible only by use of
*     literals (=elbl, section 7) or dac constants
*     (section 8-11.1).
*
* 1.7 bri opn          branch indirect
*
*     opn contains the address of a program entry point
*     (see ent). control is passed to the executable
*     code starting at the entry point address. opn is
*     left unchanged.
*
* 1.8 lei x            load entry point identification
*
*     x contains the address of an entry point for which
*     an identifying value was given on the the ent line.
*     lei replaces the contents of x by this value.

```

```

*
* -1- basic instructions (continued)
*
* 1.9 jsr pnam      call procedure pnam
* 1.10 ppm plbl     provide exit parameter
*      ppm plbl     ...
*      ...
*      ppm plbl     ...
*
*      jsr causes control to be passed to the named
*      procedure. pnam is the label on a prc statement
*      elsewhere in the program section (see prc)
*      or has been defined using an exp instruction.
*      the ppm exit parameters following the call give
*      names of program locations (plbl-s) to which
*      alternative exit returns of the called procedure may
*      pass control. they may optionally be replaced by
*      error returns (see err). the number of exit
*      parameters following a jsr must equal the int in the
*      procedure definition. the operand of ppm may be
*      omitted if the corresponding exit return is certain
*      not to be taken.
*
* 1.11 prc ptyp,int  define start of procedure
*
*      the symbol appearing in the label field is defined
*      to be the name of a procedure for use with jsr.
*      a procedure is a contiguous section of instructions
*      to which control may be passed with a jsr
*      instruction. this is the only way in which the
*      instructions in a procedure may be executed. it is
*      not permitted to fall into a procedure.
*      all procedures should be named in section 0
*      inp statements.
*
*      int is the number of exit parameters (ppm-s) to
*      be used in jsr calls.
*
*      there are three possibilities for ptyp, each
*      consisting of a single letter as follows.
*
*      r                recursive
*
*      the return point (one or more words) is stored on
*      the stack as though one or more mov ...,-(xs)
*      instructions were executed.

```

```

*
* -1- basic instructions (continued)
*
*      n                      non-recursive
*
*      the return point is to be stored either
*      (1) in a local storage word associated
*      with the procedure and not directly
*      available to the program in any other manner or
*      (2) on a subroutine link stack quite distinct from
*      the minimal stack addressed by xs.
*      it is an error to use the stack for n-links, since
*      procedure parameters or results may be passed via
*      the stack.
*      if method (2) is used for links, error exits
*      (erb,err) from a procedure will necessitate link
*      stack resetting. the ssl and sss orders provided
*      for this may be regarded as no-ops for
*      implementations using method (1).
*
*      e                      either
*
*      the return point may be stored in either manner
*      according to efficiency requirements of the actual
*      physical machine used for the implementation. note
*      that programming of e type procedures must be
*      independent of the actual implementation.
*
*      the actual form of the return point is undefined.
*      however, each word stored on the stack for an
*      r-type call must meet the following requirements.
*
*      1)                      it can be handled as an address
*                             and placed in an index register.
*
*      2)                      when used as an operand in an
*                             address comparison instruction, it
*                             must not appear to lie within
*                             the allocated data area.
*
*      3)                      it is not required to appear
*                             to lie within the program section.

```

```

*
* -1- basic instructions (continued)
*
* 1.12 exi int          exit from procedure
*
*      the ppm and err parameters following a jsr are
*      numbered starting from 1.  exi int causes control
*      to be returned to the int-th such param.  exi 1 gives
*      control to the plbl of the first ppm after the jsr.
*      if int is omitted, control is passed back past the
*      last exit parameter (or past the jsr if there are
*      none).  for r and e type procedures, the
*      stack pointer xs must be set to its appropriate
*      entry value before executing an exi instruction.
*      in this case, exi removes return points from the
*      stack if any are stored there so that the stack
*      pointer is restored to its calling value.
*
* 1.13 enp              define end of procedure body
*
*      enp delimits a procedure body and may not actually
*      be executed, hence it must have no label.
*
* 1.14 err int,text     provide error return
*
*      err may replace an exit parameter (ppm) in
*      any procedure call.  the int argument is a unique
*      error code in 0 to 899.
*      the text supplied as the other operand is
*      arbitrary text in the fortran character set and
*      may be used in constructing a file of error
*      messages for documenting purposes or for building
*      a direct access or other file of messages to be
*      used by the error handling code.
*      in the event that an exi attempts
*      to return control via an exit parameter to
*      an err, control is instead passed to the first
*      instruction in the error section (which follows the
*      program section) with the error code in wa.
*
* 1.15 erb int,text     error branch
*
*      this instruction resembles err except that it may
*      occur at any point where a branch is permitted.
*      it effects a transfer of control to the error
*      section with the error code in wa.
*
* 1.16 icv opn          increment value by one
*
*      icv increments the value of the operand by unity.
*      it is equivalent to  add =unity,opn
*
* 1.17 dcv opn          decrement value by one

```

*
* dcv decrements the value of the operand by unity.
* it is equivalent to sub =unity,opn


```

*
* basic instructions (continued)
*
* 1.18 zer  opn          zeroise opn
*
*      zer is equivalent to  mov  =zeroe,opn
*
* 1.19 mnz  opn          move non-zero to opn
*
*      any non-zero collectable value may used, for which
*      the opcodes bnz/bze will branch/fail to branch.
*
* 1.20 ssl  opw          subroutine stack load
*
* 1.21 sss  opw          subroutine stack store
*
*      this pair of operations is provided to make possible
*      the use of a local stack to hold subroutine (s-r)
*      return links for n-type procedures. sss stores the
*      s-r stack pointer in opw and ssl loads the s-r
*      stack pointer from opw. by using sss in the main
*      program or on entry to a procedure which should
*      regain control on occurrence of an err or erb and by
*      use of ssl in the error processing sections the
*      s-r stack pointer can be restored giving a link
*      stack cleaned up ready for resumed execution.
*      the form of the link stack pointer is undefined in
*      minimal (it is likely to be a private register
*      known to the translator) and the only requirement
*      is that it should fit into a single full word.
*      ssl and sss are no-ops if a private link stack is
*      not used.
*
* 1.22 rtn          define start of routine
*
*      a routine is a code chunk used for similar purposes
*      to a procedure. however it is entered by any type of
*      conditional or unconditional branch (not by jsr). on
*      termination it passes control by a branch (often
*      bri through a code word) or even permits control
*      to drop through to another routine. no return link
*      exists and the end of a routine is not marked by
*      an explicit opcode (compare enp).
*      all routines should be named in section 0
*      inr  statements.

```

```

*
*
* -2- operations on one word integer values (addresses)
*
* 2.1 add opv,opn adds opv to the value in opn and
* stores the result in opn. undefined
* if the result exceeds cfp$1.
*
* 2.2 sub opv,opn subtracts opv from opn. stores the
* result in opn. undefined if the
* result is negative.
*
* 2.3 ica opn increment address in opn
* equivalent to add *unity,opn
*
* 2.4 dca opn decrement address in opn
* equivalent to sub *unity,opn
*
* 2.5 beq opn,opv,plbl branch to plbl if opn eq opv
* 2.6 bne opn,opv,plbl branch to plbl if opn ne opv
* 2.7 bgt opn,opv,plbl branch to plbl if opn gt opv
* 2.8 bge opn,opv,plbl branch to plbl if opn ge opv
* 2.9 blt opn,opv,plbl branch to plbl if opn lt opv
* 2.10 ble opn,opv,plbl branch to plbl if opn le opv
* 2.11 blo opn,opv,plbl equivalent to blt or ble
* 2.12 bhi opn,opv,plbl equivalent to bgt or bge
*
* the above instructions compare two address
* values as unsigned integer values.
* the blo and bhi instructions are used in cases where
* the equal condition either does not occur or can
* result either in a branch or no branch. this avoids
* inefficient translations in some implementations.
*
* 2.13 bnz opn,plbl equivalent to bne opn,=zeroe,plbl
*
* 2.14 bze opn,plbl equivalent to beq opn,=zeroe,plbl
*
*
* 2.15 lct w,opv load counter for bct
*
* lct loads a counter value for use with the bct
* instruction. the value in opv is the number of loops
* to be executed. the value in w after this operation
* is an undefined one word integer quantity.
*
* 2.16 bct w,plbl branch and count
*
* bct uses the counter value in w to branch the
* required number of times and then finally to fall
* through to the next instruction. bct can only be
* used following an appropriate lct instruction.
* the value in w after execution of bct is undefined.
*

```

```

*      2.17 aov  opv,opn,plbl add with carry test
*
*      adds opv to the value in opn and stores result in
*      opn. branches to plbl if result exceeds cfp$l
*      with result in opn undefined. cf. add.
*
*      2.18 bev  opn,plbl      branch if even
*      2.19 bod  opn,plbl      branch if odd
*
*      these operations are used only if .cepp or .crpp is
*      defined.  on some implementations, a more efficient
*      implementation is possible by noting that address of
*      blocks must always be a multiple of cfp$b. we call
*      such addresses even.  thus return address on the
*      stack (.crpp) and entry point addresses (.cepp) can
*      be distinguished from block addresses if they are
*      forced to be odd (not a multiple of cfp$b).
*      bev and bod branch according as operand is even
*      or odd, respectively.

```

```

*
* -3- operations on the code pointer register (cp)
*
* the code pointer register provides a psuedo
* instruction counter for use in an interpreter. it
* may be implemented as a real register or as a
* memory location, but in either case it is separate
* from any other register. the value in the code
* pointer register is always a word address (i.e.
* a one word integer which is a multiple of cfp$b).
*
* 3.1 lcp reg      load code pointer register
*                  this instruction causes the code
*                  pointer register to be set from
*                  the value in reg which is unchanged
*
* 3.2 scp reg      store code pointer register
*                  this instruction loads the current
*                  value in the code pointer register
*                  into reg. (cp) is unchanged.
*
* 3.3 lcw reg      load next code word
*                  this instruction causes the word
*                  pointed to by cp to be loaded into
*                  the indicated reg. the value in cp
*                  is then incremented by one word.
*                  execution of lcw may destroy xl.
*
* 3.4 icp          increment cp by one word
*
* on machines with more than three index registers,
* cp can be treated simply as an index register.
* in this case, the following equivalences apply.
*
* lcp reg is like mov reg,cp
* scp reg is like mov cp,reg
* lcw reg is like mov (cp)+,reg
* icp      is like ica cp
*
* since lcw is allowed to destroy xl, the following
* implementation using a work location cp$$$ can
* also be used.
*
* lcp reg      mov reg,cp$$$
*
* scp reg      mov cp$$$,reg
*
* lcw reg      mov cp$$$,xl
*               mov (xl)+,reg
*               mov xl,cp$$$
*
* icp          ica cp$$$

```

```

*
*      -4-  operations on signed integer values
*
*      4.1  ldi  ops      load integer accumulator from ops
*      4.2  adi  ops      add ops to integer accumulator
*      4.3  mli  ops      multiply integer accumulator by ops
*      4.4  sbi  ops      subtract ops from int accumulator
*      4.5  dvi  ops      divide integer accumulator by ops
*      4.6  rmi  ops      set int accum to mod(intacc,ops)
*      4.7  sti  ops      store integer accumulator at ops
*      4.8  ngi          negate the value in the integer
*                          accumulator (change its sign)
*
*      the equation satisfied by operands and results of
*      dvi and rmi is
*
*          div = qot * ops + rem          where
*
*      div = dividend in integer accumulator
*      qot = quotient left in ia by div
*      ops = the divisor
*      rem = remainder left in ia by rmi
*
*      the sign of the result of dvi is + if (ia) and (ops)
*      have the same sign and is - if they have opposite
*      signs. the sign of (ia) is always used as the sign
*      of the result of rem.
*
*      assuming in each case that ia contains the number
*      specified in parentheses and that seven and msevn
*      hold +7 and -7 resp. the algorithm is illustrated
*      below.
*
*      (ia = 13)
*
*      dvi  seven      ia = 1
*      rmi  seven      ia = 6
*      dvi  msevn      ia = -1
*      rmi  msevn      ia = 6
*
*      (ia = -13)
*
*      dvi  seven      ia = -1
*      rmi  seven      ia = -6
*      dvi  msevn      ia = 1
*      rmi  msevn      ia = -6

```

```

*
*
*       the above instructions operate on a full range of
*       signed integer values. with the exception of ldi and
*       sti, these instructions may cause integer overflow
*       by attempting to produce an undefined or out of
*       range result in which case integer overflow is set,
*       the result in (ia) is undefined and the following
*       instruction must be iov or ino.
*       particular care may be needed on target machines
*       having distinct overflow and divide by zero
*       conditions.
*
*
*       4.9  ino  plbl          jump to plbl if no integer overflow
*       4.10 iov  plbl          jump to plbl if integer overflow
*
*       these instructions can only occur immediately
*       following an instruction which can cause integer
*       overflow (adi, sbi, mli, dvi, rmi, ngi) and
*       test the result of the preceding instruction.
*       iov and ino may not have labels.
*
*
*       4.11 ieq  plbl          jump to plbl if (ia) eq 0
*       4.12 ige  plbl          jump to plbl if (ia) ge 0
*       4.13 igt  plbl          jump to plbl if (ia) gt 0
*       4.14 ile  plbl          jump to plbl if (ia) le 0
*       4.15 ilt  plbl          jump to plbl if (ia) lt 0
*       4.16 ine  plbl          jump to plbl if (ia) ne 0
*
*
*       the above conditional jump instructions do
*       not change the contents of the accumulator.
*       on a ones complement machine, it is permissible to
*       produce negative zero in ia provided these
*       instructions operate correctly with such a value.

```

```

*
*      -5-  operations on real values
*
*      5.1  ldr  ops      load real accumulator from ops
*      5.2  str  ops      store real accumulator at ops
*      5.3  adr  ops      add ops to real accumulator
*      5.4  sbr  ops      subtract ops from real accumulator
*      5.5  mlr  ops      multiply real accumulator by ops
*      5.6  dvr  ops      divide real accumulator by ops
*
*      if the result of any of the above operations causes
*      underflow, the result yielded is 0.0.
*
*      if the result of any of the above operations is
*      undefined or out of range, real overflow is set,
*      the contents of (ra) are undefined and the following
*      instruction must be either rov or rno.
*      particular care may be needed on target machines
*      having distinct overflow and divide by zero
*      conditions.
*
*      5.7  rov  plbl      jump to plbl if real overflow
*      5.8  rno  plbl      jump to plbl if no real overflow
*
*      these instructions can only occur immediately
*      following an instruction which can cause real
*      overflow (adr,sbr,mlr,dvr).
*
*      5.9  ngr          negate real accum (change sign)
*
*      5.10 req plbl      jump to plbl if (ra) eq 0.0
*      5.11 rge plbl      jump to plbl if (ra) ge 0.0
*      5.12 rgt plbl      jump to plbl if (ra) gt 0.0
*      5.13 rle plbl      jump to plbl if (ra) le 0.0
*      5.14 rlt plbl      jump to plbl if (ra) lt 0.0
*      5.15 rne plbl      jump to plbl if (ra) ne 0.0
*
*      the above conditional instructions do not affect
*      the value stored in the real accumulator.
*      on a ones complement machine, it is permissible to
*      produce negative zero in ra provided these
*      instructions operate correctly with such a value.
if .cmth
*
*      5.16 atn          arctangent of real accum
*      5.17 chp          integer portion of real accum
*      5.18 cos          cosine of real accum
*      5.19 etx          e to the power in the real accum
*      5.20 lnf          natural logarithm of real accum
*      5.21 sin          sine of real accum
*      5.22 sqr          square root of real accum
*      5.23 tan          tangent of real accum
*

```

```

*      the above orders operate upon the real accumulator,
*      and replace the contents of the accumulator with the
*      result.
*
*      if the result of any of the above operations is
*      undefined or out of range, real overflow is set,
*      the contents of (ra) are undefined and the following
*      instruction must be either rovd or rno.

```

fi


```

*
*
* -6- operations on character values
*
* character operations employ the concept of a
* character pointer which uses either
* index register xr or xl (not xs).
*
* a character pointer points to a specific character
* in a string of characters stored cfp$c chars to a
* word. the only operations permitted on a character
* pointer are lch and sch. in particular, a character
* pointer may not even be moved with mov.
*
* restriction 1.
* -----
* it is important when coding in minimal to ensure
* that no action occurring between the initial use of
* plc or psc and the eventual clearing of xl or xr on
* completion of character operations can initiate a
* garbage collection. the latter of course could cause
* the addressed characters to be moved leaving the
* character pointers pointing to rubbish.
*
* restriction 2.
* -----
* a further restriction to be observed in code
* handling character strings, is that strings built
* dynamically should be right padded with zero
* characters to a full word boundary to permit easy
* hashing and use of ceq or cne in testing strings
* for equality.
*
* 6.1 plc x,opv      prepare ch ptr for lch,cmc,mvc,trc,
*                    mcb.
*
* 6.2 psc x,opv      prepare char. ptr for sch,mvc,mcb.
*
* opv can be omitted if it is zero.
* the char. initially addressed is determined by the
* word address in x and the integer offset opv.
* there is an automatic implied offset of cfp$f bytes.
* cfp$f is used to formally introduce into minimal a
* value needed in translating these opcodes which,
* since minimal itself does not prescribe a string
* structure in detail, depends on the choice of a data
* structure for strings in the minimal program.
* e.g. if cfp$b = cfp$c = 3, cfp$f = 6, num01 = 1, xl
* points to a series of 4 words, abc/def/ghi/jkl, then
*   plc xl,=num01
* points to h.

```

```

*
*
* -6- operations on character values (continued)
*
*
* 6.3 lch reg,opc    load character into reg
*
*
* 6.4 sch reg,opc    store character from reg
*
*
*     these operations are defined such that the character
*     is right justified in register reg with zero bits to
*     the left. after lch for example, it is legitimate
*     to regard reg as containing the ordinal integer
*     corresponding to the character.
*
*
*     opc is one of the following three possibilities.
*
*
*     (x)             the character pointed to by the
*                     character pointer in x. the
*                     character pointer is not changed.
*
*
*     (x)+            same character as (x) but the
*                     character pointer is incremented
*                     to point to the next character
*                     following execution.
*
*
*     -(x)            the character pointer is decre-
*                     mented before accessing the
*                     character so that the previous
*                     character is referenced.
*
*
* 6.5 csc x           complete store characters
*
*
*     this instruction marks completion of a
*     psc,sch,sch,...,sch sequence initiated by
*     a psc x instruction. no more sch instructions
*     using x should be obeyed until another psc is
*     obeyed. it is provided solely as an efficiency aid
*     on machines without character orders since it
*     permits use of register buffering of chars in sch
*     sequences. where csc is not a no-op, it must observe
*     restriction 2. (e.g. in spitbol, alocs zeroes the
*     last word of a string frame prior to sch sequence
*     being started so csc must not nullify this action.)
*
*
*     the following instructions are used to compare
*     two words containing cfp$c characters.
*     comparisons distinct from beq,bne are provided as
*     on some target machines, the possibility of the sign
*     bit being set may require special action.
*     note that restriction 2 above, eases use of these
*     orders in testing complete strings for equality,
*     since whole word tests are possible.
*
*
* 6.6 ceq opw,opw,plbl jump to plbl if opw eq opw

```

* 6.7 cne opw,opw,plbl jump to plbl if opw ne opw

```

*
*
*      -6- operations on character values (continued)
*
*
*      6.8  cmc  plbl,plbl   compare characters
*
*      cmc is used to compare two character strings. before
*      executing cmc, registers are set up as follows.
*      (xl)           character ptr for first string
*      (xr)           character pointer for second string
*      (wa)           character count (must be .gt. zero)
*      xl and xr should have been prepared by plc.
*      control passes to first plbl if the first string
*      is lexically less than the second string, and to
*      the second plbl if the first string is lexically
*      greater. control passes to the following instruction
*      if the strings are identical. after executing this
*      instruction, the values of xr and xl are set to
*      zero and the value in (wa) is undefined.
*      arguments to cmc may be complete or partial
*      strings, so making optimisation to use whole word
*      comparisons difficult (dependent in general on
*      shifts and masking).
*
*
*      6.9  trc           translate characters
*
*      trc is used to translate a character string using a
*      supplied translation table. before executing trc the
*      registers are set as follows.
*      (xl)           char ptr to string to be translated
*      (xr)           char ptr to translate table
*      (wa)           length of string to be translated
*      xl and xr should have been prepared by plc.
*      the translate table consists of cfp$a contiguous
*      characters giving the translations of the cfp$a
*      characters in the alphabet. on completion, (xr) and
*      (xl) are set to zero and (wa) is undefined.
*
*
*      6.10 flc  w           fold character to upper case
*      flc is used only if .culc is defined. the character
*      code value in w is translated to upper case if it
*      corresponds to a lower case character.

```

```

*
* -7- operations on bit string values
*
* 7.1 anb opw,w      and bit string values
* 7.2 orb opw,w      or bit string values
* 7.3 xob opw,w      exclusive or bit string values
*
*      in the above operations, the logical connective is
*      applied separately to each of the cfp$n bits.
*      the result is stored in the second operand location.
*
* 7.4 cmb w          complement all bits in opw
*
* 7.5 rsh w,val      right shift by val bits
* 7.6 lsh w,val      left shift by val bits
* 7.7 rsx w,(x)      right shift w number of bits in x
* 7.8 lsx w,(x)      left shift w number of bits in x
*
*      the above shifts are logical shifts in which bits
*      shifted out are lost and zero bits supplied as
*      required. the shift count is in the range 0-cfp$n.
*
* 7.9 nzb w,plbl     jump to plbl if w is not
*                   all zero bits.
*
* 7.10 zrb w,plbl     jump to plbl if w is all zero bits
*
* 7.11 zgb opn       zeroise garbage bits
*
*      opn contains a bit string representing a word
*      of characters from a string or some function
*      formed from such characters (e.g. as a result of
*      hashing). on a machine where the word size is not a
*      multiple of the character size, some bits in reg may
*      be undefined. this opcode replaces such bits by the
*      zero bit. zgb is a no-op if the word size is a
*      multiple of the character size.

```

```

*
* -8- conversion instructions
*
* the following instructions provide for conversion
* between lengths in bytes and lengths in words.
*
* 8.1 wtb reg      convert reg from words to bytes.
*                  that is, multiply by cfp$b. this is
*                  a no-op if cfp$b is one.
*
* 8.2 btw reg      convert reg from bytes to words
*                  by dividing reg by cfp$b discarding
*                  the fraction. no-op if cfp$b is one
*
* the following instructions provide for conversion
* of one word integer values (addresses) to and
* from the full signed integer format.
*
* 8.3 mti opn      the value of opn (an address)
*                  is moved as a positive integer
*                  to the integer accumulator.
*
* 8.4 mfi opn,plbl the value currently stored in the
*                  integer accumulator is moved
*                  to opn as an address if it is in
*                  the range 0 to cfp$m inclusive.
*                  if the accumulator value is
*                  outside this range, then the result
*                  in opn is undefined and control is
*                  passed to plbl. mfi destroys the
*                  value of (ia) whether or not
*                  integer overflow is signalled.
*                  plbl may be omitted if overflow
*                  is impossible.
*
* the following instructions provide for conversion
* between real values and integer values.
*
* 8.5 itr          convert integer value in integer
*                  accumulator to real and store in
*                  real accumulator (may lose
*                  precision in some cases)
*
* 8.6 rti plbl     convert the real value in ra to
*                  an integer and place result in ia.
*                  conversion is by truncation of the
*                  fraction - no rounding occurs.
*                  jump to plbl if out of range. (ra)
*                  is not changed in either case.
*                  plbl may be omitted if overflow
*                  is impossible.

```

```

*
* -8- conversion instructions (continued)
*
* the following instructions provide for computing
* the length of storage required for a text string.
*
* 8.7 ctw w,val      this instruction computes the sum
*                    (number of words required to store
*                    w characters) + (val). the sum
*                    is stored in w.
*                    for example, if cfp$c is 5, and wa
*                    contains 32, then ctw wa,2
*                    gives a result of 9 in wa.
*
* 8.8 ctb w,val      ctb is exactly like ctw except that
*                    the result is in bytes. it has the
*                    same effect as ctw w,val wtb w
*
* the following instructions provide for conversion
* from integers to and from numeric digit characters
* for use in numeric conversion routines. they employ
* negative integer values to allow for proper
* conversion of numbers which cannot be complemented.
*
* 8.9 cvm plbl      convert by multiplication
*
* the integer accumulator, which is zero or negative,
* is multiplied by 10. wb contains the character
* code for a digit. the value of this digit is then
* subtracted from the result. if the result is out of
* range, then control is passed to plbl with the
* result in (ia) undefined. execution of cvm leaves
* the result in (wb) undefined.
*
* 8.10 cvd          convert by division
*
* the integer accumulator, which is zero or negative,
* is divided by 10. the quotient (zero or negative)
* is replaced in the accumulator. the remainder is
* converted to the character code of a digit and
* placed in wa. for example, an operand of -523 gives
* a quotient of -52 and a remainder in wa of ch$d3.

```

```

*
*
* -9- block move instructions
*
*
* the following instructions are used for transferring
* data from one area of memory to another in blocks.
* they can be implemented with the indicated series of
* other macro-instructions, but more efficient imple-
* mentations will be possible on most machines.
*
*
* note that in the equivalent code sequence shown below, a
* zero value in wa will move at least one item, and may
* may wrap the counter causing a core dump in some imple-
* mentations. thus wa should be .gt. 0 prior to invoking
* any of these block move instructions.
*
*
* 9.1 mvc                move characters
*
*
* before obeying this order wa,xl,xr should have been
* set up, the latter two by plc, psc resp.
* mvc is equivalent to the sequence
*
*
*         mov  wb,dumpb
*         lct  wa,wa
* loopc   lch  wb,(xl)+
*         sch  wb,(xr)+
*         bct  wa,loopc
*         csc  xr
*         mov  dumpb,wb
*
*
* the character pointers are bumped as indicated
* and the final value of wa is undefined.
*
*
*
*
* 9.2 mvw                move words
*
*
* mvw is equivalent to the sequence
*
*
* loopw   mov  (xl)+,(xr)+
*         dca  wa                wa = bytes to move
*         bnz  wa,loopw
*
*
* note that this implies that the value in wa is the
* length in bytes which is a multiple of cfp$b.
* the initial addresses in xr,xl are word addresses.
* as indicated, the final xr,xl values point past the
* new and old regions of memory respectively.
* the final value of wa is undefined.
* wa,xl,xr must be set up before obeying mvw.
*
*
* 9.3 mwb                move words backwards
*
*
* mwb is equivalent to the sequence

```



```

*      loopb  mov  -(xl),-(xr)
*              dca  wa              wa = bytes to move
*              bnz  wa,loopb
*
*      there is a requirement that the initial value in xl
*      be at least 256 less than the value in xr. this
*      allows an implementation in which chunks of 256
*      bytes are moved forward (ibm 360, icl 1900).
*      the final value of wa is undefined.
*      wa,xl,xr must be set up before obeying mwb.
*
*      9.4  mcb              move characters backwards
*
*      mcb is equivalent to the sequence
*
*              mov  wb,dumpb
*              lct  wa,wa
*      loopc  lch  wb,-(xl)
*              sch  wb,-(xr)
*              bct  wa,loopc
*              csc  xr
*              mov  dumpb,wb
*
*      there is a requirement that the initial value in xl
*      be at least 256 less than the value in xr. this
*      allows an implementation in which chunks of 256
*      bytes are moved forward (ibm 360, icl 1900).
*      the final value of wa is undefined.
*      wa,xl,xr must be set up before obeying mcb.

```

```

*
* -10- operations connected with the stack
*
* the stack is an area in memory which is dedicated for use
* in conjunction with the stack pointer register (xs). as
* previously described, it is used by the jsr and exi
* instructions and may be used for storage of any other
* data as required.
*
* the stack builds either way in memory and an important
* restriction is that the value in (xs) must be the address
* of the stack front at all times since
* some implementations may randomly destroy stack locations
* beyond (xs).
*
* the starting stack base address is passed
* in (xs) at the start of execution. during execution it
* is necessary to make sure that the stack does not
* overflow. this is achieved by executing the following
* instruction periodically.
*
* 10.1 chk                check stack overflow
*
* after successfully executing chk, it is permissible to
* use up to 100 additional words before issuing another chk
* thus chk need not be issued every time the stack is
* expanded. in some implementations, the checking may be
* automatic and chk will have no effect. following the
* above rule makes sure that the program will operate
* correctly in implementations with no automatic check.
*
* if stack overflow occurs (detected either automatically
* or by a chk instruction), then control is passed to the
* stack overflow section (see program form). note that this
* transfer may take place following any instruction which
* stores data at a new location on the stack.
* after stack overflow, stack is arbitrarily popped
* to give some space in which the error procedure may
* operate. otherwise a loop of stack overflows may occur.

```

```

*
* -11- data generation instructions
*
* the following instructions are used to generate constant
* values in the constant section and also to assemble
* initial values in the working storage section. they
* may not appear except in these two sections.
*
* 11.1 dac  addr      assemble address constant.
*                      generates one word containing the
*                      specified one word integer
*                      value (address).
*
* 11.2 dic  integer   generates an integer value which
*                      occupies cfp$i consecutive words.
*                      the operand is a digit string with
*                      a required leading sign.
*
* 11.3 drc  real      assembles a real constant which
*                      occupies cfp$r consecutive words.
*                      the operand form must obey the
*                      rules for a fortran real constant
*                      with the extra requirement that a
*                      leading sign be present.
*
* 11.4 dtc  dtext     define text constant. dtext
*                      is started and ended with any
*                      character not contained in the
*                      characters to be assembled. the
*                      constant occupies consecutive words
*                      as dictated by the configuration
*                      parameter cfp$c. any unused chars
*                      in the last word are right filled
*                      with zeros (i.e. the character
*                      whose internal code is zero).
*                      the string contains a sequence of
*                      letters, digits, blanks and any of
*                      the following special characters.
*                      =, $, (, *, ) / + -
*                      no other characters
*                      may be used in a dtext operand.
*
* 11.5 dbc  val       assemble bit string constant. the
*                      operand is a positive integer
*                      value which is interpreted in
*                      binary, right justified and left
*                      filled with zero bits. thus 5 would
*                      imply the bit string value 00...101.

```

```

*
* -12- symbol definition instructions
*
* the following instruction is used to define symbols
* in the definitions section. it may not be used elsewhere.
*
* 12.1 equ  eqop      define symbol
*
*     the symbol which appears in the label field is
*     defined to have the absolute value given
*     by the eqop operand. a given symbol may be defined
*     only once in this manner, and any symbols occurring
*     in eqop must be previously defined.
*
*     the following are the possibilities for eqop
*
*     val           the indicated value is used
*
*     val+val       the sum of the two values is used.
*                   this sum must not exceed cfp$m
*
*     val-val       the difference between the two
*                   values (must be positive) is used.
*
*     *             this format defines the label by
*                   using a value supplied by the
*                   minimal translator. values are
*                   required for the
*
*     cfp$x         (configuration parameters)
*     e$xxx         (environment parameters)
*     ch$xx         (character codes).
*
*                   in order for a translator to
*                   handle this format correctly the
*                   definitions section must be
*                   consulted for details of required
*                   symbols as listed at the front of
*                   the section.

```

```

*
* symbol definition instructions (continued)
*
* the following instructions may be used to define symbols
* in the procedure section. they may not be used in
* any other part of the program.
*
* 12.2 exp                define external procedure
*
*     exp defines the symbol appearing in the label field
*     to be the name of an external procedure which can be
*     referenced in a subsequent jsr instruction. the
*     coding for the procedure is external to the
*     coding of the source program in this language.
*     the code for external procedures may be
*     referred to collectively as the operating system
*     interface, or more briefly, osint, and will
*     frequently be a separately compiled segment of code
*     loaded with spitbol to produce a complete system.
*
* 12.3 inp  ptyp,int      define internal procedure
*
*     inp defines the symbol appearing in the label field
*     to be the name of an internal procedure and gives
*     its type and number of exit parameters. the label
*     can be referenced in jsr instructions and
*     it must appear labelling a prc instruction in the
*     program section.
*
* 12.4 inr                define internal routine
*
*     inr defines the symbol appearing in the label
*     field to be the name of an internal routine. the
*     label may be referenced in any type of branch order
*     and it must appear labelling a rtn instruction in
*     the program section.

```

```

*
* -13- assembly listing layout instructions
*
* 13.1 ejc          eject to next page
*
* 13.2 ttl  text    set new assembly title
*
*      ttl implies an immediate eject of the
*      assembly listing to print the new title.
*
*      the use of ttl and ejc cards is such that the
*      program will list neatly if the printer prints
*      as many as 58 lines per page. in the event that
*      the printer depth is less than this, or if the
*      listing contains interspersed lines (such as actual
*      generated code), then the format may be upset.
*
*      lines starting with an asterisk are comment lines
*      which cause no code to be generated and may occur
*      freely anywhere in the program. the format for
*      comment lines is given in section -15-.

```

```

*
* -14- program form
*
*     the program consists of separate sections separated
*     by sec operations. the sections must appear in the
*     following specified order.
*
* 14.1 sec                start of procedure section
*
*     (procedure section)
*
*     sec                start of definitions section
*
*     (definitions section)
*
*     sec                start of constant storage section
*
*     (constant storage section)
*
*     sec                start of working storage section
*
*     (working storage section)
*
*     sec                start of program section
*
*     (program section)
*
*     sec                start of stack overflow section
*
*     (stack overflow section)
*
*     sec                start of error section
*
*     (error section)
*
* 14.2 end                end of assembly

```

```

*
* section 10 - program form
*
* procedure section
*
*     the procedure section contains all the exp
*     instructions for externally available procedures
*     and inp,inr opcodes for internal procedures,routines
*     so that a single pass minimal translator has advance
*     knowledge of procedure types when translating calls.
*
* definitions section
*
*     the definitions section contains equ instructions
*     which define symbols referenced later on in the
*     program, constant and work sections.
*
* constant storage section
*
*     the constant storage section consists entirely
*     of constants assembled with the dac,dic,drc,dtc,dbc
*     assembly operations. these constants can be freely
*     referenced by the program instructions.
*
* working storage section
*
*     the working storage section consists entirely of
*     dac,dic,drc,dbc,dtc instructions to define a fixed
*     length work area. the work locations in this area
*     can be directly referenced in program instructions.
*     the area is initialized in accordance with the
*     values assembled in the instructions.
*
* program section
*
*     the program section contains program instructions
*     and associated operations (such as prc, enp, ent).
*     control is passed to the first instruction in this
*     section when execution is initiated.
*
* stack overflow section
*
*     the stack overflow section contains instructions
*     like the program section. control is passed to the
*     first instruction in this section following the
*     occurrence of stack overflow, see chk instruction.
*
* error section
*
*     the error section contains instructions like the
*     program section. control is passed to the first
*     instruction in this section when a procedure exit
*     corresponds to an error parameter (see err)

```


* or when an erb opcode is obeyed. the error code
* must clean up the main stack and cater for the
* possibility that a subroutine stack may need clean
* up.

```
*      osint
*
*      though not part of the minimal source, it is useful
*      to refer to the collection of initialisation and
*      exp routines as osint (operating system interface).
*      errors occurring within osint procedures are
*      usually handled by making an error return. if this
*      is not feasible or appropriate, osint may use the
*      minimal error section to report errors directly by
*      branching to it with a suitable numeric error
*      code in wa.
```

```

*
* section 11 - statement format
*
* all labels are exactly five characters long and start
* with three letters (abcdefghijklmnopqrstuvwxy$) followed
* by two letters or digits.
* the letter z may not be used in minimal symbols but $ is
* permitted.
* for implementations where $ may not appear in the
* target code , a simple substitution of z for $
* may thus be made without risk of producing non-unique
* symbols.
* the letter z is however permitted in opcode mnemonics and
* in comments.
*
* minimal statements are in a fixed format as follows.
*
* cols 1-5          label if any (else blank)
*
* cols 6-7          always blank
*
* cols 8-10         operation mnemonic
*
* cols 11-12        blanks
*
* cols 13-28        operand field, terminated by a
*                   blank. may occasionally
*                   extend past column 28.
*
* cols 30-64        comment. always separated from the
*                   operand field by at least one blank
*                   may occasionally start after column
*                   30 if the operand extends past 28.
*                   a special exception occurs for the
*                   iff instruction, whose comment may
*                   be only 20 characters long (30-49).
*
* cols 65 on        unused
*
*
* comment lines have the following format
*
* col 1             asterisk
*
* cols 2-7          blank
*
* cols 8-64         arbitrary text, restricted to the
*                   fortran character set.
*
*
* the fortran character set is a-z 0-9 =,$.(*)-/+

```

```

*
* section 12 - program execution
*
* execution of the program begins with the first
* instruction in the program section.
*
* in addition to the fixed length memory regions defined
* by the assembly, there are two dynamically allocated
* memory regions as follows.
*
* data area          this is an area available to the
*                    program for general storage of data
*                    any data value may be stored in
*                    this area except instructions.
*                    in some implementations, it may be
*                    possible to increase the size of
*                    this area dynamically by adding
*                    words at the top end with a call
*                    to a system procedure.
*
* stack area         this region of memory holds
*                    the stack used for subroutine calls
*                    and other storage of one word
*                    integer values (addresses). this
*                    is the stack associated with
*                    index register xs.
*
* the locations and sizes of these areas are specified
* by the values in the registers at the start of program
* execution as follows.
*
* (xs)              address one past the stack base.
*                   e.g. if xs is 23456, a d-stack will
*                   occupy words 23455,23454,...
*                   whereas a u-stack will occupy
*                   23457,23458,...
*
* (xr)              address of the first word
*                   in the data area
*
* (xl)              address of the last word in the
*                   data area.
*
* (wa)              initial stack pointer
*
* (wb,wc,ia,ra,cp)  zero
*
* there is no explicit way to terminate the execution of a
* program. this function is performed by an appropriate
* system procedure referenced with the sysej instruction.

```

spitbol – basic information

```

*
* general structure
* -----
*
* this program is a translator for a version of the snobol4
* programming language. language details are contained in
* the manual macro spitbol by dewar and mccann, technical
* report 90, university of leeds 1976.
* the implementation is discussed in dewar and mccann,
* macro spitbol - a snobol4 compiler, software practice and
* experience, 7, 95-113, 1977.
* the language is as implemented by the btl translator
* (griswold, poage and polonsky, prentice hall, 1971)
* with the following principal exceptions.
*
* 1)  redefinition of standard system functions and
*      operators is not permitted.
*
* 2)  the value function is not provided.
*
* 3)  access tracing is provided in addition to the
*      other standard trace modes.
*
* 4)  the keyword stfcount is not provided.
*
* 5)  the keyword fullscan is not provided and all pattern
*      matching takes place in fullscan mode (i.e. with no
*      heuristics applied).
*
* 6)  a series of expressions separated by commas may
*      be grouped within parentheses to provide a selection
*      capability. the semantics are that the selection
*      assumes the value of the first expression within it
*      which succeeds as they are evaluated from the left.
*      if no expression succeeds the entire statement fails
*
* 7)  an explicit pattern matching operator is provided.
*      this is the binary query (see gimpel sigplan oct 74)
*
* 8)  the assignment operator is introduced as in the
*      gimpel reference.
*
* 9)  the exit function is provided for generating load
*      modules - cf. gimpels sitbol.
*
*
* the method used in this program is to translate the
* source code into an internal pseudo-code (see following
* section). an interpreter is then used to execute this
* generated pseudo-code. the nature of the snobol4 language
* is such that the latter task is much more complex than
* the actual translation phase. accordingly, nearly all the
* code in the program section is concerned with the actual

```

* execution of the snobol4 program.

```

*
* interpretive code format
* -----
*
* the interpretive pseudo-code consists of a series of
* address pointers. the exact format of the code is
* described in connection with the cdblk format. the
* purpose of this section is to give general insight into
* the interpretive approach involved.
*
* the basic form of the code is related to reverse polish.
* in other words, the operands precede the operators which
* are zero address operators. there are some exceptions to
* these rules, notably the unary not operator and the
* selection construction which clearly require advance
* knowledge of the operator involved.
*
* the operands are moved to the top of the main stack and
* the operators are applied to the top stack entries. like
* other versions of spitbol, this processor depends on
* knowing whether operands are required by name or by value
* and moves the appropriate object to the stack. thus no
* name/value checks are included in the operator circuits.
*
* the actual pointers in the code point to a block whose
* first word is the address of the interpreter routine
* to be executed for the code word.
*
* in the case of operators, the pointer is to a word which
* contains the address of the operator to be executed. in
* the case of operands such as constants, the pointer is to
* the operand itself. accordingly, all operands contain
* a field which points to the routine to load the value of
* the operand onto the stack. in the case of a variable,
* there are three such pointers. one to load the value,
* one to store the value and a third to jump to the label.
*
* the handling of failure returns deserves special comment.
* the location flptr contains the pointer to the location
* on the main stack which contains the failure return
* which is in the form of a byte offset in the current
* code block (cdblk or exblk). when a failure occurs, the
* stack is popped as indicated by the setting of flptr and
* control is passed to the appropriate location in the
* current code block with the stack pointer pointing to the
* failure offset on the stack and flptr unchanged.

```



```

*
*   internal data representations
*   -----
*
*   representation of values
*
*   a value is represented by a pointer to a block which
*   describes the type and particulars of the data value.
*   in general, a variable is a location containing such a
*   pointer (although in the case of trace associations this
*   is modified, see description of trblk).
*
*   the following is a list of possible datatypes showing the
*   type of block used to hold the value. the details of
*   each block format are given later.
*
*   datatype           block type
*   -----           -
*
*   array              arblk or vcblk
*
*   code               cdblk
*
*   expression         exblk or seblk
*
*   integer            icblk
*
*   name               nmblk
*
*   pattern            p0blk or p1blk or p2blk
*
*   real               rcblk
*
*   string             scblk
*
*   table              tbblk
*
*   program datatype   pdblk

```

```

*
* representation of variables
* -----
*
* during the course of evaluating expressions, it is
* necessary to generate names of variables (for example
* on the left side of a binary equals operator). these are
* not to be confused with objects of datatype name which
* are in fact values.
*
* from a logical point of view, such names could be simply
* represented by a pointer to the appropriate value cell.
* however in the case of arrays and program defined
* datatypes, this would violate the rule that there must be
* no pointers into the middle of a block in dynamic store.
* accordingly, a name is always represented by a base and
* offset. the base points to the start of the block
* containing the variable value and the offset is the
* offset within this block in bytes. thus the address
* of the actual variable is determined by adding the base
* and offset values.
*
* the following are the instances of variables represented
* in this manner.
*
* 1)  natural variable base is ptr to vrblk
*      offset is *vrval
*
* 2)  table element    base is ptr to teblk
*      offset is *teval
*
* 3)  array element    base is ptr to arblk
*      offset is offset to element
*
* 4)  vector element   base is ptr to vcblk
*      offset is offset to element
*
* 5)  prog def dtp     base is ptr to pdblk
*      offset is offset to field value
*
* in addition there are two cases of objects which are
* like variables but cannot be handled in this manner.
* these are called pseudo-variables and are represented
* with a special base pointer as follows=
*
* expression variable  ptr to evblk (see evblk)
*
* keyword variable     ptr to kvblk (see kvblk)
*
* pseudo-variables are handled as special cases by the
* access procedure (acess) and the assignment procedure
* (asign). see these two procedures for details.

```

```

*
* organization of data area
* -----
*
* the data area is divided into two regions.
*
* static area
*
* the static area builds up from the bottom and contains
* data areas which are allocated dynamically but are never
* deleted or moved around. the macro-program itself
* uses the static area for the following.
*
* 1) all variable blocks (vrblk).
*
* 2) the hash table for variable blocks.
*
* 3) miscellaneous buffers and work areas (see program
* initialization section).
*
* in addition, the system procedures may use this area for
* input/output buffers, external functions etc. space in
* the static region is allocated by calling procedure alast
*
* the following global variables define the current
* location and size of the static area.
*
* statb address of start of static area
* state address+1 of last word in area.
*
* the minimum size of static is given approximately by
* 12 + *e$hn + *e$sts + space for alphabet string
* and standard print buffer.

```

```

*      dynamic area
*
*      the dynamic area is built upwards in memory after the
*      static region. data in this area must all be in standard
*      block formats so that it can be processed by the garbage
*      collector (procedure gbccl). gbccl compacts blocks down
*      in this region as required by space exhaustion and can
*      also move all blocks up to allow for expansion of the
*      static region.
*      with the exception of tables and arrays, no spitbol
*      object once built in dynamic memory is ever subsequently
*      modified. observing this rule necessitates a copying
*      action during string and pattern concatenation.
*
*      garbage collection is fundamental to the allocation of
*      space for values. spitbol uses a very efficient garbage
*      collector which insists that pointers into dynamic store
*      should be identifiable without use of bit tables,
*      marker bits etc. to satisfy this requirement, dynamic
*      memory must not start at too low an address and lengths
*      of arrays, tables, strings, code and expression blocks
*      may not exceed the numerical value of the lowest dynamic
*      address.
*
*      to avoid either penalizing users with modest
*      requirements or restricting those with greater needs on
*      host systems where dynamic memory is allocated in low
*      addresses, the minimum dynamic address may be specified
*      sufficiently high to permit arbitrarily large spitbol
*      objects to be created (with the possibility in extreme
*      cases of wasting large amounts of memory below the
*      start address). this minimum value is made available
*      in variable mxlen by a system routine, sysmx.
*      alternatively sysmx may indicate that a
*      default may be used in which dynamic is placed
*      at the lowest possible address following static.
*
*      the following global work cells define the location and
*      length of the dynamic area.
*
*      dnamb          start of dynamic area
*      dnamp          next available location
*      dname          last available location + 1
*
*      dnamb is always higher than state since the alost
*      procedure maintains some expansion space above state.
*      *** dnamb must never be permitted to have a value less
*      than that in mxlen ***
*
*      space in the dynamic region is allocated by the alloc
*      procedure. the dynamic region may be used by system
*      procedures provided that all the rules are obeyed.
*      some of the rules are subtle so it is preferable for

```

* osint to manage its own memory needs. spitbol procs
* obey rules to ensure that no action can cause a garbage
* collection except at such times as contents of xl, xr
* and the stack are +clean+ (see comment before utility
* procedures and in gbcol for more detail). note
* that calls of alast may cause garbage collection (shift
* of memory to free space). spitbol procs which call
* system routines assume that they cannot precipitate
* collection and this must be respected.

```

*
*   register usage
*   -----
*
*   (cp)           code pointer register. used to
*                   hold a pointer to the current
*                   location in the interpretive pseudo
*                   code (i.e. ptr into a cdblk).
*
*   (xl,xr)        general index registers. usually
*                   used to hold pointers to blocks in
*                   dynamic storage. an important
*                   restriction is that the value in
*                   xl must be collectable for
*                   a garbage collect call. a value
*                   is collectable if it either points
*                   outside the dynamic area, or if it
*                   points to the start of a block in
*                   the dynamic area.
*
*   (xs)           stack pointer. used to point to
*                   the stack front. the stack may
*                   build up or down and is used
*                   to stack subroutine return points
*                   and other recursively saved data.
*
*   (xt)           an alternative name for xl during
*                   its use in accessing stacked items.
*
*   (wa,wb,wc)     general work registers. cannot be
*                   used for indexing, but may hold
*                   various types of data.
*
*   (ia)           used for all signed integer
*                   arithmetic, both that used by the
*                   translator and that arising from
*                   use of snobol4 arithmetic operators
*
*   (ra)           real accumulator. used for all
*                   floating point arithmetic.

```

```

*
* spitbol conditional assembly symbols
* -----
*
* in the spitbol translator, the following conditional
* assembly symbols are referred to. to incorporate the
* features referred to, the minimal source should be
* prefaced by suitable conditional assembly symbol
* definitions.
*
* in all cases it is permissible to default the definitions
* in which case the additional features will be omitted
* from the target code.
*
* .caex          define to allow up arrow for expon.
* .caht          define to include horizontal tab
* .casl          define to include 26 shifted lettrs
* .cavt          define to include vertical tab
* .cbyt          define for statistics in bytes
* .ccmc          define to include syscm function
* .ccmk          define to include compare keyword
* .cepp          define if entrys have odd parity
* .cera          define to include sysea function
* .cexp          define if spitbol pops sysex args
* .cgbc          define to include sysgc function
* .cicc          define to ignore bad control cards
* .cinc          define to add -include control card
* .ciod          define to not use default delimiter
*                in processing 3rd arg of input()
*                and output()
*
* .cmth          define to include math functions
* .cnbf          define to omit buffer extension
* .cnbt          define to omit batch initialisation
* .cncl          define to enable sysci routine
* .cncl          define to enable syscr routine
* .cnex          define to omit exit() code.
* .cnld          define to omit load() code.
* .cnlf          define to add file type for load()
* .cnpf          define to omit profile stuff
* .cnra          define to omit all real arithmetic
* .cnsc          define to no numeric-string compare
* .cnsl          define to omit sort, rsort
* .cpol          define if interface polling desired
* .crel          define to include reloc routines
* .crpp          define if returns have odd parity
* .cs16          define to initialize stlim to 32767
* .cs32          define to init stlim to 2147483647
*                omit to take default of 50000
* .csax          define if sysax is to be called
* .csed          define to use sediment in gbcol
* .csfn          define to track source file names
* .csln          define if line number in code block
* .csn5          define to pad stmt nos to 5 chars
* .csn6          define to pad stmt nos to 6 chars

```

```

*      .csn8      define to pad stmt nos to 8 chars
*      .csou      define if output, terminal to sysou
*      .ctet      define to table entry trace wanted
*      .ctmd      define if systm unit is decisecond
*      .cucf      define to include cfp$u
*      .cuej      define to suppress needless ejects
*      .culk      define to include &l/ucase keywords
*      .culc      define to include &case (lc names)
*                  if cucl defined, must support
*                  minimal op flc wreg that folds
*                  argument to upper case
*      .cust      define to include set() code
*
*                  conditional options
*                  since .undef not allowed if symbol
*                  not defined, a full comment line
*                  indicates symbol initially not
*                  defined.
*
.def    .caex      define to allow up arrow for expon.
.def    .caht      define to include horizontal tab
.def    .casl      define to include 26 shifted lettrs
.def    .cavt      define to include vertical tab
*
*      .cbyt      define for statistics in bytes
*      .ccmc      define to include syscm function
*      .ccmk      define to include compare keyword
*      .cepp      define if entrys have odd parity
*      .cera      define to include sysea function
*      .cexp      define if spitbol pops sysex args
.def    .cgbc      define to include sysgc function
*
*      .cicc      define to ignore bad control cards
*      .cinc      define to add -include control card
.def    .ciod      define to not use default delimiter
*
*                  in processing 3rd arg of input()
*                  and output()
*      .cmth      define to include math functions
.def    .cnbf      define to omit buffer extension
.def    .cnbt      define to omit batch initialisation
*
*      .ncni      define to enable sysci routine
*      .cncr      define to enable syscr routine
*      .cnex      define to omit exit() code.
.def    .cnld      define to omit load() code.
*
*      .cnlf      define to add file type to load()
*      .cnpf      define to omit profile stuff
*      .cnra      define to omit all real arithmetic
*      .cnsc      define if no numeric-string compare
*      .cnshr      define to omit sort, rsort
*      .cpol      define if interface polling desired
*      .crel      define to include reloc routines
*      .crpp      define if returns have odd parity
*      .cs16      define to initialize stlim to 32767

```



```

*          .cs32          define to init stlim to 2147483647
.def       .csax          define if sysax is to be called
*          .csed          define to use sediment in gbcol
*          .csfn          define to track source file names
*          .csln          define if line number in code block
*          .csn5          define to pad stmt nos to 5 chars
*          .csn6          define to pad stmt nos to 6 chars
.def       .csn8          define to pad stmt nos to 8 chars
*          .csou          define if output, terminal to sysou
.def       .ctet          define to table entry trace wanted
*          .ctmd          define if systm unit is decisecond
.def       .cucf          define to include cfp$u
.def       .cuej          define to suppress needless ejects
.def       .culk          define to include &l/ucase keywords
.def       .culc          define to include &case (lc names)
.def       .cust          define to include set() code
*
*          force definition of .ccmk if .ccmc is defined
*
if .ccmc
.def       .ccmk
fi

```

spitbol – procedures section

*
* this section starts with descriptions of the operating
* system dependent procedures which are used by the spitbol
* translator. all such procedures have five letter names
* beginning with sys. they are listed in alphabetical
* order.
* all procedures have a specification consisting of a
* model call, preceded by a possibly empty list of register
* contents giving parameters available to the procedure and
* followed by a possibly empty list of register contents
* required on return from the call or which may have had
* their contents destroyed. only those registers explicitly
* mentioned in the list after the call may have their
* values changed.
* the segment of code providing the external procedures is
* conveniently referred to as osint (operating system
* interface). the sysxx procedures it contains provide
* facilities not usually available as primitives in
* assembly languages. for particular target machines,
* implementors may choose for some minimal opcodes which
* do not have reasonably direct translations, to use calls
* of additional procedures which they provide in osint.
* e.g. mwb or trc might be translated as jsr sysmb,
* jsr systc in some implementations.
*
* in the descriptions, reference is made to --blk
* formats (-- = a pair of letters). see the spitbol
* definitions section for detailed descriptions of all
* such block formats except fcbk for which sysfc should
* be consulted.
*
* section 0 contains inp,inr specifications of internal
* procedures,routines. this gives a single pass translator
* information making it easy to generate alternative calls
* in the translation of jsr-s for procedures of different
* types if this proves necessary.
*

sec start of procedures section
if .csax

```

*
*      sysax -- after execution
*
sysax  exp                                define external entry point
*
*      if the conditional assembly symbol .csax is defined,
*      this routine is called immediately after execution and
*      before printing of execution statistics or dump output.
*      purpose of call is for implementor to determine and
*      if the call is not required it will be omitted if .csax
*      is undefined. in this case sysax need not be coded.
*
*      jsr  sysax                call after execution
else
fi

```

```

if .cbasp
*
*      sysbs -- backspace file
*
sysbs      exp                                define external entry point
*
*      sysbs is used to implement the snobol4 function backspace
*      if the conditional assembly symbol .cbasp is defined.
*      the meaning is system dependent.  in general, backspace
*      repositions the file one record closer to the beginning
*      of file, such that a subsequent read or write will
*      operate on the previous record.
*
*      (wa)                ptr to fcblk or zero
*      (xr)                backspace argument (scblk ptr)
*      jsr sysbs           call to backspace
*      ppm loc            return here if file does not exist
*      ppm loc            return here if backspace not allowed
*      ppm loc            return here if i/o error
*      (wa,wb)            destroyed
*
*      the second error return is used for files for which
*      backspace is not permitted.  for example, it may be expected
*      files on character devices are in this category.

```

fi

```
*
*      sysbx -- before execution
*
sysbx  exp                                define external entry point
*
*      called after initial spitbol compilation and before
*      commencing execution in case osint needs
*      to assign files or perform other necessary services.
*      osint may also choose to send a message to online
*      terminal (if any) indicating that execution is starting.
*
*      jsr sysbx                          call before execution starts
```

```

if .cnci
*
*      sysci -- convert integer
*
sysci  exp
*
*      sysci is an optional osint routine that causes spitbol to
*      call sysci to convert integer values to strings, rather
*      than using the internal spitbol conversion code.  this
*      code may be less efficient on machines with hardware
*      conversion instructions and in such cases, it may be an
*      advantage to include sysci.  the symbol .cnci must be
*      defined if this routine is to be used.
*
*      the rules for converting integers to strings are that
*      positive values are represented without any sign, and
*      there are never any leading blanks or zeros, except in
*      the case of zero itself which is represented as a single
*      zero digit.  negative numbers are represented with a
*      preceeding minus sign.  there are never any trailing
*      blanks, and conversion cannot fail.
*
*      (ia)                value to be converted
*      jsr sysci            call to convert integer value
*      (xl)                pointer to pseudo-scbk with string

```

fi

if .ccmc

```
*
*      syscm -- general string comparison function
*
syscm  exp                                define external entry point
*
*      provides string comparison determined by interface.
*      used for international string comparison.
*
*      (xr)                character pointer for first string
*      (xl)                character pointer for second string
*      (wb)                character count of first string
*      (wa)                character count of second string
*      jsr syscm           call to syscm function
*      ppm loc             string too long for syscm
*      ppm loc             first string lexically gt second
*      ppm loc             first string lexically lt second
*      ---                strings equal
*      (xl)                zero
*      (xr)                destroyed
*
```

fi

if .cnra

else

if .cncr

*

*

syscr -- convert real

*

syscr exp

*

*

syscr is an optional osint routine that causes spitbol to call syscr to convert real values to strings, rather than using the internal spitbol conversion code. this code may be desired on machines where the integer size is too small to allow production of a sufficient number of significant digits. the symbol .cncr must be defined if this routine is to be used.

*

*

the rules for converting reals to strings are that positive values are represented without any sign, and there are never any leading blanks or zeros, except in the case of zero itself which is represented as a single zero digit. negative numbers are represented with a preceeding minus sign. there are never any trailing blanks, or trailing zeros in the fractional part. conversion cannot fail.

*

*

(ra) value to be converted

*

(wa) no. of significant digits desired

*

(wb) conversion type:

*

negative for e-type conversion

*

zero for g-type conversion

*

positive for f-type conversion

*

(wc) character positions in result scblk

*

(xr) scblk for result

*

jsr syscr call to convert real value

*

(xr) result scblk

*

(wa) number of result characters

fi

fi

```

*
*      sysdc -- date check
*
sysdc  exp                                define external entry point
*
*      sysdc is called to check that the expiry date for a trial
*      version of spitbol is unexpired.
*
*      jsr  sysdc                call to check date
*      return only if date is ok

```

```

*
*      sysdm  -- dump core
*
sysdm  exp                                define external entry point
*
*      sysdm is called by a spitbol program call of dump(n) with
*      n ge 4.  its purpose is to provide a core dump.
*      n could hold an encoding of the start adrs for dump and
*      amount to be dumped e.g.  n = 256*a + s , s = start adrs
*      in kilowords,  a = kilowords to dump
*
*      (xr)                parameter n of call dump(n)
*      jsr  sysdm           call to enter routine

```

```

*
*      sysdt -- get current date
*
sysdt  exp                                define external entry point
*
*      sysdt is used to obtain the current date. the date is
*      returned as a character string in any format appropriate
*      to the operating system in use. it may also contain the
*      current time of day. sysdt is used to implement the
*      snobol4 function date().
*
*      (xr)                parameter n of call date(n)
*      jsr  sysdt           call to get date
*      (xl)                pointer to block containing date
*
*      the format of the block is like an scblk except that
*      the first word need not be set. the result is copied
*      into spitbol dynamic memory on return.
if .cera

```

```

*
*      sysea -- inform osint of compilation and runtime errors
*
sysea  exp                                define external entry point
*
*      provides means for interface to take special actions on
*      errors
*
*      (wa)                error code
*      (wb)                line number
*      (wc)                column number
*      (xr)                system stage
if .csfn
*      (xl)                file name (scblk)
fi
*
*      jsr sysea           call to sysea function
*      ppm loc            suppress printing of error message
*      (xr)               message to print (scblk) or 0
*
*      sysea may not return if interface chooses to retain
*      control.  closing files via the fcb chain will be the
*      responsibility of the interface.
*
*      all registers preserved
fi

```

```

*
*      sysef -- eject file
*
sysef  exp                                define external entry point
*
*      sysef is used to write a page eject to a named file. it
*      may only be used for files where this concept makes
*      sense. note that sysef is not normally used for the
*      standard output file (see sysep).
*
*      (wa)                ptr to fcbk or zero
*      (xr)                eject argument (scblk ptr)
*      jsr  sysef          call to eject file
*      ppm  loc            return here if file does not exist
*      ppm  loc            return here if inappropriate file
*      ppm  loc            return here if i/o error

```

```

*
*      sysej -- end of job
*
sysej  exp                                define external entry point
*
*      sysej is called once at the end of execution to
*      terminate the run. the significance of the abend and
*      code values is system dependent. in general, the code
*      value should be made available for testing, and the
*      abend value should cause some post-mortem action such as
*      a dump. note that sysej does not return to its caller.
*      see sysxi for details of fcblk chain
*
*      (wa)                value of abend keyword
*      (wb)                value of code keyword
*      (xl)                o or ptr to head of fcblk chain
*      jsr  sysej          call to end job
*
*      the following special values are used as codes in (wb)
*      999  execution suppressed
*      998  standard output file full or unavailable in a sysxi
*           load module. in these cases (wa) contains the number
*           of the statement causing premature termination.

```

```

*
*      sysem -- get error message text
*
sysem      exp                                define external entry point
*
*      sysem is used to obtain the text of err, erb calls in the
*      source program given the error code number. it is allowed
*      to return a null string if this facility is unavailable.
*
*      (wa)                error code number
*      jsr  sysem          call to get text
*      (xr)                text of message
*
*      the returned value is a pointer to a block in scblk
*      format except that the first word need not be set. the
*      string is copied into dynamic memory on return.
*      if the null string is returned either because sysem does
*      not provide error message texts or because wa is out of
*      range, spitbol will print the string stored in errtext
*      keyword.

```

```

*
*      sysen -- endfile
*
sysen      exp                                define external entry point
*
*      sysen is used to implement the snobol4 function endfile.
*      the meaning is system dependent. in general, endfile
*      implies that no further i/o operations will be performed,
*      but does not guarantee this to be the case. the file
*      should be closed after the call, a subsequent read
*      or write may reopen the file at the start or it may be
*      necessary to reopen the file via sysio.
*
*      (wa)                ptr to fcbk or zero
*      (xr)                endfile argument (scblk ptr)
*      jsr sysen           call to endfile
*      ppm loc            return here if file does not exist
*      ppm loc            return here if endfile not allowed
*      ppm loc            return here if i/o error
*      (wa,wb)            destroyed
*
*      the second error return is used for files for which
*      endfile is not permitted. for example, it may be expected
*      that the standard input and output files are in this
*      category.

```



```

*
*      sysep -- eject printer page
*
sysep  exp                                define external entry point
*
*      sysep is called to perform a page eject on the standard
*      printer output file (corresponding to syspr output).
*
*      jsr  sysep          call to eject printer output

```

```

*
*      sysex -- call external function
*
sysex  exp                                define external entry point
*
*      sysex is called to pass control to an external function
*      previously loaded with a call to sysld.
*
*      (xs)                pointer to arguments on stack
*      (xl)                pointer to control block (efblk)
*      (wa)                number of arguments on stack
*      jsr  sysex          call to pass control to function
*      ppm  loc            return here if function call fails
*      ppm  loc            return here if insufficient memory
*      ppm  loc            return here if bad argument type
if .cexp
else
*      (xs)                popped past arguments
fi
*
*      (xr)                result returned
*
*      the arguments are stored on the stack with
*      the last argument at 0(xs). on return, xs
*      is popped past the arguments.
*
*      the form of the arguments as passed is that used in the
*      spitbol translator (see definitions and data structures
*      section). the control block format is also described
*      (under efbk) in this section.
*
*      there are two ways of returning a result.
*
*      1)  return a pointer to a block in dynamic storage. this
*          block must be in exactly correct format, including
*          the first word. only functions written with intimate
*          knowledge of the system will return in this way.
*
*      2)  string, integer and real results may be returned by
*          pointing to a pseudo-block outside dynamic memory.
*          this block is in icblk, rcblk or scblk format except
*          that the first word will be overwritten
*          by a type word on return and so need not
*          be correctly set. such a result is
*          copied into main storage before proceeding.
*          unconverted results may similarly be returned in a
*          pseudo-block which is in correct format including
*          type word recognisable by garbage collector since
*          block is copied into dynamic memory.

```

```

*
*      sysfc -- file control block routine
*
sysfc  exp                                define external entry point
*
*      see also sysio
*      input and output have 3 arguments referred to as shown
*          input(variable name,file arg1,file arg2)
*          output(variable name,file arg1,file arg2)
*      file arg1 may be an integer or string used to identify
*      an i/o channel. it is converted to a string for checking.
*      the exact significance of file arg2
*      is not rigorously prescribed but to improve portability,
*      the scheme described in the spitbol user manual
*      should be adopted when possible. the preferred form is
*      a string $f$,r$r$,c$c$,i$i$,...,z$z$ where
*      $f$ is an optional file name which is placed first.
*      remaining items may be omitted or included in any order.
*      $r$ is maximum record length
*      $c$ is a carriage control character or character string
*      $i$ is some form of channel identification used in the
*      absence of $f$ to associate the variable
*      with a file allocated dynamically by jcl commands at
*      spitbol load time.
*      ,...,z$z$ are additional fields.
*      if , (comma) cannot be used as a delimiter, .ciod
*      should be defined to introduce by conditional assembly
*      another delimiter (see
*          iodel equ *
*      early in definitions section).
*      sysfc is called when a variable is input or output
*      associated to check file arg1 and file arg2 and
*      to report whether an fcblk (file control
*      block) is necessary and if so what size it should be.
*      this makes it possible for spitbol rather than osint to
*      allocate such a block in dynamic memory if required
*      or alternatively in static memory.
*      the significance of an fcblk , if one is requested, is
*      entirely up to the system interface. the only restriction
*      is that if the fcblk should appear to lie in dynamic
*      memory, pointers to it should be proper pointers to
*      the start of a recognisable and garbage collectable
*      block (this condition will be met if sysfc requests
*      spitbol to provide an fcblk).
*      an option is provided for osint to return a pointer in
*      x1 to an fcblk which it privately allocated. this ptr
*      will be made available when i/o occurs later.
*      private fcblks may have arbitrary contents and spitbol
*      stores nothing in them.

```

```

* the requested size for an fcbk in dynamic memory
* should allow a 2 word overhead for block type and
* length fields. information subsequently stored in the
* remaining words may be arbitrary if an xnblk (external
* non-relocatable block) is requested. if the request is
* for an xrblk (external relocatable block) the
* contents of words should be collectable (i.e. any
* apparent pointers into dynamic should be genuine block
* pointers). these restrictions do not apply if an fcbk
* is allocated outside dynamic or is not allocated at all.
* if an fcbk is requested, its fields will be initialised
* to zero before entry to sysio with the exception of
* words 0 and 1 in which the block type and length
* fields are placed for fcbks in dynamic memory only.
* for the possible use of sysej and sysxi, if fcbks
* are used, a chain is built so that they may all be
* found - see sysxi for details.
* if both file arg1 and file arg2 are null, calls of sysfc
* and sysio are omitted.
* if file arg1 is null (standard input/output file), sysfc
* is called to check non-null file arg2 but any request
* for an fcbk will be ignored, since spitbol handles the
* standard files specially and cannot readily keep fcbk
* pointers for them.
* filearg1 is type checked by spitbol so further checking
* may be unnecessary in many implementations.
* file arg2 is passed so that sysfc may analyse and
* check it. however to assist in this, spitbol also passes
* on the stack the components of this argument with
* file name, $f$ (otherwise null) extracted and stacked
* first.
* the other fields, if any, are extracted as substrings,
* pointers to them are stacked and a count of all items
* stacked is placed in wc. if an fcbk was earlier
* allocated and pointed to via file arg1, sysfc is also
* passed a pointer to this fcbk.
*
* (xl)          file arg1 scblk ptr (2nd arg)
* (xr)          filearg2 (3rd arg) or null
* -(xs)...-(xs)  scblks for $f$, $r$, $c$, ...
* (wc)          no. of stacked scblks above
* (wa)          existing file arg1 fcbk ptr or 0
* (wb)          0/3 for input/output assocn
* jsr sysfc     call to check need for fcbk
* ppm loc       invalid file argument
* ppm loc       fcbk already in use
* (xs)          popped (wc) times
* (wa non zero) byte size of requested fcbk
* (wa=0,xl non zero) private fcbk ptr in xl
* (wa=xl=0)     no fcbk wanted, no private fcbk
* (wc)          0/1/2 request alloc of xrblk/xnblk
*              /static block for use as fcbk
* (wb)          destroyed

```

if .cgbc

```

*
*      sysgc -- inform interface of garbage collections
*
sysgc  exp                                define external entry point
*
*      provides means for interface to take special actions
*      prior to and after a garbage collection.
*
*      possible usages-
*      1. provide visible screen icon of garbage collection
*         in progress
*      2. inform virtual memory manager to ignore page access
*         patterns during garbage collection.  such accesses
*         typically destroy the page working set accumulated
*         by the program.
*      3. inform virtual memory manager that contents of memory
*         freed by garbage collection can be discarded.
*
*      (xr)                non-zero if beginning gc
*                          =0 if completing gc
*      (wa)                dnamb=start of dynamic area
*      (wb)                dnamp=next available location
*      (wc)                dname=last available location + 1
*      jsr sysgc           call to sysgc function
*      all registers preserved

```

fi

```

*
*      syshs -- give access to host computer features
*
syshs      exp                                define external entry point
*
*      provides means for implementing special features
*      on different host computers. the only defined entry is
*      that where all arguments are null in which case syshs
*      returns an scblk containing name of computer,
*      name of operating system and name of site separated by
*      colons. the scblk need not have a correct first field
*      as this is supplied on copying string to dynamic memory.
*      spitbol does no argument checking but does provide a
*      single error return for arguments checked as erroneous
*      by osint. it also provides a single execution error
*      return. if these are inadequate, use may be made of the
*      minimal error section direct as described in minimal
*      documentation, section 10.
*      several non-error returns are provided. the first
*      corresponds to the defined entry or, for implementation
*      defined entries, any string may be returned. the others
*      permit respectively, return a null result, return with a
*      result to be stacked which is pointed at by xr, and a
*      return causing spitbol statement failure. if a returned
*      result is in dynamic memory it must obey garbage
*      collector rules. the only results copied on return
*      are strings returned via ppm loc3 return.
*
*      (wa)                argument 1
*      (xl)                argument 2
*      (xr)                argument 3
*      (wb)                argument 4
*      (wc)                argument 5
*      jsr syshs           call to get host information
*      ppm loc1            erroneous arg
*      ppm loc2            execution error
*      ppm loc3            scblk ptr in xl or 0 if unavailable
*      ppm loc4            return a null result
*      ppm loc5            return result in xr
*      ppm loc6            cause statement failure
*      ppm loc7            return string at xl, length wa
*      ppm loc8            return copy of result in xr

```

```

*
*      sysid -- return system identification
*
sysid      exp                                define external entry point
*
*      this routine should return strings to head the standard
*      printer output. the first string will be appended to
*      a heading line of the form
*          macro spitbol version v.v
*      supplied by spitbol itself. v.v are digits giving the
*      major version number and generally at least a minor
*      version number relating to osint should be supplied to
*      give say
*          macro spitbol version v.v(m.m)
*      the second string should identify at least the machine
*      and operating system. preferably it should include
*      the date and time of the run.
*      optionally the strings may include site name of the
*      the implementor and/or machine on which run takes place,
*      unique site or copy number and other information as
*      appropriate without making it so long as to be a
*      nuisance to users.
*      the first words of the scblks pointed at need not be
*      correctly set.
*
*      jsr sysid          call for system identification
*      (xr)              scblk ptr for addition to header
*      (xl)              scblk ptr for second header

```



```

if .cinc
*
*
*      sysif -- switch to new include file
*
sysif      exp                                define external entry point
*
*      sysif is used for include file processing, both to inform
*      the interface when a new include file is desired, and
*      when the end of file of an include file has been reached
*      and it is desired to return to reading from the previous
*      nested file.
*
*      it is the responsibility of sysif to remember the file
*      access path to the present input file before switching to
*      the new include file.
*
*      (xl)                ptr to scblk or zero
*      (xr)                ptr to vacant scblk of length cswin
*                          (xr not used if xl is zero)
*      jsr  sysif          call to change files
*      ppm  loc            unable to open file
*      (xr)                scblk with full path name of file
*                          (xr not used if input xl is zero)
*
*      register xl points to an scblk containing the name of the
*      include file to which the interface should switch.  data
*      is fetched from the file upon the next call to sysrd.
*
*      sysif may have the ability to search multiple libraries
*      for the include file named in (xl).  it is therefore
*      required that the full path name of the file where the
*      file was finally located be returned in (xr).  it is this
*      name that is recorded along with the source statements,
*      and will accompany subsequent error messages.
*
*      register xl is zero to mark conclusion of use of an
*      include file.

```

fi

```
*
*      sysil -- get input record length
*
sysil  exp                                define external entry point
*
*      sysil is used to get the length of the next input record
*      from a file previously input associated with a sysio
*      call. the length returned is used to establish a buffer
*      for a subsequent sysin call.  sysil also indicates to the
*      caller if this is a binary or text file.
*
*      (wa)                ptr to fcbk or zero
*      jsr  sysil           call to get record length
*      (wa)                length or zero if file closed
*      (wc)                zero if binary, non-zero if text
*
*      no harm is done if the value returned is too long since
*      unused space will be reclaimed after the sysin call.
*
*      note that it is the sysil call (not the sysio call) which
*      causes the file to be opened as required for the first
*      record input from the file.
```

```

*
*      sysin -- read input record
*
sysin  exp                                define external entry point
*
*      sysin is used to read a record from the file which was
*      referenced in a prior call to sysil (i.e. these calls
*      always occur in pairs). the buffer provided is an
*      scblk for a string of length set from the sysil call.
*      if the actual length read is less than this, the length
*      field of the scblk must be modified before returning
*      unless buffer is right padded with zeroes.
*      it is also permissible to take any of the alternative
*      returns after scblk length has been modified.
*
*      (wa)                ptr to fcblk or zero
*      (xr)                pointer to buffer (scblk ptr)
*      jsr sysin           call to read record
*      ppm loc            endfile or no i/p file after sysxi
*      ppm loc            return here if i/o error
*      ppm loc            return here if record format error
*      (wa,wb,wc)         destroyed

```

```

*
*      sysio -- input/output file association
*
sysio  exp                                define external entry point
*
*      see also sysfc.
*      sysio is called in response to a snobol4 input or output
*      function call except when file arg1 and file arg2
*      are both null.
*      its call always follows immediately after a call
*      of sysfc. if sysfc requested allocation
*      of an fcblk, its address will be in wa.
*      for input files, non-zero values of $r$ should be
*      copied to wc for use in allocating input buffers. if $r$
*      is defaulted or not implemented, wc should be zeroised.
*      once a file has been opened, subsequent input(),output()
*      calls in which the second argument is identical with that
*      in a previous call, merely associate the additional
*      variable name (first argument) to the file and do not
*      result in re-opening the file.
*      in subsequent associated accesses to the file a pointer
*      to any fcblk allocated will be made available.
*
*      (xl)                file arg1 scblk ptr (2nd arg)
*      (xr)                file arg2 scblk ptr (3rd arg)
*      (wa)                fcblk ptr (0 if none)
*      (wb)                0 for input, 3 for output
*      jsr sysio           call to associate file
*      ppm loc             return here if file does not exist
*      ppm loc             return if input/output not allowed
*      (xl)                fcblk pointer (0 if none)
*      (wc)                0 (for default) or max record lngth
*      (wa,wb)             destroyed
*
*      the second error return is used if the file named exists
*      but input/output from the file is not allowed. for
*      example, the standard output file may be in this category
*      as regards input association.

```

```

*
*      sysld -- load external function
*
sysld  exp                                define external entry point
*
*      sysld is called in response to the use of the snobol4
*      load function. the named function is loaded (whatever
*      this means), and a pointer is returned. the pointer will
*      be used on subsequent calls to the function (see sysex).
*
*      (xr)                pointer to function name (scblk)
*      (xl)                pointer to library name (scblk)
*      jsr  sysld          call to load function
*      ppm  loc            return here if func does not exist
*      ppm  loc            return here if i/o error
*      ppm  loc            return here if insufficient memory
*      (xr)                pointer to loaded code
*
*      the significance of the pointer returned is up to the
*      system interface routine. the only restriction is that
*      if the pointer is within dynamic storage, it must be
*      a proper block pointer.

```

```

*
*      sysmm -- get more memory
*
sysmm  exp                                define external entry point
*
*      sysmm is called in an attempt to allocate more dynamic
*      memory. this memory must be allocated contiguously with
*      the current dynamic data area.
*
*      the amount allocated is up to the system to decide. any
*      value is acceptable including zero if allocation is
*      impossible.
*
*      jsr  sysmm          call to get more memory
*      (xr)                number of additional words obtained

```

```

*
*      sysmx -- supply mxlen
*
sysmx  exp                                define external entry point
*
*      because of the method of garbage collection, no spitbol
*      object is allowed to occupy more bytes of memory than
*      the integer giving the lowest address of dynamic
*      (garbage collectable) memory. mxlen is the name used to
*      refer to this maximum length of an object and for most
*      users of most implementations, provided dynamic memory
*      starts at an address of at least a few thousand words,
*      there is no problem.
*      if the default starting address is less than say 10000 or
*      20000, then a load time option should be provided where a
*      user can request that he be able to create larger
*      objects. this routine informs spitbol of this request if
*      any. the value returned is either an integer
*      representing the desired value of mxlen (and hence the
*      minimum dynamic store address which may result in
*      non-use of some store) or zero if a default is acceptable
*      in which mxlen is set to the lowest address allocated
*      to dynamic store before compilation starts.
*      if a non-zero value is returned, this is used for keyword
*      maxlngh. otherwise the initial low address of dynamic
*      memory is used for this keyword.
*
*      jsr  sysmx          call to get mxlen
*      (wa)                either mxlen or 0 for default

```

```

*
*      sysou -- output record
*
sysou  exp                                define external entry point
*
*      sysou is used to write a record to a file previously
*      associated with a sysio call.
*
*      (wa)                                ptr to fcblk
if .csou
*
*      or 0 for terminal or 1 for output
fi
if .cnbf
*      (xr)                                record to be written (scblk)
else
*      (xr)                                record to write (bcblk or scblk)
fi
*
*      jsr sysou                            call to output record
*      ppm loc                             file full or no file after sysxi
*      ppm loc                             return here if i/o error
*      (wa,wb,wc)                          destroyed
*
*      note that it is the sysou call (not the sysio call) which
*      causes the file to be opened as required for the first
*      record output to the file.

```



```

*
*      syspi -- print on interactive channel
*
syspi  exp                                define external entry point
*
*      if spitbol is run from an online terminal, osint can
*      request that messages such as copies of compilation
*      errors be sent to the terminal (see syspp). if relevant
*      reply was made by syspp then syspi is called to send such
*      messages to the interactive channel.
*      syspi is also used for sending output to the terminal
*      through the special variable name, terminal.
*
*      (xr)                ptr to line buffer (scblk)
*      (wa)                line length
*      jsr syspi           call to print line
*      ppm loc            failure return
*      (wa,wb)            destroyed
if .cpol

```

```

*
*      syspl -- provide interactive control of spitbol
*
syspl  exp                                define external entry point
*
*      provides means for interface to take special actions,
*      such as interrupting execution, breakpointing, stepping,
*      and expression evaluation.  these last three options are
*      not presently implemented by the code calling syspl.
*
*      (wa)                                opcode as follows-
*      =0 poll to allow osint to interrupt
*      =1 breakpoint hit
*      =2 completion of statement stepping
*      =3 expression evaluation result
*      (wb)                                statement number
*      r$fcbl                             o or ptr to head of fcblk chain
*      jsr syspl                           call to syspl function
*      ppm loc                             user interruption
*      ppm loc                             step one statement
*      ppm loc                             evaluate expression
*      ---                                resume execution
*      (wa) = new polling interval
*

```

fi

```

*
*      syspp -- obtain print parameters
*
syspp  exp                                define external entry point
*
*      syspp is called once during compilation to obtain
*      parameters required for correct printed output format
*      and to select other options. it may also be called again
*      after sysxi when a load module is resumed. in this
*      case the value returned in wa may be less than or equal
*      to that returned in initial call but may not be
*      greater.
*      the information returned is -
*      1.  line length in chars for standard print file
*      2.  no of lines/page. 0 is preferable for a non-paged
*          device (e.g. online terminal) in which case listing
*          page throws are suppressed and page headers
*          resulting from -title,-stittl lines are kept short.
*      3.  an initial -nolist option to suppress listing unless
*          the program contains an explicit -list.
*      4.  options to suppress listing of compilation and/or
*          execution stats (useful for established programs) -
*          combined with 3. gives possibility of listing
*          file never being opened.
*      5.  option to have copies of errors sent to an
*          interactive channel in addition to standard printer.
*      6.  option to keep page headers short (e.g. if listing
*          to an online terminal).
*      7.  an option to choose extended or compact listing
*          format. in the former a page eject and in the latter
*          a few line feeds precede the printing of each
*          of-- listing, compilation statistics, execution
*          output and execution statistics.
*      8.  an option to suppress execution as though a
*          -noexecute card were supplied.
*      9.  an option to request that name /terminal/ be pre-
*          associated to an online terminal via syspi and sysri
*      10. an intermediate (standard) listing option requiring
*          that page ejects occur in source listings. redundant
*          if extended option chosen but partially extends
*          compact option.
*      11. option to suppress sysid identification.
*
*      jsr syspp          call to get print parameters
*      (wa)              print line length in chars
*      (wb)              number of lines/page
*      (wc)              bits value ...mlkjihgfedcba where
*                        a = 1 to send error copy to int.ch.
*                        b = 1 means std printer is int. ch.
*                        c = 1 for -nolist option
*                        d = 1 to suppress compiln. stats
*
*                        e = 1 to suppress execn. stats

```

```

*           f = 1/0 for extnded/compact listing
*           g = 1 for -noexecute
*           h = 1 pre-associate /terminal/
*
*           i = 1 for standard listing option.
*           j = 1 suppresses listing header
*           k = 1 for -print
*           l = 1 for -noerrors
if .culc
*
*
fi
m = 1 for -case 1

```

```

*
*      syspr -- print line on standard output file
*
syspr  exp                                define external entry point
*
*      syspr is used to print a single line on the standard
*      output file.
*
*      (xr)                pointer to line buffer (scblk)
*      (wa)                line length
*      jsr syspr           call to print line
*      ppm loc            too much o/p or no file after sysxi
*      (wa,wb)            destroyed
*
*      the buffer pointed to is the length obtained from the
*      syspp call and is filled out with trailing blanks. the
*      value in wa is the actual line length which may be less
*      than the maximum line length possible. there is no space
*      control associated with the line, all lines are printed
*      single spaced. note that null lines (wa=0) are possible
*      in which case a blank line is to be printed.
*
*      the error exit is used for systems which limit the amount
*      of printed output. if possible, printing should be
*      permitted after this condition has been signalled once to
*      allow for dump and other diagnostic information.
*      assuming this to be possible, spitbol may make more syspr
*      calls. if the error return occurs another time, execution
*      is terminated by a call of sysej with ending code 998.

```

```

*
*      sysrd -- read record from standard input file
*
sysrd  exp                                define external entry point
*
*      sysrd is used to read a record from the standard input
*      file. the buffer provided is an scblk for a string the
*      length of which in characters is given in wc, this
*      corresponding to the maximum length of string which
*      spitbol is prepared to receive. at compile time it
*      corresponds to xxx in the most recent -inxxx card
*      (default 72) and at execution time to the most recent
*      ,r$r$ (record length) in the third arg of an input()
*      statement for the standard input file (default 80).
*      if fewer than (wc) characters are read, the length
*      field of the scblk must be adjusted before returning
*      unless the buffer is right padded with zeroes.
*      it is also permissible to take the alternative return
*      after such an adjustment has been made.
*      spitbol may continue to make calls after an endfile
*      return so this routine should be prepared to make
*      repeated endfile returns.
*
*      (xr)                pointer to buffer (scblk ptr)
*      (wc)                length of buffer in characters
*      jsr  sysrd          call to read line
*      ppm  loc            endfile or no i/p file after sysxi
if .csfn
*
*                        or input file name change.  if
*                        the former, scblk length is zero.
*                        if input file name change, length
*                        is non-zero. caller should re-issue
*                        sysrd to obtain input record.
fi
*
*      (wa,wb,wc)          destroyed

```

```

*
*      sysri -- read record from interactive channel
*
sysri  exp                                define external entry point
*
*      reads a record from online terminal for spitbol variable,
*      terminal. if online terminal is unavailable then code the
*      endfile return only.
*      the buffer provided is of length 258 characters. sysri
*      should replace the count in the second word of the scblk
*      by the actual character count unless buffer is right
*      padded with zeroes.
*      it is also permissible to take the alternative
*      return after adjusting the count.
*      the end of file return may be used if this makes
*      sense on the target machine (e.g. if there is an
*      eof character.)
*
*      (xr)                                ptr to 258 char buffer (scblk ptr)
*      jsr sysri                            call to read line from terminal
*      ppm loc                             end of file return
*      (wa,wb,wc)                          may be destroyed

```

```

*
*      sysrw -- rewind file
*
sysrw  exp                                define external entry point
*
*      sysrw is used to rewind a file i.e. reposition the file
*      at the start before the first record. the file should be
*      closed and the next read or write call will open the
*      file at the start.
*
*      (wa)                ptr to fcblk or zero
*      (xr)                rewind arg (scblk ptr)
*      jsr sysrw           call to rewind file
*      ppm loc            return here if file does not exist
*      ppm loc            return here if rewind not allowed
*      ppm loc            return here if i/o error

```



```

if .cust
*
*      sysst -- set file pointer
*
sysst      exp                                define external entry point
*
*      sysst is called to change the position of a file
*      pointer. this is accomplished in a system dependent
*      manner, and thus the 2nd and 3rd arguments are passed
*      unconverted.
*
*      (wa)                fcblk pointer
*      (wb)                2nd argument
*      (wc)                3rd argument
*      jsr sysst           call to set file pointer
*      ppm loc             return here if invalid 2nd arg
*      ppm loc             return here if invalid 3rd arg
*      ppm loc             return here if file does not exist
*      ppm loc             return here if set not allowed
*      ppm loc             return here if i/o error
*

```

fi

```
*
*      systm -- get execution time so far
*
systm  exp                                define external entry point
*
*      systm is used to obtain the amount of execution time
*      used so far since spitbol was given control. the units
*      are described as milliseconds in the spitbol output, but
*      the exact meaning is system dependent. where appropriate,
*      this value should relate to processor rather than clock
*      timing values.
*      if the symbol .ctmd is defined, the units are described
*      as deciseconds (0.1 second).
*
*      jsr systm          call to get timer value
*      (ia)              time so far in milliseconds
*                       (deciseconds if .ctmd defined)
```

```

*
*      systt -- trace toggle
*
systt  exp                                define external entry point
*
*      called by spitbol function trace() with no args to
*      toggle the system trace switch.  this permits tracing of
*      labels in spitbol code to be turned on or off.
*
*      jsr  systt          call to toggle trace switch

```

```

*
*      sysul -- unload external function
*
sysul  exp                                define external entry point
*
*      sysul is used to unload a function previously
*      loaded with a call to sysld.
*
*      (xr)                ptr to control block (efblk)
*      jsr  sysul          call to unload function
*
*      the function cannot be called following a sysul call
*      until another sysld call is made for the same function.
*
*      the efblk contains the function code pointer and also a
*      pointer to the vrblk containing the function name (see
*      definitions and data structures section).
if .cnex
else

```

```

*
*      sysxi -- exit to produce load module
*
sysxi      exp                                define external entry point
*
*      when sysxi is called, xl contains either a string pointer
*      or zero. in the former case, the string gives the
*      character name of a program. the intention is that
*      spitbol execution should be terminated forthwith and
*      the named program loaded and executed. this type of chain
*      execution is very system dependent and implementors may
*      choose to omit it or find it impossible to provide.
*      if (xl) is zero, ia contains one of the following integers
*
*      -1, -2, -3, -4
*          create if possible a load module containing only the
*          impure area of memory which needs to be loaded with
*          a compatible pure segment for subsequent executions.
*          version numbers to check compatibility should be
*          kept in both segments and checked on loading.
*          to assist with this check, (xr) on entry is a
*          pointer to an scblk containing the spitbol major
*          version number v.v (see sysid). the file thus
*          created is called a save file.
*
*      0      if possible, return control to job control
*              command level. the effect if available will be
*              system dependent.
*
*      +1, +2, +3, +4
*          create if possible a load module from all of
*          memory. it should be possible to load and execute
*          this module directly.
*
*      in the case of saved load modules, the status of open
*      files is not preserved and implementors may choose to
*      offer means of attaching files before execution of load
*      modules starts or leave it to the user to include
*      suitable input(), output() calls in his program.
*      sysxi should make a note that no i/o channels,
*      including standard files, have files attached so that
*      calls of sysin, sysou, syspr, sysrd should fail unless
*      new associations are made for the load module.
*      at least in the case of the standard output file, it is
*      recommended that either the user be required to attach
*      a file or that a default file is attached, since the
*      problem of error messages generated by the load module
*      is otherwise severe. as a last resort, if spitbol
*      attempts to write to the standard output file and gets a
*      reply indicating that such output is unacceptable it stops
*      by using an entry to sysej with ending code 998.
*      as described below, passing of some arguments makes it
*      clear that load module will use a standard output file.

```

*
* if use is made of fcbks for i/o association, spitbol
* builds a chain so that those in use may be found in sysxi
* and sysej. the nodes are 4 words long. third word
* contains link to next node or 0, fourth word contains
* fcbk pointer.

```

*
* sysxi (continued)
*
* (xl)          zero or scblk ptr to first argument
* (xr)          ptr to v.v scblk
* (ia)          signed integer argument
* (wa)          scblk ptr to second argument
* (wb)          0 or ptr to head of fcblk chain
* jsr sysxi     call to exit
* ppm loc       requested action not possible
* ppm loc       action caused irrecoverable error
* (wb,wc,ia,xr,xl,cp) should be preserved over call
* (wa)          0 in all cases except sucessful
*               performance of exit(4) or exit(-4),
*               in which case 1 should be returned.
*
* loading and running the load module or returning from
* jcl command level causes execution to resume at the point
* after the error returns which follow the call of sysxi.
* the value passed as exit argument is used to indicate
* options required on resumption of load module.
* +1 or -1 require that on resumption, sysid and syspp be
* called and a heading printed on the standard output file.
* +2 or -2 indicate that syspp will be called but not sysid
* and no heading will be put on standard output file.
* above options have the obvious implication that a
* standard o/p file must be provided for the load module.
* +3, +4, -3 or -4 indicate calls of neither sysid nor
* syspp and no heading will be placed on standard output
* file.
* +4 or -4 indicate that execution is to continue after
* creation of the save file or load module, although all
* files will be closed by the sysxi action. this permits
* the user to checkpoint long-running programs while
* continuing execution.
*
* no return from sysxi is possible if another program
* is loaded and entered.

```

fi

```

*
*      introduce the internal procedures.
*
access  inp
acomp   inp
alloc   inp
if .cnbf
else
alobf   inp
fi

alocs   inp
alost   inp
if .cnbf
else
apndb   inp
fi

if .cnra
arith   inp
else
arith   inp
fi

assign   inp
asinp    inp
blkln    inp
cdgchg   inp
cdgex    inp
cdgnm    inp
cdgvl    inp
cdwrd    inp
cmgen    inp
cmpil    inp
cnrd     inp
copyb    inp
dffnc    inp
dtach    inp
dtype    inp
dumpr    inp
if .ceng
enevs    inp
engts    inp
fi

ermsg    inp
ertex    inp
evali    inp
evalp    inp
evals    inp
evalx    inp
exbld    inp
expan    inp
expap    inp
expdm    inp

```


expop inp
if .csfn
filnm inp
fi

if .culc
flstg inp
fi

gbcol inp
gbcpf inp
gtarr inp

```

gtcod    inp
gtexp    inp
gtint    inp
gtnum    inp
gtivr    inp
gtpat    inp
if .cnra
else
gtrea    inp
fi

gtsmi    inp
if .cnbf
else
gtstb    inp
fi

gtstg    inp
gtvar    inp
hashs    inp
icbld    inp
ident    inp
inout    inp
if .cnbf
else
insbf    inp
fi

insta    inp
iofcb    inp
ioppf    inp
ioput    inp
ktrex    inp
kwnam    inp
lcomp    inp
listr    inp
listt    inp
if .csfn
newfn    inp
fi

nexts    inp
patin    inp
patst    inp
pbild    inp
pconc    inp
pcopy    inp
if .cnpf
else
prflr    inp
prflu    inp
fi

prpar    inp
prtch    inp

```

prtic	inp
prtis	inp
prtin	inp
prtmi	inp
prtmm	inp
prtmx	inp
prtnl	inp
prtnm	inp
prtnv	inp
prtpg	inp
prtps	inp
prtsn	inp
prtst	inp

```

prttr  inp
prtv1  inp
prtvn  inp
if .cnra
else
rcbld  inp
fi

readr  inp
if .crel
relaj  inp
relcr  inp
reldn  inp
reloc  inp
relst  inp
relws  inp
fi

rstrt  inp
if .c370
sbool  inp
fi

sbstr  inp
scane  inp
scngf  inp
setvr  inp
if .cnsr
else
sorta  inp
sortc  inp
sortf  inp
sorth  inp
fi

start  inp
stgcc  inp
tfind  inp
tmake  inp
trace  inp
trbld  inp
trimr  inp
trxeq  inp
vmake  inp
xscan  inp
xscni  inp

*
*      introduce the internal routines
*

arref  inr
cfunc  inr
exfal  inr
exint  inr
exits  inr

```

exixr inr
exnam inr
exnul inr
if .cnra
else
exrea inr
fi

exsid inr
exvnm inr
failp inr
flpop inr
indir inr
match inr
retrn inr
stcov inr
stmgo inr
stopr inr
succp inr
sysab inr
systu inr

spitbol – definitions and data structures

```

*      this section contains all symbol definitions and also
*      pictures of all data structures used in the system.
*
sec                                     start of definitions section
*
*      definitions of machine parameters
*
*      the minimal translator should supply appropriate values
*      for the particular target machine for all the
*      equ *
*      definitions given at the start of this section.
*      note that even if conditional assembly is used to omit
*      some feature (e.g. real arithmetic) a full set of cfp$-
*      values must be supplied. use dummy values if genuine
*      ones are not needed.
*
cfp$a equ *                           number of characters in alphabet
*
cfp$b equ *                           bytes/word addressing factor
*
cfp$c equ *                           number of characters per word
*
cfp$f equ *                           offset in bytes to chars in
*                                     scblk. see scblk format.
*
cfp$i equ *                           number of words in integer constant
*
cfp$m equ *                           max positive integer in one word
*
cfp$n equ *                           number of bits in one word
*
*      the following definitions require the supply of either
*      a single parameter if real arithmetic is omitted or
*      three parameters if real arithmetic is included.
*
if .cnra
nstmx equ *                           no. of decimal digits in cfp$m
else
*
cfp$r equ *                           number of words in real constant
*
cfp$s equ *                           number of sig digs for real output
*

```

```

cfp$x equ *                                max digits in real exponent
  if .cncr
nstm$x equ *                                no. of decimal digits in cfp$m
*
mxdgs equ cfp$s+cfp$x                      max digits in real number
*
*      max space for real (for +0.e+) needs five more places
*
nstmr equ mxdgs+5                          max space for real
  else
*
mxdgs equ cfp$s+cfp$x                      max digits in real number
*
*
*      max space for real (for +0.e+) needs five more places
*
nstm$x equ mxdgs+5                          max space for real
  fi
fi
if .cucf
*
*      the following definition for cfp$u supplies a realistic
*      upper bound on the size of the alphabet.  cfp$u is used
*      to save space in the scan bsw-iff-esw table and to ease
*      translation storage requirements.
*
cfp$u equ *                                realistic upper bound on alphabet
fi

```

```

*
*   environment parameters
*
*   the spitbol program is essentially independent of
*   the definitions of these parameters. however, the
*   efficiency of the system may be affected. consequently,
*   these parameters may require tuning for a given version
*   the values given in comments have been successfully used.
*
*   e$srs is the number of words to reserve at the end of
*   storage for end of run processing. it should be
*   set as small as possible without causing memory overflow
*   in critical situations (e.g. memory overflow termination)
*   and should thus reserve sufficient space at least for
*   an scblk containing say 30 characters.
*
e$srs equ *                               30 words
*
*   e$sts is the number of words grabbed in a chunk when
*   storage is allocated in the static region. the minimum
*   permitted value is 256/cfp$b. larger values will lead
*   to increased efficiency at the cost of wasting memory.
*
e$sts equ *                               500 words
*
*   e$cbs is the size of code block allocated initially and
*   the expansion increment if overflow occurs. if this value
*   is too small or too large, excessive garbage collections
*   will occur during compilation and memory may be lost
*   in the case of a too large value.
*
e$cbs equ *                               500 words
*
*   e$hnb is the number of bucket headers in the variable
*   hash table. it should always be odd. larger values will
*   speed up compilation and indirect references at the
*   expense of additional storage for the hash table itself.
*
e$hnb equ *                               127 bucket headers
*
*   e$hnbw is the maximum number of words of a string
*   name which participate in the string hash algorithm.
*   larger values give a better hash at the expense of taking
*   longer to compute the hash. there is some optimal value.
*
e$hnbw equ *                               6 words
*
*   e$fsp. if the amount of free space left after a garbage
*   collection is small compared to the total amount of space
*   in use garbage collector thrashing is likely to occur as
*   this space is used up. e$fsp is a measure of the

```



```

*      minimum percentage of dynamic memory left as free space
*      before the system routine sysmm is called to try to
*      obtain more memory.
*
e$fsp equ *      15 percent
if .csed

*
*      e$sed.  if the amount of free space left in the sediment
*      after a garbage collection is a significant fraction of
*      the new sediment size, the sediment is marked for
*      collection on the next call to the garbage collector.
*
e$sed equ *      25 percent
fi

```

```

*
*      definitions of codes for letters
*
ch$1a equ *      letter a
ch$1b equ *      letter b
ch$1c equ *      letter c
ch$1d equ *      letter d
ch$1e equ *      letter e
ch$1f equ *      letter f
ch$1g equ *      letter g
ch$1h equ *      letter h
ch$1i equ *      letter i
ch$1j equ *      letter j
ch$1k equ *      letter k
ch$1l equ *      letter l
ch$1m equ *      letter m
ch$1n equ *      letter n
ch$1o equ *      letter o
ch$1p equ *      letter p
ch$1q equ *      letter q
ch$1r equ *      letter r
ch$1s equ *      letter s
ch$1t equ *      letter t
ch$1u equ *      letter u
ch$1v equ *      letter v
ch$1w equ *      letter w
ch$1x equ *      letter x
ch$1y equ *      letter y
ch$1$ equ *      letter z

*
*      definitions of codes for digits
*
ch$d0 equ *      digit 0
ch$d1 equ *      digit 1
ch$d2 equ *      digit 2
ch$d3 equ *      digit 3
ch$d4 equ *      digit 4
ch$d5 equ *      digit 5
ch$d6 equ *      digit 6
ch$d7 equ *      digit 7
ch$d8 equ *      digit 8
ch$d9 equ *      digit 9

```

```

*
*      definitions of codes for special characters
*
*      the names of these characters are related to their
*      original representation in the ebcdic set corresponding
*      to the description in standard snobol4 manuals and texts.
*
ch$am equ *      keyword operator (ampersand)
ch$as equ *      multiplication symbol (asterisk)
ch$at equ *      cursor position operator (at)
ch$bb equ *      left array bracket (less than)
ch$bl equ *      blank
ch$br equ *      alternation operator (vertical bar)
ch$cl equ *      goto symbol (colon)
ch$cm equ *      comma
ch$dl equ *      indirection operator (dollar)
ch$dt equ *      name operator (dot)
ch$dq equ *      double quote
ch$eq equ *      equal sign
ch$ex equ *      exponentiation operator (exclm)
ch$mn equ *      minus sign / hyphen
ch$nm equ *      number sign
ch$nt equ *      negation operator (not)
ch$pc equ *      percent
ch$pl equ *      plus sign
ch$pp equ *      left parenthesis
ch$rb equ *      right array bracket (grtr than)
ch$rp equ *      right parenthesis
ch$qu equ *      interrogation operator (question)
ch$sl equ *      slash
ch$sm equ *      semicolon
ch$sq equ *      single quote
ch$un equ *      special identifier char (underline)
ch$ob equ *      opening bracket
ch$cb equ *      closing bracket

```

```

*
*      remaining chars are optional additions to the standards.
if .caht
*
*      tab characters - syntactically equivalent to blank
*
ch$ht equ *      horizontal tab
fi

if .cavt
ch$vt equ *      vertical tab
fi

if .caex
*
*      up arrow same as exclamation mark for exponentiation
*
ch$ey equ *      up arrow
fi

if .casl
*
*      lower case or shifted case alphabetic chars
*
ch$$a equ *      shifted a
ch$$b equ *      shifted b
ch$$c equ *      shifted c
ch$$d equ *      shifted d
ch$$e equ *      shifted e
ch$$f equ *      shifted f
ch$$g equ *      shifted g
ch$$h equ *      shifted h
ch$$i equ *      shifted i
ch$$j equ *      shifted j
ch$$k equ *      shifted k
ch$$l equ *      shifted l
ch$$m equ *      shifted m
ch$$n equ *      shifted n
ch$$o equ *      shifted o
ch$$p equ *      shifted p
ch$$q equ *      shifted q
ch$$r equ *      shifted r
ch$$s equ *      shifted s
ch$$t equ *      shifted t
ch$$u equ *      shifted u
ch$$v equ *      shifted v
ch$$w equ *      shifted w
ch$$x equ *      shifted x
ch$$y equ *      shifted y
ch$$$ equ *      shifted z
fi

*      if a delimiter other than ch$cm must be used in

```

```

*      the third argument of input(),output() then .ciod should
*      be defined and a parameter supplied for iodel.
*
if .ciod
iodel  equ  *
else
iodel  equ  *
fi

```

*
 * data block formats and definitions
 *
 * the following sections describe the detailed format of
 * all possible data blocks in static and dynamic memory.
 *
 * every block has a name of the form xxblk where xx is a
 * unique two character identifier. the first word of every
 * block must contain a pointer to a program location in the
 * interpreter which is immediately preceded by an address
 * constant containing the value bl\$xx where xx is the block
 * identifier. this provides a uniform mechanism for
 * distinguishing between the various block types.
 *
 * in some cases, the contents of the first word is constant
 * for a given block type and merely serves as a pointer
 * to the identifying address constant. however, in other
 * cases there are several possibilities for the first
 * word in which case each of the several program entry
 * points must be preceded by the appropriate constant.
 *
 * in each block, some of the fields are relocatable. this
 * means that they may contain a pointer to another block
 * in the dynamic area. (to be more precise, if they contain
 * a pointer within the dynamic area, then it is a pointer
 * to a block). such fields must be modified by the garbage
 * collector (procedure gbccl) whenever blocks are compacted
 * in the dynamic region. the garbage collector (actually
 * procedure gbcpl) requires that all such relocatable
 * fields in a block must be contiguous.

```

*
* the description format uses the following scheme.
*
* 1) block title and two character identifier
*
* 2) description of basic use of block and indication
* of circumstances under which it is constructed.
*
* 3) picture of the block format. in these pictures low
* memory addresses are at the top of the page. fixed
* length fields are surrounded by i (letter i). fields
* which are fixed length but whose length is dependent
* on a configuration parameter are surrounded by *
* (asterisk). variable length fields are surrounded
* by / (slash).
*
* 4) definition of symbolic offsets to fields in
* block and of the size of the block if fixed length
* or of the size of the fixed length fields if the
* block is variable length.
* note that some routines such as gbcpf assume
* certain offsets are equal. the definitions
* given here enforce this. make changes to
* them only with due care.
*
* definitions of common offsets
*
offs1 equ *
offs2 equ *
offs3 equ *
*
* 5) detailed comments on the significance and formats
* of the various fields.
*
* the order is alphabetical by identification code.

```

```

*
*      definitions of block codes
*
*      this table provides a unique identification code for
*      each separate block type. the first word of a block in
*      the dynamic area always contains the address of a program
*      entry point. the block code is used as the entry point id
*      the order of these codes dictates the order of the table
*      used by the datatype function (scnmt in the constant sec)
*
*      block codes for accessible datatypes
*
*      note that real and buffer types are always included, even
*      if they are conditionally excluded elsewhere. this main-
*      tains block type codes across all versions of spitbol,
*      providing consistency for external functions. but note
*      that the bcbk is out of alphabetic order, placed at the
*      end of the list so as not to change the block type
*      ordering in use in existing external functions.
*
bl$ar    equ  0                                arblk array
bl$cd    equ  bl$ar+1                          cdblk code
bl$ex    equ  bl$cd+1                          exblk expression
bl$ic    equ  bl$ex+1                          icblk integer
bl$nm    equ  bl$ic+1                          nmblk name
bl$p0    equ  bl$nm+1                          p0blk pattern
bl$p1    equ  bl$p0+1                          p1blk pattern
bl$p2    equ  bl$p1+1                          p2blk pattern
bl$rc    equ  bl$p2+1                          rcblk real
bl$sc    equ  bl$rc+1                          scblk string
bl$se    equ  bl$sc+1                          seblk expression
bl$tb    equ  bl$se+1                          tbblk table
bl$vc    equ  bl$tb+1                          vcblk array
bl$xn    equ  bl$vc+1                          xnblk external
bl$xr    equ  bl$xn+1                          xrblk external
bl$bc    equ  bl$xr+1                          bcbk buffer
bl$pd    equ  bl$bc+1                          pdblk program defined datatype
*
bl$$d    equ  bl$pd+1                          number of block codes for data
*
*      other block codes
*
bl$tr    equ  bl$pd+1                          trblk
bl$bf    equ  bl$tr+1                          bfblk
bl$cc    equ  bl$bf+1                          ccblk
bl$cm    equ  bl$cc+1                          cmbk
bl$ct    equ  bl$cm+1                          ctblk
bl$df    equ  bl$ct+1                          dfblk
bl$ef    equ  bl$df+1                          efblk
bl$ev    equ  bl$ef+1                          evblk
bl$ff    equ  bl$ev+1                          ffblk
bl$kv    equ  bl$ff+1                          kvblk

```


bl\$pf	equ	bl\$kv+1	pfbk
bl\$te	equ	bl\$pf+1	tebk
*			
bl\$\$i	equ	0	default identification code
bl\$\$t	equ	bl\$tr+1	code for data or trace block
bl\$\$\$	equ	bl\$te+1	number of block codes

```

*
*   field references
*
*   references to the fields of data blocks are symbolic
*   (i.e. use the symbolic offsets) with the following
*   exceptions.
*
*   1)  references to the first word are usually not
*        symbolic since they use the (x) operand format.
*
*   2)  the code which constructs a block is often not
*        symbolic and should be changed if the corresponding
*        block format is modified.
*
*   3)  the plc and psc instructions imply an offset
*        corresponding to the definition of cfp$f.
*
*   4)  there are non-symbolic references (easily changed)
*        in the garbage collector (procedures gbcpf, blkln).
*
*   5)  the fields idval, fargs appear in several blocks
*        and any changes must be made in parallel to all
*        blocks containing the fields. the actual references
*        to these fields are symbolic with the above
*        listed exceptions.
*
*   6)  several spots in the code assume that the
*        definitions of the fields vrval, teval, trnxt are
*        the same (these are sections of code which search
*        out along a trblk chain from a variable).
*
*   7)  references to the fields of an array block in the
*        array reference routine arref are non-symbolic.
*
*   apart from the exceptions listed, references are symbolic
*   as far as possible and modifying the order or number
*   of fields will not require changes.

```

```

*
*      common fields for function blocks
*
*      blocks which represent callable functions have two
*      common fields at the start of the block as follows.
*
*      +-----+
*      i          fcode          i
*      +-----+
*      i          fargs          i
*      +-----+
*      /                      /
*      /      rest of function block      /
*      /                      /
*      +-----+
*
fcode equ 0                      pointer to code for function
fargs equ 1                      number of arguments
*
*      fcode is a pointer to the location in the interpreter
*      program which processes this type of function call.
*
*      fargs is the expected number of arguments. the actual
*      number of arguments is adjusted to this amount by
*      deleting extra arguments or supplying trailing nulls
*      for missing ones before transferring though fcode.
*      a value of 999 may be used in this field to indicate a
*      variable number of arguments (see svblk field svnar).
*
*      the block types which follow this scheme are.
*
*      ffbk      field function
*      dfbk      datatype function
*      pfbk      program defined function
*      efbk      external loaded function

```

```

*
*      identification field
*
*
*      id      field
*
*      certain program accessible objects (those which contain
*      other data values and can be copied) are given a unique
*      identification number (see exsid). this id value is an
*      address integer value which is always stored in word two.
*
idval      equ      1                                id value field
*
*      the blocks containing an idval field are.
*
*      arblk                array
if .cnbf
else
*      bcblk                buffer control block
fi
*
*      pdblk                program defined datatype
*      tbblk                table
*      vcblk                vector block (array)
*
*      note that a zero idval means that the block is only
*      half built and should not be dumped (see dumph).

```

```

*
* array block (arblk)
*
* an array block represents an array value other than one
* with one dimension whose lower bound is one (see vcblk).
* an arblk is built with a call to the functions convert
* (s$cnv) or array (s$arr).
*
*
*      +-----+
*      i          artyp          i
*      +-----+
*      i          idval         i
*      +-----+
*      i          arlen         i
*      +-----+
*      i          arofs         i
*      +-----+
*      i          arndm         i
*      +-----+
*      *          arlbd         *
*      +-----+
*      *          ardim         *
*      +-----+
*      *
*      * above 2 flds repeated for each dim *
*      *
*      +-----+
*      i          arpro         i
*      +-----+
*      /
*      /          arvls         /
*      /
*      +-----+

```

```

*
*      array block (continued)
*
artyp equ 0                                pointer to dummy routine b$art
arlen equ idval+1                          length of arblk in bytes
arofs equ arlen+1                          offset in arblk to arpro field
arndm equ arofs+1                          number of dimensions
arlb1 equ arndm+1                          low bound (first subscript)
ardim equ arlb1+cfp$i                      dimension (first subscript)
arlb2 equ ardim+cfp$i                      low bound (second subscript)
ardm2 equ arlb2+cfp$i                      dimension (second subscript)
arpro equ ardim+cfp$i                      array prototype (one dimension)
arvls equ arpro+1                          start of values (one dimension)
arpr2 equ ardm2+cfp$i                      array prototype (two dimensions)
arvl2 equ arpr2+1                          start of values (two dimensions)
arsis equ arlb1                            number of standard fields in block
ardms equ arlb2-arlb1                      size of info for one set of bounds

*
*      the bounds and dimension fields are signed integer
*      values and each occupy cfp$i words in the arblk.
*
*      the length of an arblk in bytes may not exceed mxlen.
*      this is required to keep name offsets garbage collectable
*
*      the actual values are arranged in row-wise order and
*      can contain a data pointer or a pointer to a trblk.
if .cnbf
else
*
*      buffer control block (bcbk)
*
*      a bcbk is built for every bfbk.
*
*      +-----+
*      i          bctyp          i
*      +-----+
*      i          idval         i
*      +-----+
*      i          bclen         i
*      +-----+
*      i          bcbuf         i
*      +-----+
*
bctyp equ 0                                ptr to dummy routine b$bct
bclen equ idval+1                          defined buffer length
bcbuf equ bclen+1                          ptr to bfbk
bcsis equ bcbuf+1                          size of bcbk

*
*      a bcbk is an indirect control header for bfbk.
*      the reason for not storing this data directly
*      in the related bfbk is so that the bfbk can
*      maintain the same skeletal structure as an scblk

```

* thus facilitating transparent string operations
* (for the most part). specifically, cfp\$f is the
* same for a bfbk as for an scbk. by convention,
* wherever a buffer value is employed, the bcbk
* is pointed to.
*
* the corresponding bfbk is pointed to by the
* bcbuf pointer in the bcbk.
*
* bclen is the current defined size of the character
* array in the bfbk. characters following the offset
* of bclen are undefined.
*

```

*
*      string buffer block (bfblk)
*
*      a bfblk is built by a call to buffer(...)
*
*      +-----+
*      i          bftyp          i
*      +-----+
*      i          bfalc          i
*      +-----+
*      /                      /
*      /          bfchr          /
*      /                      /
*      +-----+
*
bftyp equ 0                      ptr to dummy routine b$bft
bfalc equ bftyp+1                allocated size of buffer
bfchr equ bfalc+1                characters of string
bfsi$ equ bfchr                  size of standard fields in bfblk
*
*      the characters in the buffer are stored left justified.
*      the final word of defined characters is always zero
*      (character) padded.  any trailing allocation past the
*      word containing the last character contains
*      unpredictable contents and is never referenced.
*
*      note that the offset to the characters of the string
*      is given by cfp$f, as with an scblk.  however, the
*      offset which is occupied by the length for an scblk
*      is the total char space for bfblks, and routines which
*      deal with both must account for this difference.
*
*      the value of bfalc may not exceed mxlen.  the value of
*      bclen is always less than or equal to bfalc.
*

```

fi


```

*
*      code construction block (ccblk)
*
*      at any one moment there is at most one ccblk into
*      which the compiler is currently storing code (cdwrd).
*
*      +-----+
*      i          cctyp          i
*      +-----+
*      i          cclen          i
*
if .csln
*      +-----+
*      i          ccsln          i
fi
*
*      +-----+
*      i          ccuse          i
*      +-----+
*      /          /
*      /          cccod          /
*      /          /
*      +-----+
*
cctyp equ 0                      pointer to dummy routine b$cct
cclen equ cctyp+1                length of ccblk in bytes
if .csln
ccsln equ cclen+1                source line number
ccuse equ ccsln+1                offset past last used word (bytes)
else
ccuse equ cclen+1                offset past last used word (bytes)
fi
cccod equ ccuse+1                start of generated code in block
*
*      the reason that the ccblk is a separate block type from
*      the usual cdblk is that the garbage collector must
*      only process those fields which have been set (see gbcpf)

```

```

*
*   code block (cdblk)
*
*   a code block is built for each statement compiled during
*   the initial compilation or by subsequent calls to code.
*
*       +-----+
*       i             cdjmp             i
*       +-----+
*       i             cdstm             i
*
if .csln
*       +-----+
*       i             cdsln             i
fi
*
*       +-----+
*       i             cdlen             i
*       +-----+
*       i             cdfal             i
*       +-----+
*       /             /
*       /             cdcod             /
*       /             /
*       +-----+
*
cdjmp equ 0                               ptr to routine to execute statement
cdstm equ cdjmp+1                         statement number
if .csln
cdsln equ cdstm+1                         source line number
cdlen equ cdsln+1                         length of cdblk in bytes
cdfal equ cdlen+1                         failure exit (see below)
else
cdlen equ offs2                           length of cdblk in bytes
cdfal equ offs3                           failure exit (see below)
fi
cdcod equ cdfal+1                         executable pseudo-code
cdsi$ equ cdcod                           number of standard fields in cdblk
*
*   cdstm is the statement number of the current statement.
*
*   cdjmp, cdfal are set as follows.
*
*   1)  if the failure exit is the next statement
*
*       cdjmp = b$cds
*       cdfal = ptr to cdblk for next statement
*
*   2)  if the failure exit is a simple label name
*
*       cdjmp = b$cds
*       cdfal is a ptr to the vrtra field of the vrblk
*
*   3)  if there is no failure exit (-nofail mode)

```

```

*
*      cdjmp = b$cds
*      cdfal = o$unf
*
*      4)  if the failure exit is complex or direct
*
*      cdjmp = b$cdc
*      cdfal is the offset to the o$gof word

```

```

*
* code block (continued)
*
* cdcod is the start of the actual code. first we describe
* the code generated for an expression. in an expression,
* elements are fetched by name or by value. for example,
* the binary equal operator fetches its left argument
* by name and its right argument by value. these two
* cases generate quite different code and are described
* separately. first we consider the code by value case.
*
* generation of code by value for expressions elements.
*
* expression          pointer to exblk or seblk
*
* integer constant    pointer to icblk
*
* null constant       pointer to nulls
*
* pattern              (resulting from preevaluation)
*                      =o$lpt
*                      pointer to p0blk,p1blk or p2blk
*
* real constant        pointer to rcblk
*
* string constant      pointer to scblk
*
* variable             pointer to vrget field of vrbk
*
* addition             value code for left operand
*                      value code for right operand
*                      =o$add
*
* affirmation          value code for operand
*                      =o$aff
*
* alternation           value code for left operand
*                      value code for right operand
*                      =o$alt
*
* array reference      (case of one subscript)
*                      value code for array operand
*                      value code for subscript operand
*                      =o$aov
*
*                      (case of more than one subscript)
*                      value code for array operand
*                      value code for first subscript
*                      value code for second subscript
*                      ...
*                      value code for last subscript
*                      =o$amv
*                      number of subscripts

```

```

*
* code block (continued)
*
* assignment          (to natural variable)
*                    value code for right operand
*                    pointer to vrsto field of vrblk
*
*                    (to any other variable)
*                    name code for left operand
*                    value code for right operand
*                    =o$ass
*
* compile error       =o$cer
*
* complementation     value code for operand
*                    =o$com
*
* concatenation        (case of pred func left operand)
*                    value code for left operand
*                    =o$pop
*                    value code for right operand
*
*                    (all other cases)
*                    value code for left operand
*                    value code for right operand
*                    =o$cnc
*
* cursor assignment   name code for operand
*                    =o$cas
*
* division            value code for left operand
*                    value code for right operand
*                    =o$dvd
*
* exponentiation       value code for left operand
*                    value code for right operand
*                    =o$exp
*
* function call        (case of call to system function)
*                    value code for first argument
*                    value code for second argument
*                    ...
*                    value code for last argument
*                    pointer to svfnc field of svblk
*

```

```

*
* code block (continued)
*
* function call      (case of non-system function 1 arg)
*                   value code for argument
*                   =o$fns
*                   pointer to vrbk for function
*
*                   (non-system function, gt 1 arg)
*                   value code for first argument
*                   value code for second argument
*                   ...
*                   value code for last argument
*                   =o$fnc
*                   number of arguments
*                   pointer to vrbk for function
*
* immediate assignment value code for left operand
*                   name code for right operand
*                   =o$ima
*
* indirection        value code for operand
*                   =o$inv
*
* interrogation      value code for operand
*                   =o$int
*
* keyword reference   name code for operand
*                   =o$kwv
*
* multiplication      value code for left operand
*                   value code for right operand
*                   =o$m1t
*
* name reference      (natural variable case)
*                   pointer to nmbk for name
*
*                   (all other cases)
*                   name code for operand
*                   =o$nam
*
* negation            =o$nta
*                   cdblk offset of o$ntc word
*                   value code for operand
*                   =o$ntb
*                   =o$ntc

```

```

*
* code block (continued)
*
* pattern assignment      value code for left operand
*                          name code for right operand
*                          =o$pas
*
* pattern match           value code for left operand
*                          value code for right operand
*                          =o$pmv
*
* pattern replacement     name code for subject
*                          value code for pattern
*                          =o$pmn
*                          value code for replacement
*                          =o$rp1
*
* selection               (for first alternative)
*                          =o$sla
*                          cdblk offset to next o$slc word
*                          value code for first alternative
*                          =o$slb
*                          cdblk offset past alternatives
*
*                          (for subsequent alternatives)
*                          =o$slc
*                          cdblk offset to next o$slc,o$sld
*                          value code for alternative
*                          =o$slb
*                          offset in cdblk past alternatives
*
*                          (for last alternative)
*                          =o$sld
*                          value code for last alternative
*
* subtraction             value code for left operand
*                          value code for right operand
*                          =o$sub

```

```

*
* code block (continued)
*
* generation of code by name for expression elements.
*
* variable          =o$lvn
*                  pointer to vrbk
*
* expression        (case of *natural variable)
*                  =o$lvn
*                  pointer to vrbk
*
*                  (all other cases)
*                  =o$lex
*                  pointer to exblk
*
*
* array reference    (case of one subscript)
*                  value code for array operand
*                  value code for subscript operand
*                  =o$aon
*
*                  (case of more than one subscript)
*                  value code for array operand
*                  value code for first subscript
*                  value code for second subscript
*                  ...
*                  value code for last subscript
*                  =o$amn
*                  number of subscripts
*
* compile error      =o$cer
*
* function call      (same code as for value call)
*                  =o$fne
*
* indirection        value code for operand
*                  =o$inn
*
* keyword reference   name code for operand
*                  =o$kwn
*
* any other operand is an error in a name position
*
* note that in this description, =o$xxx refers to the
* generation of a word containing the address of another
* word which contains the entry point address o$xxx.

```



```

*
* code block (continued)
*
* now we consider the overall structure of the code block
* for a statement with possible goto fields.
*
* first comes the code for the statement body.
* the statement body is an expression to be evaluated
* by value although the value is not actually required.
* normal value code is generated for the body of the
* statement except in the case of a pattern match by
* value, in which case the following is generated.
*
*             value code for left operand
*             value code for right operand
*             =o$pm
*
* next we have the code for the success goto. there are
* several cases as follows.
*
* 1)  no success goto  ptr to cdblk for next statement
*
* 2)  simple label     ptr to vrtra field of vrbk
*
* 3)  complex goto     (code by name for goto operand)
*                     =o$goc
*
* 4)  direct goto      (code by value for goto operand)
*                     =o$god
*
* following this we generate code for the failure goto if
* it is direct or if it is complex, simple failure gotos
* having been handled by an appropriate setting of the
* cdfal field of the cdblk. the generated code is one
* of the following.
*
* 1)  complex fgoto    =o$fif
*                     =o$gof
*                     name code for goto operand
*                     =o$goc
*
* 2)  direct fgoto     =o$fif
*                     =o$gof
*                     value code for goto operand
*                     =o$god
*
* an optimization occurs if the success and failure gotos
* are identical and either complex or direct. in this case,
* no code is generated for the success goto and control
* is allowed to fall into the failure goto on success.

```

```

*
*      compiler block (cmbblk)
*
*      a compiler block (cmbblk) is built by expan to represent
*      one node of a tree structured expression representation.
*
*      +-----+
*      i          cmidn          i
*      +-----+
*      i          cmlen          i
*      +-----+
*      i          cmtyp          i
*      +-----+
*      i          cmopn          i
*      +-----+
*      /          cmvls or cmrop  /
*      /          /              /
*      /          cmlop          /
*      /          /              /
*      +-----+
*
cmidn equ 0                      pointer to dummy routine b$cmf
cmlen equ cmidn+1                length of cmbblk in bytes
cmtyp equ cmlen+1                type (c$xxx, see list below)
cmopn equ cmtyp+1                operand pointer (see below)
cmvls equ cmopn+1                operand value pointers (see below)
cmrop equ cmvls                  right (only) operator operand
cmlop equ cmvls+1                left operator operand
cmsi$ equ cmvls                  number of standard fields in cmbblk
cmus$ equ cmsi$+1                size of unary operator cmbblk
cmbs$ equ cmsi$+2                size of binary operator cmbblk
cmarl equ cmvls+1                array subscript pointers
*
*      the cmopn and cmvls fields are set as follows
*
*      array reference      cmopn = ptr to array operand
*                          cmvls = ptrs to subscript operands
*
*      function call        cmopn = ptr to vrbk for function
*                          cmvls = ptrs to argument operands
*
*      selection            cmopn = zero
*                          cmvls = ptrs to alternate operands
*
*      unary operator        cmopn = ptr to operator dvblk
*                          cmrop = ptr to operand
*
*      binary operator      cmopn = ptr to operator dvblk
*                          cmrop = ptr to right operand
*                          cmlop = ptr to left operand

```

```

*
*      cmtyp is set to indicate the type of expression element
*      as shown by the following table of definitions.
*
c$arr  equ  0                      array reference
c$fnc  equ  c$arr+1                function call
c$def  equ  c$fnc+1                deferred expression (unary *)
c$ind  equ  c$def+1                indirection (unary $)
c$key  equ  c$ind+1                keyword reference (unary ampersand)
c$ubo  equ  c$key+1                undefined binary operator
c$uuo  equ  c$ubo+1                undefined unary operator
c$uo$  equ  c$uuo+1                test value (=c$uuo+1=c$ubo+2)
c$$nm  equ  c$uuo+1                number of codes for name operands
*
*      the remaining types indicate expression elements which
*      can only be evaluated by value (not by name).
*
c$bvl  equ  c$uuo+1                binary op with value operands
c$uvl  equ  c$bvl+1                unary operator with value operand
c$alt  equ  c$uvl+1                alternation (binary bar)
c$cnc  equ  c$alt+1                concatenation
c$cnp  equ  c$cnc+1                concatenation, not pattern match
c$unm  equ  c$cnp+1                unary op with name operand
c$bvn  equ  c$unm+1                binary op (operands by value, name)
c$ass  equ  c$bvn+1                assignment
c$int  equ  c$ass+1                interrogation
c$neg  equ  c$int+1                negation (unary not)
c$sel  equ  c$neg+1                selection
c$pmt  equ  c$sel+1                pattern match
*
c$pr$  equ  c$bvn                  last preevaluable code
c$$nv  equ  c$pmt+1                number of different cmbblk types

```

```

*
* character table block (ctblk)
*
* a character table block is used to hold logical character
* tables for use with any,notany,span,break,breakx
* patterns. each character table can be used to store
* cfp$n distinct tables as bit columns. a bit column
* allocated for each argument of more than one character
* in length to one of the above listed pattern primitives.
*
*
*      +-----+
*      i               cttyp               i
*      +-----+
*      *                               *
*      *                               *
*      *               ctchs               *
*      *                               *
*      *                               *
*      +-----+
*
cttyp equ 0                               pointer to dummy routine b$ctt
ctchs equ cttyp+1                         start of character table words
ctsi$ equ ctchs+cfp$a                     number of words in ctblk
*
* ctchs is cfp$a words long and consists of a one word
* bit string value for each possible character in the
* internal alphabet. each of the cfp$n possible bits in
* a bitstring is used to form a column of bit indicators.
* a bit is set on if the character is in the table and off
* if the character is not present.

```

```

*
*      datatype function block (dfblk)
*
*      a datatype function is used to control the construction
*      of a program defined datatype object. a call to the
*      system function data builds a dfblk for the datatype name
*
*      note that these blocks are built in static because pdblk
*      length is got from dflen field. if dfblk was in dynamic
*      store this would cause trouble during pass two of garbage
*      collection. scblk referred to by dfnam field is also put
*      in static so that there are no reloc. fields. this cuts
*      garbage collection task appreciably for pdblk which are
*      likely to be present in large numbers.
*
*      +-----+
*      i          fcode          i
*      +-----+
*      i          fargs          i
*      +-----+
*      i          dflen          i
*      +-----+
*      i          dfpdl          i
*      +-----+
*      i          dfnam          i
*      +-----+
*      /                      /
*      /          dffld          /
*      /                      /
*      +-----+

```

dflen	equ	fargs+1	length of dfblk in bytes
dfpdl	equ	dflen+1	length of corresponding pdblk
dfnam	equ	dfpdl+1	pointer to scblk for datatype name
dffld	equ	dfnam+1	start of vrbk ptrs for field names
dfflb	equ	dffld-1	offset behind dffld for field func
dfsi\$	equ	dffld	number of standard fields in dfblk

```

*
*      the fcode field points to the routine b$dfc
*
*      fargs (the number of arguments) is the number of fields.

```

```

*
*      dope vector block (dvblk)
*
*      a dope vector is assembled for each possible operator in
*      the snobol4 language as part of the constant section.
*
*      +-----+
*      i          dvopn          i
*      +-----+
*      i          dvtyp          i
*      +-----+
*      i          dvlpr          i
*      +-----+
*      i          dvrpr          i
*      +-----+
*
dvopn equ 0                      entry address (ptr to o$xxx)
dvtyp equ dvopn+1                type code (c$xxx, see cmblk)
dvlpr equ dvtyp+1                left precedence (llxxx, see below)
dvrpr equ dvlpr+1                right precedence (rrxxx, see below)
dvus$ equ dvlpr+1                size of unary operator dv
dvbs$ equ dvrpr+1                size of binary operator dv
dvubs equ dvus$+dvbs$            size of unop + binop (see scan)
*
*      the contents of the dvtyp field is copied into the cmtyp
*      field of the cmblk for the operator if it is used.
*
*      the cmopn field of an operator cmblk points to the dvblk
*      itself, providing the required entry address pointer ptr.
*
*      for normally undefined operators, the dvopn (and cmopn)
*      fields contain a word offset from r$uba of the function
*      block pointer for the operator (instead of o$xxx ptr).
*      for certain special operators, the dvopn field is not
*      required at all and is assembled as zero.
*
*      the left precedence is used in comparing an operator to
*      the left of some other operator. it therefore governs the
*      precedence of the operator towards its right operand.
*
*      the right precedence is used in comparing an operator to
*      the right of some other operator. it therefore governs
*      the precedence of the operator towards its left operand.
*
*      higher precedence values correspond to a tighter binding
*      capability. thus we have the left precedence lower
*      (higher) than the right precedence for right (left)
*      associative binary operators.
*
*      the left precedence of unary operators is set to an
*      arbitrary high value. the right value is not required and
*      consequently the dvrpr field is omitted for unary ops.

```

*		
*		
table of operator precedence values		
*		
rrass	equ	10
llass	equ	00
rrpmt	equ	20
llpmt	equ	30
rramp	equ	40
llamp	equ	50
rralt	equ	70
llalt	equ	60
rrcnc	equ	90
llcnc	equ	80
rrats	equ	110
llats	equ	100
rrplm	equ	120
llplm	equ	130
rrnum	equ	140
llnum	equ	150
rrdvd	equ	160
lldvd	equ	170
rrmlt	equ	180
llmlt	equ	190
rrpct	equ	200
llpct	equ	210
rrexp	equ	230
llexp	equ	220
rrdld	equ	240
lldld	equ	250
rrnot	equ	270
llnot	equ	260
lluno	equ	999
		right equal
		left equal
		right question mark
		left question mark
		right ampersand
		left ampersand
		right vertical bar
		left vertical bar
		right blank
		left blank
		right at
		left at
		right plus, minus
		left plus, minus
		right number
		left number
		right slash
		left slash
		right asterisk
		left asterisk
		right percent
		left percent
		right exclamation
		left exclamation
		right dollar, dot
		left dollar, dot
		right not
		left not
		left all unary operators

- *
 *
 * precedences are the same as in btl snobol4 with the
 * following exceptions.
 *
 *
 * 1) binary question mark is lowered and made left assoc-
 * iative to reflect its new use for pattern matching.
 *
 *
 * 2) alternation and concatenation are made right
 * associative for greater efficiency in pattern
 * construction and matching respectively. this change
 * is transparent to the snobol4 programmer.
 *
 *
 * 3) the equal sign has been added as a low precedence
 * operator which is right associative to reflect its
 * more general usage in this version of snobol4.
 *

```

*
*      external function block (efblk)
*
*      an external function block is used to control the calling
*      of an external function. it is built by a call to load.
*
*      +-----+
*      i          fcode          i
*      +-----+
*      i          fargs          i
*      +-----+
*      i          eflen          i
*      +-----+
*      i          efuse          i
*      +-----+
*      i          efcod          i
*      +-----+
*      i          efvar          i
*      +-----+
*      i          efrsl          i
*      +-----+
*      /                      /
*      /          eftar          /
*      /                      /
*      +-----+
*
eflen equ fargs+1          length of efbk in bytes
efuse equ eflen+1          use count (for opsyn)
efcod equ efuse+1          ptr to code (from sysld)
efvar equ efcod+1          ptr to associated vrbk
efrsl equ efvar+1          result type (see below)
eftar equ efrsl+1          argument types (see below)
efsi$ equ eftar            number of standard fields in efbk
*
*      the fcode field points to the routine b$efc.
*
*      efuse is used to keep track of multiple use when opsyn
*      is employed. the function is automatically unloaded
*      when there are no more references to the function.
*
*      efrsl and eftar are type codes as follows.
*
*      0          type is unconverted
*      1          type is string
*      2          type is integer
if .cnra
  if .cnlf
    *      3          type is file
  fi
else
  *      3          type is real
  if .cnlf

```


f_i^* 4 type is file
 f_i

```

*
*      expression variable block (evblk)
*
*      in this version of spitbol, an expression can be used in
*      any position which would normally expect a name (for
*      example on the left side of equals or as the right
*      argument of binary dot). this corresponds to the creation
*      of a pseudo-variable which is represented by a pointer to
*      an expression variable block as follows.
*
*      +-----+
*      i          evtyp          i
*      +-----+
*      i          evexp          i
*      +-----+
*      i          evvar          i
*      +-----+

```

evtyp	equ 0	pointer to dummy routine b\$evt
evexp	equ evtyp+1	pointer to exblk for expression
evvar	equ evexp+1	pointer to trbev dummy trblk
evsi\$	equ evvar+1	size of evblk

```

*
*      the name of an expression variable is represented by a
*      base pointer to the evblk and an offset of evvar. this
*      value appears to be trapped by the dummy trbev block.
*
*      note that there is no need to allow for the case of an
*      expression variable which references an seblk since a
*      variable which is of the form *var is equivalent to var.

```

```

*
*      expression block (exblk)
*
*      an expression block is built for each expression
*      referenced in a program or created by eval or convert
*      during execution of a program.
*
*      +-----+
*      i          extyp          i
*      +-----+
*      i          exstm          i
*
if.csln
*      +-----+
*      i          exsln          i
fi
*
*      +-----+
*      i          exlen          i
*      +-----+
*      i          exflc          i
*      +-----+
*      /          /
*      /          excod          /
*      /          /
*      +-----+
*
extyp equ 0                      ptr to routine b$exl to load expr
exstm equ cdstm                  stores stmnt no. during evaluation
if.csln
exsln equ exstm+1                stores line no. during evaluation
exlen equ exsln+1                length of exblk in bytes
else
exlen equ exstm+1                length of exblk in bytes
fi
exflc equ exlen+1                failure code (=o$fx)
excod equ exflc+1                pseudo-code for expression
exsi$ equ excod                  number of standard fields in exblk
*
*      there are two cases for excod depending on whether the
*      expression can be evaluated by name (see description
*      of cdblk for details of code for expressions).
*
*      if the expression can be evaluated by name we have.
*
*      (code for expr by name)
*      =o$rnrm
*
*      if the expression can only be evaluated by value.
*
*      (code for expr by value)
*      =o$rvl

```

```

*
*      field function block (ffblk)
*
*      a field function block is used to control the selection
*      of a field from a program defined datatype block.
*      a call to data creates an ffbk for each field.
*
*      +-----+
*      i             fcode             i
*      +-----+
*      i             fargs             i
*      +-----+
*      i             ffdfp             i
*      +-----+
*      i             ffnxt             i
*      +-----+
*      i             ffofs             i
*      +-----+
*
ffdfp equ fargs+1           pointer to associated dfblk
ffnxt equ ffdfp+1          ptr to next ffbk on chain or zero
ffofs equ ffnxt+1         offset (bytes) to field in pdblk
ffsi$ equ ffofs+1         size of ffbk in words
*
*      the fcode field points to the routine b$ffc.
*
*      fargs always contains one.
*
*      ffdfp is used to verify that the correct program defined
*      datatype is being accessed by this call.
*      ffdfp is non-reloc. because dfblk is in static
*
*      ffofs is used to select the appropriate field. note that
*      it is an actual offset (not a field number)
*
*      ffnxt is used to point to the next ffbk of the same name
*      in the case where there are several fields of the same
*      name for different datatypes. zero marks the end of chain

```

```

*
*      integer constant block (icblk)
*
*      an icblk is created for every integer referenced or
*      created by a program. note however that certain internal
*      integer values are stored as addresses (e.g. the length
*      field in a string constant block)
*
*      +-----+
*      i             icget             i
*      +-----+
*      *             icval             *
*      +-----+
*
icget equ 0                                ptr to routine b$icl to load int
icval equ icget+1                          integer value
icsi$ equ icval+cfp$i                      size of icblk
*
*      the length of the icval field is cfp$i.

```

```

*
* keyword variable block (kvblk)
*
* a kvblk is used to represent a keyword pseudo-variable.
* a kvblk is built for each keyword reference (kwnam).
*
*      +-----+
*      i          kvtyp          i
*      +-----+
*      i          kvvar          i
*      +-----+
*      i          kvnum          i
*      +-----+
*
kvtyp equ 0                      pointer to dummy routine b$kv
kvvar equ kvtyp+1                pointer to dummy block trbkv
kvnum equ kvvar+1                keyword number
kvsiz equ kvnum+1                size of kvblk
*
* the name of a keyword variable is represented by a
* base pointer to the kvblk and an offset of kvvar. the
* value appears to be trapped by the pointer to trbkv.

```

```

*
*      name block (nmbblk)
*
*      a name block is used wherever a name must be stored as
*      a value following use of the unary dot operator.
*
*      +-----+
*      i             nmtyp             i
*      +-----+
*      i             nmbas             i
*      +-----+
*      i             nmofs             i
*      +-----+
*
nmtyp equ 0                      ptr to routine b$nm1 to load name
nmbas equ nmtyp+1                base pointer for variable
nmofs equ nmbas+1                offset for variable
nmsi$ equ nmofs+1                size of nmbblk
*
*      the actual field representing the contents of the name
*      is found nmofs bytes past the address in nmbas.
*
*      the name is split into base and offset form to avoid
*      creation of a pointer into the middle of a block which
*      could not be handled properly by the garbage collector.
*
*      a name may be built for any variable (see section on
*      representations of variables) this includes the
*      cases of pseudo-variables.

```

```

*
*      pattern block, no parameters (p0blk)
*
*      a p0blk is used to represent pattern nodes which do
*      not require the use of any parameter values.
*
*      +-----+
*      i           pcode           i
*      +-----+
*      i           pthen           i
*      +-----+
*
pcode equ 0                      ptr to match routine (p$xxx)
pthen equ pcode+1                pointer to subsequent node
pasi$ equ pthen+1                size of p0blk
*
*      pthen points to the pattern block for the subsequent
*      node to be matched. this is a pointer to the pattern
*      block ndnth if there is no subsequent (end of pattern)
*
*      pcode is a pointer to the match routine for the node.

```



```

*
*      pattern block (one parameter)
*
*      a p1blk is used to represent pattern nodes which
*      require one parameter value.
*
*      +-----+
*      i           pcode           i
*      +-----+
*      i           pthen           i
*      +-----+
*      i           parm1           i
*      +-----+
*
parm1 equ pthen+1           first parameter value
pbsi$ equ parm1+1         size of p1blk in words
*
*      see p0blk for definitions of pcode, pthen
*
*      parm1 contains a parameter value used in matching the
*      node. for example, in a len pattern, it is the integer
*      argument to len. the details of the use of the parameter
*      field are included in the description of the individual
*      match routines. parm1 is always an address pointer which
*      is processed by the garbage collector.

```

```

*
* pattern block (two parameters)
*
* a p2blk is used to represent pattern nodes which
* require two parameter values.
*
*      +-----+
*      i           pcode           i
*      +-----+
*      i           pthen           i
*      +-----+
*      i           parm1           i
*      +-----+
*      i           parm2           i
*      +-----+
*
parm2 equ parm1+1           second parameter value
pcsi$ equ parm2+1         size of p2blk in words
*
* see p1blk for definitions of pcode, pthen, parm1
*
* parm2 is a parameter which performs the same sort of
* function as parm1 (see description of p1blk).
*
* parm2 is a non-relocatable field and is not
* processed by the garbage collector. accordingly, it may
* not contain a pointer to a block in dynamic memory.

```

```

*
*      program-defined datatype block
*
*      a pdblk represents the data item formed by a call to a
*      datatype function as defined by the system function data.
*
*      +-----+
*      i          pdtyp          i
*      +-----+
*      i          idval         i
*      +-----+
*      i          pddfp         i
*      +-----+
*      /          /
*      /          pdfld         /
*      /          /
*      +-----+

```

pdtyp	equ	0	ptr to dummy routine b\$pdt
pddfp	equ	idval+1	ptr to associated dfblk
pdfld	equ	pddfp+1	start of field value pointers
pdfof	equ	dffld-pdfld	difference in offset to field ptrs
pdsi\$	equ	pdfld	size of standard fields in pdblk
pddfs	equ	dfsi\$-pdsi\$	difference in dfblk, pdblk sizes

```

*
*      the pddfp pointer may be used to determine the datatype
*      and the names of the fields if required. the dfblk also
*      contains the length of the pdblk in bytes (field dfpdl).
*      pddfp is non-reloc. because dfblk is in static
*
*      pdfld values are stored in order from left to right.
*      they contain values or pointers to trblk chains.

```

```

*
*   program defined function block (pfblok)
*
*   a pfblok is created for each call to the define function
*   and a pointer to the pfblok placed in the proper vrblok.
*
*       +-----+
*       i           fcode           i
*       +-----+
*       i           fargs           i
*       +-----+
*       i           pflen           i
*       +-----+
*       i           pfvbl           i
*       +-----+
*       i           pfnlo           i
*       +-----+
*       i           pfcod           i
*       +-----+
*       i           pfctr           i
*       +-----+
*       i           pfrtr           i
*       +-----+
*       /           /
*       /           pfarg           /
*       /           /
*       +-----+
*
pflen equ fargs+1           length of pfblok in bytes
pfvbl equ pflen+1           pointer to vrblok for function name
pfnlo equ pfvbl+1           number of locals
pfcod equ pfnlo+1           ptr to vrblok for entry label
pfctr equ pfcod+1           trblk ptr if call traced else 0
pfrtr equ pfctr+1           trblk ptr if return traced else 0
pfarg equ pfrtr+1           vrblok ptrs for arguments and locals
pfagb equ pfarg-1           offset behind pfarg for arg, local
pfsi$ equ pfarg             number of standard fields in pfblok
*
*   the fcode field points to the routine b$pfcode.
*
*   pfarg is stored in the following order.
*
*       arguments (left to right)
*       locals (left to right)
if .cnra
else

```

```

*
*      real constant block (rcblk)
*
*      an rcblk is created for every real referenced or
*      created by a program.
*
*      +-----+
*      i             rcget             i
*      +-----+
*      *             rcval             *
*      +-----+
*
rcget  equ  0                      ptr to routine b$rc1 to load real
rcval  equ  rcget+1                real value
rcsi$  equ  rcval+cfp$r            size of rcblk
*
*      the length of the rcval field is cfp$r.
fi

```

```

*
*      string constant block (scblk)
*
*      an scblk is built for every string referenced or created
*      by a program.
*
*      +-----+
*      i          scget          i
*      +-----+
*      i          sclen         i
*      +-----+
*      /
*      /          schar         /
*      /
*      +-----+
*
scget equ 0                      ptr to routine b$sc1 to load string
sclen equ scget+1                length of string in characters
schar equ sclen+1                characters of string
scsi$ equ schar                  size of standard fields in scblk
*
*      the characters of the string are stored left justified.
*      the final word is padded on the right with zeros.
*      (i.e. the character whose internal code is zero).
*
*      the value of sclen may not exceed mxlen. this ensures
*      that character offsets (e.g. the pattern match cursor)
*      can be correctly processed by the garbage collector.
*
*      note that the offset to the characters of the string
*      is given in bytes by cfp$f and that this value is
*      automatically allowed for in plc, psc.
*      note that for a spitbol scblk, the value of cfp$f
*      is given by cfp$b*schar.

```

```

*
*      simple expression block (seblk)
*
*      an seblk is used to represent an expression of the form
*      *(natural variable). all other expressions are exblks.
*
*      +-----+
*      i           setyp           i
*      +-----+
*      i           sevar           i
*      +-----+
*
setyp equ 0                      ptr to routine b$sel to load expr
sevar equ setyp+1                ptr to vrbk for variable
sesi$ equ sevar+1                length of seblk in words

```

```

*
* standard variable block (svblk)
*
* an svblk is assembled in the constant section for each
* variable which satisfies one of the following conditions.
*
* 1) it is the name of a system function
* 2) it has an initial value
* 3) it has a keyword association
* 4) it has a standard i/o association
* 6) it has a standard label association
*
* if vrblks are constructed for any of these variables,
* then the vrsvp field points to the svblk (see vrblk)
*
*
* +-----+
* i          svbit          i
* +-----+
* i          svlen          i
* +-----+
* /          svchs          /
* +-----+
* i          svknm          i
* +-----+
* i          svfnc          i
* +-----+
* i          svnar          i
* +-----+
* i          svlbl          i
* +-----+
* i          svval          i
* +-----+

```



```

*
*      standard variable block (continued)
*
svbit  equ  0                      bit string indicating attributes
svlen  equ  1                      (=sclen) length of name in chars
svchs  equ  2                      (=schar) characters of name
svsi$  equ  2                      number of standard fields in svblk
svpre  equ  1                      set if preevaluation permitted
svffc  equ  svpre+svpre            set on if fast call permitted
svckw  equ  svffc+svffc            set on if keyword value constant
svprd  equ  svckw+svckw            set on if predicate function
svnbt  equ  4                      number of bits to right of svknm
svknm  equ  svprd+svprd            set on if keyword association
svfnc  equ  svknm+svknm            set on if system function
svnar  equ  svfnc+svfnc            set on if system function
svlbl  equ  svnar+svnar            set on if system label
svval  equ  svlbl+svlbl            set on if predefined value
*
*      note that the last five bits correspond in order
*      to the fields which are present (see procedure gtnvr).
*
*      the following definitions are used in the svblk table
*
svfnf  equ  svfnc+svnar            function with no fast call
svfnn  equ  svfnf+svffc            function with fast call, no preeval
svfnp  equ  svfnn+svpre            function allowing preevaluation
svfpr  equ  svfnn+svprd            predicate function
svfnk  equ  svfnn+svknm            no preeval func + keyword
svkwv  equ  svknm+svval            keyword + value
svkwc  equ  svckw+svknm            keyword with constant value
svkvc  equ  svkwv+svckw            constant keyword + value
svkvl  equ  svkvc+svlbl            constant keyword + value + label
svfpk  equ  svfnp+svkvc            preeval fcn + const keywd + val
*
*      the svpre bit allows the compiler to preevaluate a call
*      to the associated system function if all the arguments
*      are themselves constants. functions in this category
*      must have no side effects and must never cause failure.
*      the call may generate an error condition.
*
*      the svffc bit allows the compiler to generate the special
*      fast call after adjusting the number of arguments. only
*      the item and apply functions fall outside this category.
*
*      the svckw bit is set if the associated keyword value is
*      a constant, thus allowing preevaluation for a value call.
*
*      the svprd bit is set on for all predicate functions to
*      enable the special concatenation code optimization.

```

```

*
*   svblk (continued)
*
*   svknm                keyword number
*
*       svknm is present only for a standard keyword assoc.
*       it contains a keyword number as defined by the
*       keyword number table given later on.
*
*   svfnc                system function pointer
*
*       svfnc is present only for a system function assoc.
*       it is a pointer to the actual code for the system
*       function. the generated code for a fast call is a
*       pointer to the svfnc field of the svblk for the
*       function. the vrfnc field of the vrbk points to
*       this same field, in which case, it serves as the
*       fcode field for the function call.
*
*   svnar                number of function arguments
*
*       svnar is present only for a system function assoc.
*       it is the number of arguments required for a call
*       to the system function. the compiler uses this
*       value to adjust the number of arguments in a fast
*       call and in the case of a function called through
*       the vrfnc field of the vrbk, the svnar field
*       serves as the fargs field for o$fnc. a special
*       case occurs if this value is set to 999. this is
*       used to indicate that the function has a variable
*       number of arguments and causes o$fnc to pass control
*       without adjusting the argument count. the only
*       predefined functions using this are apply and item.
*
*   svlbl                system label pointer
*
*       svlbl is present only for a standard label assoc.
*       it is a pointer to a system label routine (l$xxx).
*       the vrlbl field of the corresponding vrbk points to
*       the svlbl field of the svblk.
*
*   svval                system value pointer
*
*       svval is present only for a standard value.
*       it is a pointer to the pattern node (ndxxx) which
*       is the standard initial value of the variable.
*       this value is copied to the vrval field of the vrbk

```

```

*
*      svblk (continued)
*
*      keyword number table
*
*      the following table gives symbolic names for keyword
*      numbers. these values are stored in the svknm field of
*      svblks and in the kvnum field of kvblks. see also
*      procedures assign, access and kwnam.
*
*      unprotected keywords with one word integer values
*
k$abe  equ  0                      abend
k$anc  equ  k$abe+cfp$b           anchor
if .culc
k$cas  equ  k$anc+cfp$b           case
k$cod  equ  k$cas+cfp$b           code
else
k$cod  equ  k$anc+cfp$b           code
fi

if .ccmk
k$com  equ  k$cod+cfp$b           compare
k$dmp  equ  k$com+cfp$b           dump
else
k$dmp  equ  k$cod+cfp$b           dump
fi

k$erl  equ  k$dmp+cfp$b           errlimit
k$ert  equ  k$erl+cfp$b           errtype
k$ftr  equ  k$ert+cfp$b           ftrace
k$fls  equ  k$ftr+cfp$b           fullscan
k$inp  equ  k$fls+cfp$b           input
k$mxl  equ  k$inp+cfp$b           maxlength
k$soup  equ  k$mxl+cfp$b           output
if .cnpf
k$tra  equ  k$soup+cfp$b           trace
else
k$pf1  equ  k$soup+cfp$b           profile
k$tra  equ  k$pf1+cfp$b           trace
fi

k$trm  equ  k$tra+cfp$b           trim
*
*      protected keywords with one word integer values
*
k$fnc  equ  k$trm+cfp$b           fnclevel
k$lst  equ  k$fnc+cfp$b           lastno
if .csln
k$lln  equ  k$lst+cfp$b           lastline
k$lin  equ  k$lln+cfp$b           line
k$stn  equ  k$lin+cfp$b           stno
else
k$stn  equ  k$lst+cfp$b           stno

```

fi

```
*
*      keywords with constant pattern values
*
k$abo equ k$stn+cfp$b      abort
k$arb equ k$abo+pasi$      arb
k$bal equ k$arb+pasi$      bal
k$fal equ k$bal+pasi$      fail
k$fen equ k$fal+pasi$      fence
k$rem equ k$fen+pasi$      rem
k$suc equ k$rem+pasi$      succeed
```

```

*
*      keyword number table (continued)
*
*      special keywords
*
k$alp equ k$suc+1      alphabet
k$rtn equ k$alp+1      rtntype
k$stc equ k$rtn+1      stcount
k$etx equ k$stc+1      errtext
if .csfn
k$fil equ k$etx+1      file
k$lfl equ k$fil+1      lastfile
k$stl equ k$lfl+1      stlimit
else
k$stl equ k$etx+1      stlimit
fi

if .culk
k$lcs equ k$stl+1      lcase
k$ucs equ k$lcs+1      ucase
fi

*
*      relative offsets of special keywords
*
k$$al equ k$alp-k$alp  alphabet
k$$rt equ k$rtn-k$alp  rtntype
k$$sc equ k$stc-k$alp  stcount
k$$et equ k$etx-k$alp  errtext
if .csfn
k$$fl equ k$fil-k$alp  file
k$$lf equ k$lfl-k$alp  lastfile
fi

k$$sl equ k$stl-k$alp  stlimit
if .culk
k$$lc equ k$lcs-k$alp  lcase
k$$uc equ k$ucs-k$alp  ucase
k$$n$ equ k$$uc+1      number of special cases
else
k$$n$ equ k$$sl+1      number of special cases
fi

*
*      symbols used in asign and access procedures
*
k$p$$ equ k$fnc        first protected keyword
k$v$$ equ k$abo        first keyword with constant value
k$s$$ equ k$alp        first keyword with special access

```

```

*
*      format of a table block (tbblk)
*
*      a table block is used to represent a table value.
*      it is built by a call to the table or convert functions.
*
*      +-----+
*      i          tbtyp          i
*      +-----+
*      i          idval         i
*      +-----+
*      i          tblen         i
*      +-----+
*      i          tbinv         i
*      +-----+
*      /          /
*      /          tbbuk         /
*      /          /
*      +-----+
*
tbtyp equ 0          pointer to dummy routine b$tb
tblen equ offs2      length of tbblk in bytes
tbinv equ offs3      default initial lookup value
tbbuk equ tbinv+1    start of hash bucket pointers
tbsi$ equ tbbuk      size of standard fields in tbblk
tbnbk equ 11         default no. of buckets
*
*      the table block is a hash table which points to chains
*      of table element blocks representing the elements
*      in the table which hash into the same bucket.
*
*      tbbuk entries either point to the first teblk on the
*      chain or they point to the tbblk itself to indicate the
*      end of the chain.

```

```

*
*      table element block (teblk)
*
*      a table element is used to represent a single entry in
*      a table (see description of tbblk format for hash table)
*
*      +-----+
*      i          tety          i
*      +-----+
*      i          tesub         i
*      +-----+
*      i          teval         i
*      +-----+
*      i          tenxt         i
*      +-----+
*
tety    equ  0                      pointer to dummy routine b$tet
tesub   equ  tety+1                subscript value
teval   equ  tesub+1              (=vrval) table element value
tenxt   equ  teval+1              link to next teblk

*      see s$cnv where relation is assumed with tenxt and tbbuk
tesis$  equ  tenxt+1              size of teblk in words
*
*      tenxt points to the next teblk on the hash chain from the
*      tbbuk chain for this hash index. at the end of the chain,
*      tenxt points back to the start of the tbblk.
*
*      teval contains a data pointer or a trblk pointer.
*
*      tesub contains a data pointer.

```

```

*
*      trap block (trblk)
*
*      a trap block is used to represent a trace or input or
*      output association in response to a call to the trace
*      input or output system functions. see below for details
*
*      +-----+
*      i          tridn          i
*      +-----+
*      i          trtyp          i
*      +-----+
*      i  trval or trlbl or trnxt or trkvr  i
*      +-----+
*      i          trtag or trter or trtrf    i
*      +-----+
*      i          trfnc or trfpt            i
*      +-----+
*
tridn  equ  0                      pointer to dummy routine b$trt
trtyp  equ  tridn+1                trap type code
trval  equ  trtyp+1                value of trapped variable (=vrval)
trnxt  equ  trval                  ptr to next trblk on trblk chain
trlbl  equ  trval                  ptr to actual label (traced label)
trkvr  equ  trval                  vrbk pointer for keyword trace
trtag  equ  trval+1                trace tag
trter  equ  trtag                  ptr to terminal vrbk or null
trtrf  equ  trtag                  ptr to trblk holding fcbk ptr
trfnc  equ  trtag+1                trace function vrbk (zero if none)
trfpt  equ  trfnc                  fcbk ptr for sysio
trsi$  equ  trfnc+1                number of words in trblk
*
trtin  equ  0                      trace type for input association
trtac  equ  trtin+1                trace type for access trace
trtv1  equ  trtac+1                trace type for value trace
trtou  equ  trtv1+1                trace type for output association
trtfc  equ  trtou+1                trace type for fcbk identification

```



```

*
* trap block (continued)
*
* variable input association
*
*     the value field of the variable points to a trblk
*     instead of containing the data value. in the case
*     of a natural variable, the vrget and vrsto fields
*     contain =b$vra and =b$vrsv to activate the check.
*
*     trtyp is set to trtin
*     trnxt points to next trblk or trval has variable val
*     trter is a pointer to svblk if association is
*     for input, terminal, else it is null.
*     trtrf points to the trap block which in turn points
*     to an fcblk used for i/o association.
*     trfpt is the fcblk ptr returned by sysio.
*
* variable access trace association
*
*     the value field of the variable points to a trblk
*     instead of containing the data value. in the case
*     of a natural variable, the vrget and vrsto fields
*     contain =b$vra and =b$vrsv to activate the check.
*
*     trtyp is set to trtac
*     trnxt points to next trblk or trval has variable val
*     trtag is the trace tag (0 if none)
*     trfnc is the trace function vrbk ptr (0 if none)
*
* variable value trace association
*
*     the value field of the variable points to a trblk
*     instead of containing the data value. in the case
*     of a natural variable, the vrget and vrsto fields
*     contain =b$vra and =b$vrsv to activate the check.
*
*     trtyp is set to trtv1
*     trnxt points to next trblk or trval has variable val
*     trtag is the trace tag (0 if none)
*     trfnc is the trace function vrbk ptr (0 if none)

```

```

*      trap block (continued)
*
*      variable output association
*
*          the value field of the variable points to a trblk
*          instead of containing the data value. in the case
*          of a natural variable, the vrget and vrsto fields
*          contain =b$vra and =b$vrw to activate the check.
*
*          trtyp is set to trtou
*          trnxt points to next trblk or trval has variable val
*          trter is a pointer to svblk if association is
*          for output, terminal, else it is null.
*          trtrf points to the trap block which in turn points
*          to an fcbk used for i/o association.
*          trfpt is the fcbk ptr returned by sysio.
*
*      function call trace
*
*          the pfctr field of the corresponding pfbk is set
*          to point to a trblk.
*
*          trtyp is set to trtin
*          trnxt is zero
*          trtag is the trace tag (0 if none)
*          trfnc is the trace function vrbk ptr (0 if none)
*
*      function return trace
*
*          the pfrtr field of the corresponding pfbk is set
*          to point to a trblk
*
*          trtyp is set to trtin
*          trnxt is zero
*          trtag is the trace tag (0 if none)
*          trfnc is the trace function vrbk ptr (0 if none)
*
*      label trace
*
*          the vrlbl of the vrbk for the label is
*          changed to point to a trblk and the vrtra field is
*          set to b$vrt to activate the check.
*
*          trtyp is set to trtin
*          trlbl points to the actual label (cdbl) value
*          trtag is the trace tag (0 if none)
*          trfnc is the trace function vrbk ptr (0 if none)

```

```

*
* trap block (continued)
*
* keyword trace
*
*     keywords which can be traced possess a unique
*     location which is zero if there is no trace and
*     points to a trblk if there is a trace. the locations
*     are as follows.
*
*     r$ert          errtype
*     r$fnc          fnclevel
*     r$stc          stcount
*
*     the format of the trblk is as follows.
*
*     trtyp is set to trtin
*     trkvr is a pointer to the vrbk for the keyword
*     trtag is the trace tag (0 if none)
*     trfnc is the trace function vrbk ptr (0 if none)
*
* input/output file arg1 trap block
*
*     the value field of the variable points to a trblk
*     instead of containing the data value. in the case of
*     a natural variable, the vrget and vrsto fields
*     contain =b$vra and =b$vrsv. this trap block is used
*     to hold a pointer to the fcbk which an
*     implementation may request to hold information
*     about a file.
*
*     trtyp is set to trtfc
*     trnext points to next trblk or trval is variable val
*     trfnc is 0
*     trfpt is the fcbk pointer.
*
* note that when multiple traps are set on a variable
* the order is in ascending value of trtyp field.
*
* input association (if present)
* access trace (if present)
* value trace (if present)
* output association (if present)
*
* the actual value of the variable is stored in the trval
* field of the last trblk on the chain.
*
* this implementation does not permit trace or i/o
* associations to any of the pseudo-variables.

```

```

*
*      vector block (vcblk)
*
*      a vcblk is used to represent an array value which has
*      one dimension whose lower bound is one. all other arrays
*      are represented by arblks. a vcblk is created by the
*      system function array (s$arr) when passed an integer arg.
*
*      +-----+
*      i                vctyp                i
*      +-----+
*      i                idval               i
*      +-----+
*      i                vcrlen              i
*      +-----+
*      i                vcvls              i
*      +-----+
*
vctyp  equ  0                pointer to dummy routine b$vct
vcrlen equ  offs2           length of vcblk in bytes
vcvls  equ  offs3           start of vector values
vcsi$  equ  vcvls           size of standard fields in vcblk
vcv1b  equ  vcvls-1         offset one word behind vcvls
vctbd  equ  tbsi$-vcsi$     difference in sizes - see prtvl
*
*      vcvls are either data pointers or trblk pointers
*
*      the dimension can be deduced from vcrlen.

```

```

*
* variable block (vrblk)
*
* a variable block is built in the static memory area
* for every variable referenced or created by a program.
* the order of fields is assumed in the model vrblk stnvr.
*
* note that since these blocks only occur in the static
* region, it is permissible to point to any word in
* the block and this is used to provide three distinct
* access points from the generated code as follows.
*
* 1) point to vrget (first word of vrblk) to load the
* value of the variable onto the main stack.
*
* 2) point to vrsto (second word of vrblk) to store the
* top stack element as the value of the variable.
*
* 3) point to vrtra (fourth word of vrblk) to jump to
* the label associated with the variable name.
*
*
* +-----+
* i          vrget          i
* +-----+
* i          vrsto          i
* +-----+
* i          vrval          i
* +-----+
* i          vrtra          i
* +-----+
* i          vrlbl          i
* +-----+
* i          vrfnc          i
* +-----+
* i          vrnxt          i
* +-----+
* i          vrlen          i
* +-----+
* /                          /
* /          vrchs = vrsvp    /
* /                          /
* +-----+

```

```

*
*      variable block (continued)
*
vrget equ 0                      pointer to routine to load value
vrsto equ vrget+1                pointer to routine to store value
vrval equ vrsto+1                variable value
vrvlo equ vrval-vrsto            offset to value from store field
vrtra equ vrval+1                pointer to routine to jump to label
vrlbl equ vrtra+1                pointer to code for label
vrlbo equ vrlbl-vrtra            offset to label from transfer field
vrfnc equ vrlbl+1                pointer to function block
vrnxt equ vrfnc+1                pointer to next vrbk on hash chain
vrln equ vrnxt+1                 length of name (or zero)
vrchs equ vrln+1                 characters of name (vrln gt 0)
vrsvp equ vrln+1                 ptr to svblk (vrln eq 0)
vrsi$ equ vrchs+1                number of standard fields in vrbk
vrsof equ vrln-sclen             offset to dummy scblk for name
vrsvo equ vrsvp-vrsof            pseudo-offset to vrsvp field
*
*      vrget = b$vr1 if not input associated or access traced
*      vrget = b$vr4 if input associated or access traced
*
*      vrsto = b$vr5 if not output associated or value traced
*      vrsto = b$vr6 if output associated or value traced
*      vrsto = b$vre if value is protected pattern value
*
*      vrval points to the appropriate value unless the
*      variable is i/o/trace associated in which case, vrval
*      points to an appropriate trblk (trap block) chain.
*
*      vrtra = b$vrg if the label is not traced
*      vrtra = b$vrt if the label is traced
*
*      vrlbl points to a cdbk if there is a label
*      vrlbl points to the svblk svlbl field for a system label
*      vrlbl points to stndl for an undefined label
*      vrlbl points to a trblk if the label is traced
*
*      vrfnc points to a ffbk for a field function
*      vrfnc points to a dfbk for a datatype function
*      vrfnc points to a pfbk for a program defined function
*      vrfnc points to a efbk for an external loaded function
*      vrfnc points to svfnc (svblk) for a system function
*      vrfnc points to stndf if the function is undefined
*
*      vrnxt points to the next vrbk on this chain unless
*      this is the end of the chain in which case it is zero.
*
*      vrln is the name length for a non-system variable.
*      vrln is zero for a system variable.
*
*      vrchs is the name (ljrz) if vrln is non-zero.
*      vrsvp is a ptr to the svblk if vrln is zero.

```

```

*
*      format of a non-relocatable external block (xnblk)
*
*      an xnblk is a block representing an unknown (external)
*      data value. the block contains no pointers to other
*      relocatable blocks. an xnblk is used by external function
*      processing or possibly for system i/o routines etc.
*      the macro-system itself does not use xnblks.
*      this type of block may be used as a file control block.
*      see sysfc,sysin,sysou,s$inp,s$oup for details.
*
*
*      +-----+
*      i             xntyp             i
*      +-----+
*      i             xnlen            i
*      +-----+
*      /             /
*      /             xndta            /
*      /             /
*      +-----+
*
xntyp equ 0                pointer to dummy routine b$xnt
xnlen equ xntyp+1          length of xnblk in bytes
xndta equ xnlen+1          data words
xnsi$ equ xndta            size of standard fields in xnblk
*
*      note that the term non-relocatable refers to the contents
*      and not the block itself. an xnblk can be moved around if
*      it is built in the dynamic memory area.

```

```

*
*      relocatable external block (xrbk)
*
*      an xrbk is a block representing an unknown (external)
*      data value. the data area in this block consists only
*      of address values and any addresses pointing into the
*      dynamic memory area must point to the start of other
*      data blocks. see also description of xnblk.
*      this type of block may be used as a file control block.
*      see sysfc,sysin,sysou,s$inp,s$oup for details.
*
*
*      +-----+
*      i          xrtyp          i
*      +-----+
*      i          xrlen          i
*      +-----+
*      /          /
*      /          xrptra         /
*      /          /
*      +-----+
*
xrtyp equ 0                      pointer to dummy routine b$xrt
xrlen equ xrtyp+1                length of xrbk in bytes
xrptra equ xrlen+1               start of address pointers
xrsta$ equ xrptra                size of standard fields in xrbk

```



```

*
*      s$cnv (convert) function switch constants.  the values
*      are tied to the order of the entries in the svctb table
*      and hence to the branch table in s$cnv.
*
cnvst  equ  8                                max standard type code for convert
if .cnra
cnvrt  equ  cnvst                            no reals - same as standard types
else
cnvrt  equ  cnvst+1                          convert code for reals
fi

if .cnbf
cnvbt  equ  cnvrt                            no buffers - same as real code
else
cnvbt  equ  cnvrt+1                          convert code for buffer
fi

cnvtt  equ  cnvbt+1                          bsw code for convert

*
*      input image length
*
iniln  equ  1024                             default image length for compiler
inils  equ  1024                             image length if -sequ in effect

*
ionmb  equ  2                                name base used for ioch in sysio
ionmo  equ  4                                name offset used for ioch in sysio

*
*      minimum value for keyword maxlngth
*      should be larger than iniln
*
mnlenn equ  1024                             min value allowed keyword maxlngth
mxern  equ  329                             err num inadequate startup memory

*
*      in general, meaningful mnemonics should be used for
*      offsets. however for small integers used often in
*      literals the following general definitions are provided.
*
num01  equ  329
num02  equ  329
num03  equ  329
num04  equ  329
num05  equ  329
num06  equ  329
num07  equ  329
num08  equ  329
num09  equ  329
num10  equ  329
nm320  equ  329
nm321  equ  329
nini8  equ  329
nini9  equ  329

```

thsnd equ 329

```

*
*      numbers of undefined spitbol operators
*
opbun equ 5          no. of binary undefined ops
opuun equ 6          no of unary undefined ops
*
*      offsets used in prtsn, prtmi and acess
*
prsnf equ 13         offset used in prtsn
prtmf equ 21         offset to col 21 (prtmi)
rilen equ 1024       buffer length for sysri
*
*      codes for stages of processing
*
stgic equ 0          initial compile
stgxc equ stgic+1    execution compile (code)
stgev equ stgxc+1    expression eval during execution
stgxt equ stgev+1    execution time
stgce equ stgxt+1    initial compile after end line
stgxe equ stgce+1    exec. compile after end line
stgnd equ stgce-stgic difference in stage after end
stgee equ stgxe+1    eval evaluating expression
stgno equ stgee+1    number of codes

```

```

*
*
*      statement number pad count for listr
*
if .csn6
stnprd equ 6                      statement no. pad count
fi

if .csn8
stnprd equ 8                      statement no. pad count
fi

if .csn5
stnprd equ 5                      statement no. pad count
fi

*
*      syntax type codes
*
*      these codes are returned from the scane procedure.
*
*      they are spaced 3 apart for the benefit of expan.
*

t$uop equ 0                      unary operator
t$lpr equ t$uop+3                left paren
t$lbr equ t$lpr+3                left bracket
t$cma equ t$lbr+3                comma
t$fnc equ t$cma+3                function call
t$var equ t$fnc+3                variable
t$con equ t$var+3                constant
t$bop equ t$con+3                binary operator
t$rpr equ t$bop+3                right paren
t$rbr equ t$rpr+3                right bracket
t$col equ t$rbr+3                colon
t$smc equ t$col+3                semi-colon

*
*      the following definitions are used only in the goto field
*

t$fgo equ t$smc+1                failure goto
t$sgo equ t$fgo+1                success goto

*
*      the above codes are grouped so that codes for elements
*      which can legitimately immediately precede a unary
*      operator come first to facilitate operator syntax check.
*

t$uok equ t$fnc                  last code ok before unary operator

```

```

*
*      definitions of values for expan jump table
*
t$uo0 equ t$uop+0      unary operator, state zero
t$uo1 equ t$uop+1      unary operator, state one
t$uo2 equ t$uop+2      unary operator, state two
t$lp0 equ t$lpr+0      left paren, state zero
t$lp1 equ t$lpr+1      left paren, state one
t$lp2 equ t$lpr+2      left paren, state two
t$lb0 equ t$lbr+0      left bracket, state zero
t$lb1 equ t$lbr+1      left bracket, state one
t$lb2 equ t$lbr+2      left bracket, state two
t$cm0 equ t$cma+0      comma, state zero
t$cm1 equ t$cma+1      comma, state one
t$cm2 equ t$cma+2      comma, state two
t$fn0 equ t$fncl+0     function call, state zero
t$fn1 equ t$fncl+1     function call, state one
t$fn2 equ t$fncl+2     function call, state two
t$va0 equ t$var+0      variable, state zero
t$va1 equ t$var+1      variable, state one
t$va2 equ t$var+2      variable, state two
t$co0 equ t$con+0      constant, state zero
t$co1 equ t$con+1      constant, state one
t$co2 equ t$con+2      constant, state two
t$bo0 equ t$bop+0      binary operator, state zero
t$bo1 equ t$bop+1      binary operator, state one
t$bo2 equ t$bop+2      binary operator, state two
t$rp0 equ t$rpr+0      right paren, state zero
t$rp1 equ t$rpr+1      right paren, state one
t$rp2 equ t$rpr+2      right paren, state two
t$rb0 equ t$rbr+0      right bracket, state zero
t$rb1 equ t$rbr+1      right bracket, state one
t$rb2 equ t$rbr+2      right bracket, state two
t$cl0 equ t$col+0      colon, state zero
t$cl1 equ t$col+1      colon, state one
t$cl2 equ t$col+2      colon, state two
t$sm0 equ t$smc+0      semicolon, state zero
t$sm1 equ t$smc+1      semicolon, state one
t$sm2 equ t$smc+2      semicolon, state two
*
t$nes equ t$sm2+1      number of entries in branch table

```

```

*
*      definition of offsets used in control card processing
*
if .culc
cc$ca equ 0 -case
cc$do equ cc$ca+1 -double
else
cc$do equ 0 -double
fi

if .ccmk
cc$co equ cc$do+1 -compare
cc$du equ cc$co+1 -dump
else
cc$du equ cc$do+1 -dump
fi

if .cinc
cc$cp equ cc$du+1 -copy
cc$ej equ cc$cp+1 -eject
else
cc$ej equ cc$du+1 -eject
fi

cc$er equ cc$ej+1 -errors
cc$ex equ cc$er+1 -execute
cc$fa equ cc$ex+1 -fail
if .cinc
cc$in equ cc$fa+1 -include
if .csln
cc$ln equ cc$in+1 -line
cc$li equ cc$ln+1 -list
else
cc$li equ cc$in+1 -list
fi

else
if .csln
cc$ln equ cc$fa+1 -line
cc$li equ cc$ln+1 -list
else
cc$li equ cc$fa+1 -list
fi
fi

cc$nr equ cc$li+1 -noerrors
cc$nx equ cc$nr+1 -noexecute
cc$nf equ cc$nx+1 -nofail
cc$nl equ cc$nf+1 -nolist
cc$no equ cc$nl+1 -noopt
cc$np equ cc$no+1 -noprint
cc$op equ cc$np+1 -optimise
cc$pr equ cc$op+1 -print
cc$si equ cc$pr+1 -single
cc$sp equ cc$si+1 -space

```

<code>cc\$st</code>	<code>equ</code>	<code>cc\$sp+1</code>	<code>-stitl</code>
<code>cc\$ti</code>	<code>equ</code>	<code>cc\$st+1</code>	<code>-title</code>
<code>cc\$tr</code>	<code>equ</code>	<code>cc\$ti+1</code>	<code>-trace</code>
<code>cc\$nc</code>	<code>equ</code>	<code>cc\$tr+1</code>	number of control cards
<code>ccnoc</code>	<code>equ</code>	<code>4</code>	no. of chars included in match
<code>ccofs</code>	<code>equ</code>	<code>7</code>	offset to start of title/subtitle
<code>if .cinc</code>			
<code>ccinm</code>	<code>equ</code>	<code>9</code>	max depth of include file nesting
<code>fi</code>			

```

*
*      definitions of stack offsets used in cmpil procedure
*
*      see description at start of cmpil procedure for details
*      of use of these locations on the stack.
*
cmstm equ 0                                tree for statement body
msgo equ cmstm+1                          tree for success goto
mfgo equ msgo+1                          tree for fail goto
mcgo equ mfgo+1                          conditional goto flag
mpcd equ mcgo+1                          previous cdblk pointer
mffp equ mpcd+1                          failure fill in flag for previous
mffc equ mffp+1                          failure fill in flag for current
msop equ mffc+1                          success fill in offset for previous
msoc equ msop+1                          success fill in offset for current
mlbl equ msoc+1                          ptr to vrbk for current label
mtra equ lbl+1                          ptr to entry cdblk
*
cmnen equ mtra+1                          count of stack entries for cmpil
if .cnpf
else
*
*      a few constants used by the profiler
pfpd1 equ 8                              pad positions ...
pfpd2 equ 20                             ... for profile ...
pfpd3 equ 32                             ... printout
pf$i2 equ cfp$i+cfp$i                    size of table entry (2 ints)
fi
if .crel

```



```

*
*      definition of limits and adjustments that are built by
*      relcr for use by the routines that relocate pointers
*      after a save file is reloaded.  see reloc etc. for usage.
*
*      a block of information is built that is used in
*      relocating pointers.  there are rnsi$ instances
*      of a rssi$ word structure.  each instance corresponds
*      to one of the regions that a pointer might point into.
*
*      each structure takes the form:
*
*      +-----+
*      i      address past end of section      i
*      +-----+
*      i      adjustment from old to new adrs   i
*      +-----+
*      i      address of start of section      i
*      +-----+
*
*      the instances are ordered thusly:
*
*      +-----+
*      i      dynamic storage                   i
*      +-----+
*      i      static storage                   i
*      +-----+
*      i      working section globals          i
*      +-----+
*      i      constant section                 i
*      +-----+
*      i      code section                     i
*      +-----+
*
*      symbolic names for these locations as offsets from
*      the first entry are provided here.
*
*      definitions within a section
*
rlend equ 0                                end
rladj equ rlend+1                          adjustment
rlstr equ rladj+1                          start
rssi$ equ rlstr+1                          size of section
rnsi$ equ 5                                number of structures
*
*      overall definitions of all structures
*
rldye equ 0                                dynamic region end
rldya equ rldye+1                          dynamic region adjustment
rldys equ rldya+1                          dynamic region start
rlste equ rldys+1                          static region end
rlsta equ rlste+1                          static region adjustment
rlsts equ rlsta+1                          static region start

```

```

rlwke equ rlsts+1
rlwka equ rlwke+1
rlwks equ rlwka+1
rlcne equ rlwks+1
rlcna equ rlcne+1
rlcns equ rlcna+1
rlcde equ rlcns+1
rlcda equ rlcde+1
rlcds equ rlcda+1
rlsi$ equ rlcds+1
fi

```

*

```

working section globals end
working section globals adjustment
working section globals start
constants section end
constants section adjustment
constants section start
code section end
code section adjustment
code section start
number of fields in structure

```

spitbol – constant section

```

*
*      this section consists entirely of assembled constants.
*
*      all label names are five letters. the order is
*      approximately alphabetical, but in some cases (always
*      documented), constants must be placed in some special
*      order which must not be disturbed.
*
*      it must also be remembered that there is a requirement
*      for no forward references which also disturbs the
*      alphabetical order in some cases.
*
sec                                start of constant section
*
*      start of constant section
*
c$aaa dac 0                        first location of constant section
*
*      free store percentage (used by alloc)
*
alfsp dac e$fsp                    free store percentage
*
*      bit constants for general use
*
bits0 dbc 0                        all zero bits
bits1 dbc 1                        one bit in low order position
bits2 dbc 2                        bit in position 2
bits3 dbc 4                        bit in position 3
bits4 dbc 8                        bit in position 4
bits5 dbc 16                       bit in position 5
bits6 dbc 32                       bit in position 6
bits7 dbc 64                       bit in position 7
bits8 dbc 128                      bit in position 8
bits9 dbc 256                      bit in position 9
bit10 dbc 512                      bit in position 10
bit11 dbc 1024                     bit in position 11
bit12 dbc 2048                     bit in position 12
bitism dbc cfp$m                   mask for max integer
*
*      bit constants for svblk (svbit field) tests
*
btfnc dbc svfnc                    bit to test for function
btknm dbc svknm                    bit to test for keyword number
btlbl dbc svlbl                     bit to test for label
btffc dbc svffc                     bit to test for fast call
btckw dbc svckw                     bit to test for constant keyword
btkwv dbc svkwv                     bits to test for keyword with value

```

btprd	dbc	svprd
btpre	dbc	svpre
btval	dbc	svval

bit to test for predicate function
bit to test for preevaluation
bit to test for value

```

*
*      list of names used for control card processing
*
if .culc
ccnms   dtc   svval
        dtc   svval
else
ccnms   dtc   svval
fi

if .ccmk
        dtc   svval
fi

        dtc   svval
if .cinc
        dtc   svval
fi

        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval

if .cinc
        dtc   svval
fi

if .csln
        dtc   svval
fi

        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval
        dtc   svval

*
*      header messages for dumph procedure (scblk format)
*

dmhdk   dac   b$$scl           dump of keyword values
        dac   b$$scl           dump of keyword values
        dtc   /dump of keyword values/

*

dmhdv   dac   b$$scl           dump of natural variables
        dac   b$$scl           dump of natural variables
```

dtc /dump of natural

variables/

```

*
*      message text for compilation statistics
*
encm1  dac  /dump of natural
if .cbyt
    dac  /dump of natural
    dtc  /dump of natural
*
encm2  dac  /dump of natural
    dac  /dump of natural
    dtc  /dump of natural
else
    dac  /dump of natural
    dtc  /dump of natural
*
encm2  dac  /dump of natural
    dac  /dump of natural
    dtc  /dump of natural
fi
*
encm3  dac  /dump of natural
    dac  /dump of natural
    dtc  /dump of natural
*
encm4  dac  /dump of natural
if .ctmd
    dac  /dump of natural
    dtc  /dump of natural
else
    dac  /dump of natural
    dtc  /dump of natural
fi
*
encm5  dac  b$$scl          execution suppressed
    dac  b$$scl          execution suppressed
    dtc  b$$scl          execution suppressed
*
*      string constant for abnormal end
*
endab  dac  b$$scl
    dac  b$$scl
    dtc  b$$scl

```

```

*
*      memory overflow during initialisation
*
endmo  dac  b$$scl
endml  dac  b$$scl
      dtc  b$$scl

*
*      string constant for message issued by l$end
*
endms  dac  b$$scl
      dac  b$$scl
      dtc  b$$scl

*
*      fail message for stack fail section
*
endso  dac  b$$scl                                stack overflow in garbage collector
      dac  b$$scl                                stack overflow in garbage collector
      dtc  /stack overflow in                    garbage collection/

*
*      string constant for time up
*
endtu  dac  /stack overflow inin
      dac  /stack overflow ininin
      dtc  /stack overflow inininin

```



```

*
*      string constant for error message (error section)
*
ermms  dac  b$sc1          error
        dac  b$sc1          error
        dtc  b$sc1          error

*
ermns  dac  b$sc1          string / - /
        dac  b$sc1          string / - /
        dtc  b$sc1          string / - /

*
*      string constant for page numbering
*
lstms  dac  b$sc1          page
        dac  b$sc1          page
        dtc  b$sc1          page

*
*      listing header message
*
headr  dac  b$sc1
        dac  b$sc1
        dtc  /macro spitbol version      3.7/

*
headv  dac  b$sc1          for exit() version no. check
        dac  b$sc1          for exit() version no. check
        dtc  b$sc1          for exit() version no. check
if .csed

*      free store percentage (used by gbcol)
*
gbsdp  dac  e$sed          sediment percentage
fi

*
*      integer constants for general use
*      icbld optimisation uses the first three.
*
int$r  dac  e$sed
intv0  dic  +0             0
inton  dac  +0             0
intv1  dic  +1             1
inttw  dac  +1             1
intv2  dic  +2             2
intvt  dic  +10            10
intvh  dic  +100           100
intth  dic  +1000          1000

*
*      table used in icbld optimisation
*
intab  dac  int$r          pointer to 0
        dac  inton         pointer to 1

```

dac **inttw**

pointer to 2

```

*
*      special pattern nodes. the following pattern nodes
*      consist simply of a pcode pointer, see match routines
*      (p$xxx) for full details of their use and format).
*
ndabb  dac  p$abb          arbno
ndabd  dac  p$abd          arbno
ndarc  dac  p$arc          arb
ndexb  dac  p$exb          expression
ndfnb  dac  p$fnb          fence()
ndfnd  dac  p$fnd          fence()
ndexc  dac  p$exc          expression
ndimb  dac  p$imb          immediate assignment
ndimd  dac  p$imd          immediate assignment
ndnth  dac  p$nth          pattern end (null pattern)
ndpab  dac  p$pab          pattern assignment
ndpad  dac  p$pad          pattern assignment
nduna  dac  p$una          anchor point movement
*
*      keyword constant pattern nodes. the following nodes are
*      used as the values of pattern keywords and the initial
*      values of the corresponding natural variables. all
*      nodes are in p0blk format and the order is tied to the
*      definitions of corresponding k$xxx symbols.
*
ndabo  dac  p$abo          abort
      dac  p$abo          abort
ndarb  dac  p$arb          arb
      dac  p$arb          arb
ndbal  dac  p$bal          bal
      dac  p$bal          bal
ndfal  dac  p$fal          fail
      dac  p$fal          fail
ndfen  dac  p$fen          fence
      dac  p$fen          fence
ndrem  dac  p$rem          rem
      dac  p$rem          rem
ndsuc  dac  p$suc          succeed
      dac  p$suc          succeed
*
*      null string. all null values point to this string. the
*      svchs field contains a blank to provide for easy default
*      processing in trace, stoptr, lpad and rpad.
*      nullw contains 10 blanks which ensures an all blank word
*      but for very exceptional machines.
*
nulls  dac  b$scl          null string value
      dac  0              sclen = 0
nullw  dtc  0              sclen = 0
*
if.culk

```

```

*
*      constant strings for lcase and ucase keywords
*
lcase  dac  0
       dac  0
       dtc  0
*
ucase  dac  0
       dac  0
       dtc  0
fi

```

```

*
*      operator dope vectors (see dvblk format)
*
opdvc  dac  o$cnc          concatenation
        dac  o$cnc          concatenation
        dac  o$cnc          concatenation
        dac  o$cnc          concatenation
*
*      opdvs is used when scanning below the top level to
*      insure that the concatenation will not be later
*      mistaken for pattern matching
*
opdvp  dac  o$cnc          concatenation - not pattern match
        dac  o$cnc          concatenation - not pattern match
        dac  o$cnc          concatenation - not pattern match
        dac  o$cnc          concatenation - not pattern match
*
*      note that the order of the remaining entries is tied to
*      the order of the coding in the scan procedure.
*
opdvs  dac  o$ass          assignment
        dac  o$ass          assignment
        dac  o$ass          assignment
        dac  o$ass          assignment
*
        dac  6             unary equal
        dac  6             unary equal
        dac  6             unary equal
*
        dac  o$pmv         pattern match
        dac  o$pmv         pattern match
        dac  o$pmv         pattern match
        dac  o$pmv         pattern match
*
        dac  o$int         interrogation
        dac  o$int         interrogation
        dac  o$int         interrogation
*
        dac  1             binary ampersand
        dac  1             binary ampersand
        dac  1             binary ampersand
        dac  1             binary ampersand
*
        dac  o$kwv         keyword reference
        dac  o$kwv         keyword reference
        dac  o$kwv         keyword reference
*
        dac  o$alt         alternation
        dac  o$alt         alternation

```

dac o\$alt
dac o\$alt

alternation
alternation

```

*
*      operator dope vectors (continued)
*
    dac  5          unary vertical bar
    dac  5          unary vertical bar
    dac  5          unary vertical bar
*
    dac  0          binary at
    dac  0          binary at
    dac  0          binary at
    dac  0          binary at
*
    dac  o$cas      cursor assignment
    dac  o$cas      cursor assignment
    dac  o$cas      cursor assignment
*
    dac  2          binary number sign
    dac  2          binary number sign
    dac  2          binary number sign
    dac  2          binary number sign
*
    dac  7          unary number sign
    dac  7          unary number sign
    dac  7          unary number sign
*
    dac  o$dvd      division
    dac  o$dvd      division
    dac  o$dvd      division
    dac  o$dvd      division
*
    dac  9          unary slash
    dac  9          unary slash
    dac  9          unary slash
*
    dac  o$mlt      multiplication
    dac  o$mlt      multiplication
    dac  o$mlt      multiplication
    dac  o$mlt      multiplication

```

```

*
*      operator dope vectors (continued)
*
    dac  0      deferred expression
    dac  0      deferred expression
    dac  0      deferred expression
*
    dac  3      binary percent
    dac  3      binary percent
    dac  3      binary percent
    dac  3      binary percent
*
    dac  8      unary percent
    dac  8      unary percent
    dac  8      unary percent
*
    dac  o$exp  exponentiation
    dac  o$exp  exponentiation
    dac  o$exp  exponentiation
    dac  o$exp  exponentiation
*
    dac  10     unary exclamation
    dac  10     unary exclamation
    dac  10     unary exclamation
*
    dac  o$ima  immediate assignment
    dac  o$ima  immediate assignment
    dac  o$ima  immediate assignment
    dac  o$ima  immediate assignment
*
    dac  o$inv  indirection
    dac  o$inv  indirection
    dac  o$inv  indirection
*
    dac  4      binary not
    dac  4      binary not
    dac  4      binary not
    dac  4      binary not
*
    dac  0      negation
    dac  0      negation
    dac  0      negation

```



```

*
*      operator dope vectors (continued)
*
      dac  o$sub          subtraction
      dac  o$sub          subtraction
      dac  o$sub          subtraction
      dac  o$sub          subtraction
*
      dac  o$com          complementation
      dac  o$com          complementation
      dac  o$com          complementation
*
      dac  o$add          addition
      dac  o$add          addition
      dac  o$add          addition
      dac  o$add          addition
*
      dac  o$aff          affirmation
      dac  o$aff          affirmation
      dac  o$aff          affirmation
*
      dac  o$pas          pattern assignment
      dac  o$pas          pattern assignment
      dac  o$pas          pattern assignment
      dac  o$pas          pattern assignment
*
      dac  o$nam          name reference
      dac  o$nam          name reference
      dac  o$nam          name reference
*
*      special dvs for goto operators (see procedure scngf)
*
opdvd  dac  o$god          direct goto
      dac  o$god          direct goto
      dac  o$god          direct goto
*
opdvn  dac  o$goc          complex normal goto
      dac  o$goc          complex normal goto
      dac  o$goc          complex normal goto

```

*			
*			
operator entry address pointers, used in code			
*			
oamn\$	dac	o\$amn	array ref (multi-subs by value)
oamv\$	dac	o\$amv	array ref (multi-subs by value)
oaon\$	dac	o\$aon	array ref (one sub by name)
oav\$	dac	o\$aov	array ref (one sub by value)
ocer\$	dac	o\$cer	compilation error
ofex\$	dac	o\$fex	failure in expression evaluation
ofif\$	dac	o\$fif	failure during goto evaluation
ofnc\$	dac	o\$fnc	function call (more than one arg)
ofne\$	dac	o\$fne	function name error
ofns\$	dac	o\$fns	function call (single argument)
ogof\$	dac	o\$gof	set goto failure trap
oinn\$	dac	o\$inn	indirection by name
okwn\$	dac	o\$kwn	keyword reference by name
olex\$	dac	o\$lex	load expression by name
olpt\$	dac	o\$lpt	load pattern
olvn\$	dac	o\$lvn	load variable name
onta\$	dac	o\$nta	negation, first entry
ontb\$	dac	o\$ntb	negation, second entry
ontc\$	dac	o\$ntc	negation, third entry
opmn\$	dac	o\$pmn	pattern match by name
opms\$	dac	o\$pmn	pattern match (statement)
opop\$	dac	o\$pop	pop top stack item
ornm\$	dac	o\$rnrm	return name from expression
orpl\$	dac	o\$rpl	pattern replacement
orvl\$	dac	o\$rvl	return value from expression
osla\$	dac	o\$sla	selection, first entry
oslb\$	dac	o\$slb	selection, second entry
oslc\$	dac	o\$slc	selection, third entry
osld\$	dac	o\$sld	selection, fourth entry
ostp\$	dac	o\$stp	stop execution
ounf\$	dac	o\$unf	unexpected failure

```

*
*      table of names of undefined binary operators for opsyn
*
opsnb  dac  ch$at                      at
        dac  ch$am                      ampersand
        dac  ch$nm                      number
        dac  ch$pc                      percent
        dac  ch$nt                      not

*
*      table of names of undefined unary operators for opsyn
*
opnsu  dac  ch$br                      vertical bar
        dac  ch$eq                      equal
        dac  ch$nm                      number
        dac  ch$pc                      percent
        dac  ch$sl                      slash
        dac  ch$ex                      exclamation
if .cnpf
else
*
*      address const containing profile table entry size
*
pfi2a  dac  ch$ex

*
*      profiler message strings
*
pfms1  dac  ch$ex
        dac  ch$ex
        dtc  ch$ex
pfms2  dac  ch$ex
        dac  ch$ex
        dtc  /stmt number of           - execution time -/
pfms3  dac  /stmt number ofof          - execution time -/
        dac  /stmt number ofofof       - execution time -/
        dtc  /number executions        total(msec) per excn(mcsec)/

fi

*
if .cnra
else
*
*      real constants for general use. note that the constants
*      starting at reav1 form a powers of ten table (used in
*      gtnum and gtstg)
*
reav0  drc  +0.0                      0.0
if .cnrcr
else
reap1  drc  +0.1                      0.1
reap5  drc  +0.5                      0.5
fi

```

reav1	drc	+1.0	10**0
reavt	drc	+1.0e+1	10**1
	drc	+1.0e+2	10**2
	drc	+1.0e+3	10**3
	drc	+1.0e+4	10**4
	drc	+1.0e+5	10**5
	drc	+1.0e+6	10**6
	drc	+1.0e+7	10**7
	drc	+1.0e+8	10**8
	drc	+1.0e+9	10**9
reatt	drc	+1.0e+10	10**10

fi

```

*
*      string constants (scblk format) for dtype procedure
*
scarr  dac  b$$scl          array
       dac  b$$scl          array
       dtc  b$$scl          array
if .cnbf
else
*
scbuf  dac  b$$scl          buffer
       dac  b$$scl          buffer
       dtc  b$$scl          buffer
fi

*
sccod  dac  b$$scl          code
       dac  b$$scl          code
       dtc  b$$scl          code

*
scexp  dac  b$$scl          expression
       dac  b$$scl          expression
       dtc  b$$scl          expression

*
scext  dac  b$$scl          external
       dac  b$$scl          external
       dtc  b$$scl          external

*
scint  dac  b$$scl          integer
       dac  b$$scl          integer
       dtc  b$$scl          integer

*
scnam  dac  b$$scl          name
       dac  b$$scl          name
       dtc  b$$scl          name

*
scnum  dac  b$$scl          numeric
       dac  b$$scl          numeric
       dtc  b$$scl          numeric

*
scpat  dac  b$$scl          pattern
       dac  b$$scl          pattern
       dtc  b$$scl          pattern
if .cnra
else
*
screa  dac  b$$scl          real
       dac  b$$scl          real
       dtc  b$$scl          real
fi

```

	*		
scstr	dac	b\$sc1	string
	dac	b\$sc1	string
	dtc	b\$sc1	string
	*		
sctab	dac	b\$sc1	table
	dac	b\$sc1	table
	dtc	b\$sc1	table
<i>if</i> .cnlf			
scfil	dac	b\$sc1	file (for extended load arguments)
	dac	b\$sc1	file (for extended load arguments)
	dtc	b\$sc1	file (for extended load arguments)
<i>fi</i>			

```

*
*      string constants (scblk format) for kvrtn (see retrn)
*
scfrrt  dac  b$$scl                      freturn
        dac  b$$scl                      freturn
        dtc  b$$scl                      freturn

*
scnrrt  dac  b$$scl                      nreturn
        dac  b$$scl                      nreturn
        dtc  b$$scl                      nreturn

*
scrtrn  dac  b$$scl                      return
        dac  b$$scl                      return
        dtc  b$$scl                      return

*
*      datatype name table for dtype procedure. the order of
*      these entries is tied to the b$xxx definitions for blocks
*
*      note that slots for buffer and real data types are filled
*      even if these data types are conditionalized out of the
*      implementation. this is done so that the block numbering
*      at bl$ar etc. remains constant in all versions.
*
scnmt   dac  scarr                      arblk array
        dac  sccod                      cdblk code
        dac  scexp                      exblk expression
        dac  scint                      icblk integer
        dac  scnam                      nmblk name
        dac  scpat                      p0blk pattern
        dac  scpat                      p1blk pattern
        dac  scpat                      p2blk pattern
if .cnra
        dac  nulls                      rcbk no real in this version
else
        dac  screa                      rcbk real
fi

        dac  scstr                      scblk string
        dac  scexp                      seblk expression
        dac  sctab                      tbbk table
        dac  scarr                      vcbk array
        dac  scext                      xnblk external
        dac  scext                      xrblk external
if .cnbf
        dac  nulls                      bfbk no buffer in this version
else
        dac  scbuf                      bfbk buffer
fi

*
if .cnra
else

```

```

*      string constant for real zero
*
scre0  dac  scbuf
       dac  scbuf
       dtc  scbuf
fi

```



```

*
*      used to re-initialise kvstl
*
if .cs16
stlim  dic  +32767                      default statement limit
else
  if .cs32
stlim  dic  +2147483647                  default statement limit
  else
stlim  dic  +50000                      default statement limit
  fi
fi

*
*      dummy function block used for undefined functions
*
stndf  dac  o$fun                      ptr to undefined function err call
      dac  0                          dummy fargs count for call circuit

*
*      dummy code block used for undefined labels
*
stndl  dac  l$und                      code ptr points to undefined lbl

*
*      dummy operator block used for undefined operators
*
stndo  dac  o$oun                      ptr to undefined operator err call
      dac  0                          dummy fargs count for call circuit

*
*      standard variable block. this block is used to initialize
*      the first seven fields of a newly constructed vrblk.
*      its format is tied to the vrblk definitions (see gtnvr).
*
stnvr  dac  b$vrl                      vrget
      dac  b$vrs                      vrsto
      dac  nulls                      vrval
      dac  b$vrg                      vrtra
      dac  stndl                      vrlbl
      dac  stndf                      vrfnc
      dac  0                          vrnxt

```

```

*
*      messages used in end of run processing (stopr)
*
stpm1  dac  b$$scl          in statement
       dac  b$$scl          in statement
       dtc  b$$scl          in statement

*
stpm2  dac  b$$scl
       dac  b$$scl
       dtc  b$$scl

*
stpm3  dac  b$$scl
if .ctmd
       dac  b$$scl
       dtc  b$$scl
else
       dac  b$$scl
       dtc  b$$scl
fi

*
stpm4  dac  b$$scl
       dac  b$$scl
       dtc  b$$scl

*
stpm5  dac  b$$scl
       dac  b$$scl
       dtc  b$$scl
if .csln

*
stpm6  dac  b$$scl          in line
       dac  b$$scl          in line
       dtc  b$$scl          in line
fi

if .csfn

*
stpm7  dac  b$$scl          in file
       dac  b$$scl          in file
       dtc  b$$scl          in file
fi

*
*      chars for /tu/ ending code
*
strtu  dtc  b$$scl

*
*      table used by convert function to check datatype name
*      the entries are ordered to correspond to branch table
*      in s$cnv

```

	*	
svctb	dac	scstr
	dac	scint
	dac	scnam
	dac	scpat
	dac	scarr
	dac	sctab
	dac	scexp
	dac	sccod
	dac	scnum
<i>if .cnra</i>		
<i>else</i>		
	dac	screa
<i>fi</i>		
<i>if .cnbf</i>		
<i>else</i>		
	dac	scbuf
<i>fi</i>		
	dac	0

string
integer
name
pattern
array
table
expression
code
numeric
real
buffer
zero marks end of list

```

*
*      messages (scblk format) used by trace procedures
*
*
tmasb  dac  b$sc1          asterisks for trace statement no
      dac  b$sc1          asterisks for trace statement no
      dtc  b$sc1          asterisks for trace statement no
*
tmbeb  dac  b$sc1          blank-equal-blank
      dac  b$sc1          blank-equal-blank
      dtc  b$sc1          blank-equal-blank
*
*      dummy trblk for expression variable
*
trbev  dac  b$trt          dummy trblk
*
*      dummy trblk for keyword variable
*
trbkv  dac  b$trt          dummy trblk
*
*      dummy code block to return control to trxeq procedure
*
*
trxdr  dac  o$txr          block points to return routine
trxdc  dac  trxdr          pointer to block

```

```

*
*      standard variable blocks
*
*      see svblk format for full details of the format. the
*      vrblks are ordered by length and within each length the
*      order is alphabetical by name of the variable.
*
v$eqf  dbc  svfpr          eq
        dac  svfpr          eq
        dtc  svfpr          eq
        dac  svfpr          eq
        dac  svfpr          eq
*
v$gef  dbc  svfpr          ge
        dac  svfpr          ge
        dtc  svfpr          ge
        dac  svfpr          ge
        dac  svfpr          ge
*
v$gtf  dbc  svfpr          gt
        dac  svfpr          gt
        dtc  svfpr          gt
        dac  svfpr          gt
        dac  svfpr          gt
*
v$lef  dbc  svfpr          le
        dac  svfpr          le
        dtc  svfpr          le
        dac  svfpr          le
        dac  svfpr          le
if .cmth
*
v$lnf  dbc  svfnp          ln
        dac  svfnp          ln
        dtc  svfnp          ln
        dac  svfnp          ln
        dac  svfnp          ln
fi
*
v$ltf  dbc  svfpr          lt
        dac  svfpr          lt
        dtc  svfpr          lt
        dac  svfpr          lt
        dac  svfpr          lt
*
v$nef  dbc  svfpr          ne
        dac  svfpr          ne
        dtc  svfpr          ne
        dac  svfpr          ne

```

	dac	svfpr	ne
<i>if .c370</i>			
	*		
v\$orf	dbc	svfnp	or
	dac	svfnp	or
	dte	svfnp	or
	dac	svfnp	or
	dac	svfnp	or
<i>fi</i>			
<i>if .c370</i>			
	*		
v\$abs	dbc	svfnp	abs
	dac	svfnp	abs
	dte	svfnp	abs
	dac	svfnp	abs
	dac	svfnp	abs
<i>fi</i>			
<i>if .c370</i>			
	*		
v\$and	dbc	svfnp	and
	dac	svfnp	and
	dte	svfnp	and
	dac	svfnp	and
	dac	svfnp	and
<i>fi</i>			
	*		
v\$any	dbc	svfnp	any
	dac	svfnp	any
	dte	svfnp	any
	dac	svfnp	any
	dac	svfnp	any
	*		
v\$arb	dbc	svkvc	arb
	dac	svkvc	arb
	dte	svkvc	arb
	dac	svkvc	arb
	dac	svkvc	arb

```

*
*      standard variable blocks (continued)
*
v$arg  dbc  svfnn          arg
        dac  svfnn          arg
        dtc  svfnn          arg
        dac  svfnn          arg
        dac  svfnn          arg

*
v$bal  dbc  svkvc          bal
        dac  svkvc          bal
        dtc  svkvc          bal
        dac  svkvc          bal
        dac  svkvc          bal

if .cmth

*
v$cos  dbc  svfnp          cos
        dac  svfnp          cos
        dtc  svfnp          cos
        dac  svfnp          cos
        dac  svfnp          cos

fi

*
v$end  dbc  svlbl          end
        dac  svlbl          end
        dtc  svlbl          end
        dac  svlbl          end

if .cmth

*
v$exp  dbc  svfnp          exp
        dac  svfnp          exp
        dtc  svfnp          exp
        dac  svfnp          exp
        dac  svfnp          exp

fi

*
v$len  dbc  svfnp          len
        dac  svfnp          len
        dtc  svfnp          len
        dac  svfnp          len
        dac  svfnp          len

*
v$leq  dbc  svfpr          leq
        dac  svfpr          leq
        dtc  svfpr          leq
        dac  svfpr          leq
        dac  svfpr          leq

*

```

v\$lge	dbc	svfpr	lge
	dac	svfpr	lge
	dtc	svfpr	lge
	dac	svfpr	lge
	dac	svfpr	lge
	*		
v\$lgt	dbc	svfpr	lgt
	dac	svfpr	lgt
	dtc	svfpr	lgt
	dac	svfpr	lgt
	dac	svfpr	lgt
	*		
v\$lle	dbc	svfpr	lle
	dac	svfpr	lle
	dtc	svfpr	lle
	dac	svfpr	lle
	dac	svfpr	lle


```

*
*      standard variable blocks (continued)
*
v$llt  dbc  svfpr          llt
       dac  svfpr          llt
       dtc  svfpr          llt
       dac  svfpr          llt
       dac  svfpr          llt

*
v$lne  dbc  svfpr          lne
       dac  svfpr          lne
       dtc  svfpr          lne
       dac  svfpr          lne
       dac  svfpr          lne

*
v$pos  dbc  svfnp          pos
       dac  svfnp          pos
       dtc  svfnp          pos
       dac  svfnp          pos
       dac  svfnp          pos

*
v$rem  dbc  svkvc          rem
       dac  svkvc          rem
       dtc  svkvc          rem
       dac  svkvc          rem
       dac  svkvc          rem

if .cust
*
v$set  dbc  svfnn          set
       dac  svfnn          set
       dtc  svfnn          set
       dac  svfnn          set
       dac  svfnn          set

fi

if .cmth
*
v$sin  dbc  svfnp          sin
       dac  svfnp          sin
       dtc  svfnp          sin
       dac  svfnp          sin
       dac  svfnp          sin

fi

*
v$tab  dbc  svfnp          tab
       dac  svfnp          tab
       dtc  svfnp          tab
       dac  svfnp          tab
       dac  svfnp          tab

if .cmth

```

	*		
v\$tan	dbc	svfnp	tan
	dac	svfnp	tan
	dte	svfnp	tan
	dac	svfnp	tan
	dac	svfnp	tan
<i>fi</i>			
<i>if</i> .c370			
	*		
v\$xor	dbc	svfnp	xor
	dac	svfnp	xor
	dte	svfnp	xor
	dac	svfnp	xor
	dac	svfnp	xor
<i>fi</i>			
<i>if</i> .cmth			
	*		
v\$atn	dbc	svfnp	atan
	dac	svfnp	atan
	dte	svfnp	atan
	dac	svfnp	atan
	dac	svfnp	atan
<i>fi</i>			
<i>if</i> .culc			
	*		
v\$cas	dbc	svknm	case
	dac	svknm	case
	dte	svknm	case
	dac	svknm	case
<i>fi</i>			
	*		
v\$chr	dbc	svfnp	char
	dac	svfnp	char
	dte	svfnp	char
	dac	svfnp	char
	dac	svfnp	char
	*		
<i>if</i> .cmth			
	*		
v\$chp	dbc	svfnp	chop
	dac	svfnp	chop
	dte	svfnp	chop
	dac	svfnp	chop
	dac	svfnp	chop
<i>fi</i>			
v\$cod	dbc	svfnk	code
	dac	svfnk	code
	dte	svfnk	code

*

v\$cop

```

*
*      standard variable blocks (continued)
*
v$dat  dbc  svfnn          data
       dac  svfnn          data
       dtc  svfnn          data
       dac  svfnn          data
       dac  svfnn          data

*
v$dte  dbc  svfnn          date
       dac  svfnn          date
       dtc  svfnn          date
       dac  svfnn          date
       dac  svfnn          date

*
v$dmp  dbc  svfnn          dump
       dac  svfnn          dump
       dtc  svfnn          dump
       dac  svfnn          dump
       dac  svfnn          dump
       dac  svfnn          dump

*
v$dup  dbc  svfnn          dupl
       dac  svfnn          dupl
       dtc  svfnn          dupl
       dac  svfnn          dupl
       dac  svfnn          dupl

*
v$evl  dbc  svfnn          eval
       dac  svfnn          eval
       dtc  svfnn          eval
       dac  svfnn          eval
       dac  svfnn          eval

if .cnex
else

*
v$ext  dbc  svfnn          exit
       dac  svfnn          exit
       dtc  svfnn          exit
       dac  svfnn          exit
       dac  svfnn          exit

fi

*
v$fal  dbc  svkvc          fail
       dac  svkvc          fail
       dtc  svkvc          fail
       dac  svkvc          fail
       dac  svkvc          fail

*

```

if .csfn

v\$fil	dbc	svknn	file
	dac	svknn	file
	dte	svknn	file
	dac	svknn	file

*

fi

v\$hst	dbc	svfnn	host
	dac	svfnn	host
	dte	svfnn	host
	dac	svfnn	host
	dac	svfnn	host

```

*
*      standard variable blocks (continued)
*
v$itm  dbc  svfnf          item
        dac  svfnf          item
        dtc  svfnf          item
        dac  svfnf          item
        dac  svfnf          item
if .csln
*
v$lin  dbc  svknm          line
        dac  svknm          line
        dtc  svknm          line
        dac  svknm          line
fi
if .cnld
else
*
v$lod  dbc  svfnn          load
        dac  svfnn          load
        dtc  svfnn          load
        dac  svfnn          load
        dac  svfnn          load
fi
*
v$lpd  dbc  svfnp          lpad
        dac  svfnp          lpad
        dtc  svfnp          lpad
        dac  svfnp          lpad
        dac  svfnp          lpad
*
v$rpdp dbc  svfnp          rpad
        dac  svfnp          rpad
        dtc  svfnp          rpad
        dac  svfnp          rpad
        dac  svfnp          rpad
*
v$rps  dbc  svfnp          rpos
        dac  svfnp          rpos
        dtc  svfnp          rpos
        dac  svfnp          rpos
        dac  svfnp          rpos
*
v$rtb  dbc  svfnp          rtab
        dac  svfnp          rtab
        dtc  svfnp          rtab
        dac  svfnp          rtab
        dac  svfnp          rtab

```

```

      *
v$si$  dbc  svfnp      size
      dac  svfnp      size
      dtc  svfnp      size
      dac  svfnp      size
      dac  svfnp      size

      *
if .cnsr
else
      *
v$srt  dbc  svfnn      sort
      dac  svfnn      sort
      dtc  svfnn      sort
      dac  svfnn      sort
      dac  svfnn      sort

fi

v$spn  dbc  svfnp      span
      dac  svfnp      span
      dtc  svfnp      span
      dac  svfnp      span
      dac  svfnp      span

```

```

*
*      standard variable blocks (continued)
*
if .cmth
*
v$sqr  dbc  svfnp          sqrt
        dac  svfnp          sqrt
        dtc  svfnp          sqrt
        dac  svfnp          sqrt
        dac  svfnp          sqrt
fi

v$stn  dbc  svknm          stno
        dac  svknm          stno
        dtc  svknm          stno
        dac  svknm          stno

*
v$tim  dbc  svfnn          time
        dac  svfnn          time
        dtc  svfnn          time
        dac  svfnn          time
        dac  svfnn          time

*
v$trm  dbc  svfnk          trim
        dac  svfnk          trim
        dtc  svfnk          trim
        dac  svfnk          trim
        dac  svfnk          trim
        dac  svfnk          trim

*
v$abe  dbc  svknm          abend
        dac  svknm          abend
        dtc  svknm          abend
        dac  svknm          abend

*
v$abo  dbc  svkvl          abort
        dac  svkvl          abort
        dtc  svkvl          abort
        dac  svkvl          abort
        dac  svkvl          abort
        dac  svkvl          abort

*
v$app  dbc  svfnf          apply
        dac  svfnf          apply
        dtc  svfnf          apply
        dac  svfnf          apply
        dac  svfnf          apply

*
v$abn  dbc  svfnp          arbno
        dac  svfnp          arbno

```


$$v_{arr}^*$$

```

*
*      standard variable blocks (continued)
*
v$brk  dbc  svfnp          break
       dac  svfnp          break
       dtc  svfnp          break
       dac  svfnp          break
       dac  svfnp          break

*
v$clr  dbc  svfnn          clear
       dac  svfnn          clear
       dtc  svfnn          clear
       dac  svfnn          clear
       dac  svfnn          clear

if .c370
*
v$cmp  dbc  svfnp          compl
       dac  svfnp          compl
       dtc  svfnp          compl
       dac  svfnp          compl
       dac  svfnp          compl

fi

*
v$ejc  dbc  svfnn          eject
       dac  svfnn          eject
       dtc  svfnn          eject
       dac  svfnn          eject
       dac  svfnn          eject

*
v$fen  dbc  svfnp          fence
       dac  svfnp          fence
       dtc  svfnp          fence
       dac  svfnp          fence
       dac  svfnp          fence
       dac  svfnp          fence
       dac  svfnp          fence

*
v$fld  dbc  svfnn          field
       dac  svfnn          field
       dtc  svfnn          field
       dac  svfnn          field
       dac  svfnn          field

*
v$idn  dbc  svfpr          ident
       dac  svfpr          ident
       dtc  svfpr          ident
       dac  svfpr          ident
       dac  svfpr          ident

*

```

$v\$inp$	dbc	svfnk	input
	dac	svfnk	input
	dtc	svfnk	input
	dac	svfnk	input
	dac	svfnk	input
	dac	svfnk	input
<i>if</i> .culk			
	*		
$v\$lcs$	dbc	svkwc	lcase
	dac	svkwc	lcase
	dtc	svkwc	lcase
	dac	svkwc	lcase
<i>fi</i>			
	*		
$v\$loc$	dbc	svfnn	local
	dac	svfnn	local
	dtc	svfnn	local
	dac	svfnn	local
	dac	svfnn	local

```

*
*      standard variable blocks (continued)
*
v$ops  dbc  svfnn          opsyn
        dac  svfnn          opsyn
        dtc  svfnn          opsyn
        dac  svfnn          opsyn
        dac  svfnn          opsyn

*
v$rmr  dbc  svfnp          remdr
        dac  svfnp          remdr
        dtc  svfnp          remdr
        dac  svfnp          remdr
        dac  svfnp          remdr

if .cnsr
else

*
v$rsr  dbc  svfnn          rsort
        dac  svfnn          rsort
        dtc  svfnn          rsort
        dac  svfnn          rsort
        dac  svfnn          rsort

fi

*
v$tbl  dbc  svfnn          table
        dac  svfnn          table
        dtc  svfnn          table
        dac  svfnn          table
        dac  svfnn          table

*
v$tra  dbc  svfnn          trace
        dac  svfnn          trace
        dtc  svfnn          trace
        dac  svfnn          trace
        dac  svfnn          trace
        dac  svfnn          trace

if .culk

*
v$ucs  dbc  svkwc          ucase
        dac  svkwc          ucase
        dtc  svkwc          ucase
        dac  svkwc          ucase

fi

*
v$anc  dbc  svknn          anchor
        dac  svknn          anchor
        dtc  svknn          anchor
        dac  svknn          anchor

if .cnbf

```

```

else
    *
v$apn  dbc  svfnn      append
       dac  svfnn      append
       dtc  svfnn      append
       dac  svfnn      append
       dac  svfnn      append
fi

    *
v$bkx  dbc  svfnp      breakx
       dac  svfnp      breakx
       dtc  svfnp      breakx
       dac  svfnp      breakx
       dac  svfnp      breakx

    *
if .cnbf
else
v$buf  dbc  svfnn      buffer
       dac  svfnn      buffer
       dtc  svfnn      buffer
       dac  svfnn      buffer
       dac  svfnn      buffer
fi

    *
v$def  dbc  svfnn      define
       dac  svfnn      define
       dtc  svfnn      define
       dac  svfnn      define
       dac  svfnn      define

    *
v$det  dbc  svfnn      detach
       dac  svfnn      detach
       dtc  svfnn      detach
       dac  svfnn      detach
       dac  svfnn      detach

```

```

*
*      standard variable blocks (continued)
*
v$dif  dbc  svfpr          differ
       dac  svfpr          differ
       dtc  svfpr          differ
       dac  svfpr          differ
       dac  svfpr          differ

*
v$ftr  dbc  svknm          ftrace
       dac  svknm          ftrace
       dtc  svknm          ftrace
       dac  svknm          ftrace

*
if .cnbf
else
v$ins  dbc  svfnn          insert
       dac  svfnn          insert
       dtc  svfnn          insert
       dac  svfnn          insert
       dac  svfnn          insert

*
fi

v$lst  dbc  svknm          lastno
       dac  svknm          lastno
       dtc  svknm          lastno
       dac  svknm          lastno

*
v$nay  dbc  svfnp          notany
       dac  svfnp          notany
       dtc  svfnp          notany
       dac  svfnp          notany
       dac  svfnp          notany

*
v$oup  dbc  svfnn          output
       dac  svfnn          output
       dtc  svfnn          output
       dac  svfnn          output
       dac  svfnn          output
       dac  svfnn          output

*
v$ret  dbc  svlbl          return
       dac  svlbl          return
       dtc  svlbl          return
       dac  svlbl          return

*
v$rew  dbc  svfnn          rewind
       dac  svfnn          rewind
       dtc  svfnn          rewind

```

$$v_{stt}^*$$

```

*
*      standard variable blocks (continued)
*
v$sub  dbc  svfnn          substr
       dac  svfnn          substr
       dtc  svfnn          substr
       dac  svfnn          substr
       dac  svfnn          substr

*
v$unl  dbc  svfnn          unload
       dac  svfnn          unload
       dtc  svfnn          unload
       dac  svfnn          unload
       dac  svfnn          unload

*
v$col  dbc  svfnn          collect
       dac  svfnn          collect
       dtc  svfnn          collect
       dac  svfnn          collect
       dac  svfnn          collect

if .ccmk

*
v$com  dbc  svknn          compare
       dac  svknn          compare
       dtc  svknn          compare
       dac  svknn          compare

fi

*
v$cnv  dbc  svfnn          convert
       dac  svfnn          convert
       dtc  svfnn          convert
       dac  svfnn          convert
       dac  svfnn          convert

*
v$enf  dbc  svfnn          endfile
       dac  svfnn          endfile
       dtc  svfnn          endfile
       dac  svfnn          endfile
       dac  svfnn          endfile

*
v$etx  dbc  svknn          errtext
       dac  svknn          errtext
       dtc  svknn          errtext
       dac  svknn          errtext

*
v$ert  dbc  svknn          errtype
       dac  svknn          errtype
       dtc  svknn          errtype
       dac  svknn          errtype

```


	*		
v\$frt	dbc	svlbl	freturn
	dac	svlbl	freturn
	dtc	svlbl	freturn
	dac	svlbl	freturn
	*		
v\$int	dbc	svfpr	integer
	dac	svfpr	integer
	dtc	svfpr	integer
	dac	svfpr	integer
	dac	svfpr	integer
	*		
v\$nrt	dbc	svlbl	nreturn
	dac	svlbl	nreturn
	dtc	svlbl	nreturn
	dac	svlbl	nreturn

```

*
*      standard variable blocks (continued)
*
if .cnpf
else
*
v$pfl  dbc  svknm      profile
      dac  svknm      profile
      dtc  svknm      profile
      dac  svknm      profile
fi

*
v$rp1  dbc  svfnp      replace
      dac  svfnp      replace
      dtc  svfnp      replace
      dac  svfnp      replace
      dac  svfnp      replace

*
v$rvs  dbc  svfnp      reverse
      dac  svfnp      reverse
      dtc  svfnp      reverse
      dac  svfnp      reverse
      dac  svfnp      reverse

*
v$rt1  dbc  svknm      rtntype
      dac  svknm      rtntype
      dtc  svknm      rtntype
      dac  svknm      rtntype

*
v$stx  dbc  svfnn      setexit
      dac  svfnn      setexit
      dtc  svfnn      setexit
      dac  svfnn      setexit
      dac  svfnn      setexit

*
v$stc  dbc  svknm      stcount
      dac  svknm      stcount
      dtc  svknm      stcount
      dac  svknm      stcount

*
v$stl  dbc  svknm      stlimit
      dac  svknm      stlimit
      dtc  svknm      stlimit
      dac  svknm      stlimit

*
v$suc  dbc  svkvc      succeed
      dac  svkvc      succeed
      dtc  svkvc      succeed
      dac  svkvc      succeed

```

	dac	svkvc	succeed
*			
v\$alp	dbc	svkwc	alphabet
	dac	svkwc	alphabet
	dtc	svkwc	alphabet
	dac	svkwc	alphabet
*			
v\$cnt	dbc	svlbl	continue
	dac	svlbl	continue
	dtc	svlbl	continue
	dac	svlbl	continue

```

*
*      standard variable blocks (continued)
*
v$dtb  dbc  svfnp          datatype
        dac  svfnp          datatype
        dtc  svfnp          datatype
        dac  svfnp          datatype
        dac  svfnp          datatype

*
v$erl   dbc  svknn          errlimit
        dac  svknn          errlimit
        dtc  svknn          errlimit
        dac  svknn          errlimit

*
v$fnc   dbc  svknn          fnclevel
        dac  svknn          fnclevel
        dtc  svknn          fnclevel
        dac  svknn          fnclevel

*
v$fls   dbc  svknn          fullscan
        dac  svknn          fullscan
        dtc  svknn          fullscan
        dac  svknn          fullscan

*
if .csfn
v$lfl   dbc  svknn          lastfile
        dac  svknn          lastfile
        dtc  svknn          lastfile
        dac  svknn          lastfile

*
fi
if .csln
v$lln   dbc  svknn          lastline
        dac  svknn          lastline
        dtc  svknn          lastline
        dac  svknn          lastline

*
fi
v$mxl   dbc  svknn          maxlength
        dac  svknn          maxlength
        dtc  svknn          maxlength
        dac  svknn          maxlength

*
v$ter   dbc  0              terminal
        dac  0              terminal
        dtc  0              terminal
        dac  0              terminal

*

```

<i>if .cbasp</i>			
<i>v\$bsp</i>	dbc	svfnn	backspace
	dac	svfnn	backspace
	dtc	svfnn	backspace
	dac	svfnn	backspace
	dac	svfnn	backspace
	*		
<i>fi</i>			
<i>v\$pro</i>	dbc	svfnn	prototype
	dac	svfnn	prototype
	dtc	svfnn	prototype
	dac	svfnn	prototype
	dac	svfnn	prototype
	*		
<i>v\$scn</i>	dbc	svlbl	scontinue
	dac	svlbl	scontinue
	dtc	svlbl	scontinue
	dac	svlbl	scontinue
	*		
	dbc	0	dummy entry to end list
	dac	10	length gt 9 (scontinue)

```

*
*      list of svblk pointers for keywords to be dumped. the
*      list is in the order which appears on the dump output.
*
vdmkw  dac  v$anc                                anchor
if .culc
      dac  v$cas                                ccase
fi
      dac  v$cod                                code
if .ccmk
  if .ccmc
    dac  v$com                                compare
  else
    dac  1                                    compare not printed
  fi
fi
      dac  v$dmp                                dump
      dac  v$erl                                errlimit
      dac  v$etx                                errtext
      dac  v$ert                                errtype
if .csfn
  dac  v$fil                                file
fi
      dac  v$fnc                                fnclevel
      dac  v$ftr                                ftrace
      dac  v$fls                                fullscan
      dac  v$inp                                input
if .csfn
  dac  v$lfl                                lastfile
fi
if .csln
  dac  v$lln                                lastline
fi
      dac  v$lst                                lastno
if .csln
  dac  v$lin                                line
fi
      dac  v$mxl                                maxlength
      dac  v$oup                                output
if .cnpf
  else
    dac  v$pfl                                profile
  fi
      dac  v$rtn                                rtntype
      dac  v$stc                                stcount
      dac  v$stl                                stlimit
      dac  v$stn                                stno
      dac  v$tra                                trace

```

	dac	v\$trm	trim
	dac	0	end of list
	* * table used by gtnvr to search svblk lists *		
vsrch	dac	0	dummy entry to get proper indexing
	dac	v\$eqf	start of 1 char variables (none)
	dac	v\$eqf	start of 2 char variables
	dac	v\$any	start of 3 char variables
<i>if .cmth</i>			
	dac	v\$atn	start of 4 char variables
<i>else</i>			
<i>if .culc</i>			
	dac	v\$cas	start of 4 char variables
<i>else</i>			
	dac	v\$chr	start of 4 char variables
<i>fi</i>			
<i>fi</i>			
	dac	v\$abe	start of 5 char variables
	dac	v\$anc	start of 6 char variables
	dac	v\$col	start of 7 char variables
	dac	v\$alp	start of 8 char variables
<i>if .cbasp</i>			
	dac	v\$bsp	start of 9 char variables
<i>else</i>			
	dac	v\$pro	start of 9 char variables
<i>fi</i>			
	* * last location in constant section *		
c\$yyy	dac	0	last location in constant section

spitbol – working storage section

```
*
*
* the working storage section contains areas which are
* changed during execution of the program. the value
* assembled is the initial value before execution starts.
*
* all these areas are fixed length areas. variable length
* data is stored in the static or dynamic regions of the
* allocated data areas.
*
* the values in this area are described either as work
* areas or as global values. a work area is used in an
* ephemeral manner and the value is not saved from one
* entry into a routine to another. a global value is a
* less temporary location whose value is saved from one
* call to another.
*
* w$aaa marks the start of the working section whilst
* w$yyy marks its end. g$aaa marks the division between
* temporary and global values.
*
* global values are further subdivided to facilitate
* processing by the garbage collector. r$aaa through
* r$yyy are global values that may point into dynamic
* storage and hence must be relocated after each garbage
* collection. they also serve as root pointers to all
* allocated data that must be preserved. pointers between
* a$aaa and r$aaa may point into code, static storage,
* or mark the limits of dynamic memory. these pointers
* must be adjusted when the working section is saved to a
* file and subsequently reloaded at a different address.
*
* a general part of the approach in this program is not
* to overlap work areas between procedures even though a
* small amount of space could be saved. such overlap is
* considered a source of program errors and decreases the
* information left behind after a system crash of any kind.
*
* the names of these locations are labels with five letter
* (a-y,$) names. as far as possible the order is kept
* alphabetical by these names but in some cases there
* are slight departures caused by other order requirements.
*
* unless otherwise documented, the order of work areas
* does not affect the execution of the spitbol program.
*
```

sec

start of working storage section


```

*
*      this area is not cleared by initial code
*
cmlab  dac  b$$scl          string used to check label legality
      dac  b$$scl          string used to check label legality
      dtc  b$$scl          string used to check label legality
*
*      label to mark start of work area
*
w$aaa  dac  b$$scl
*
*      work areas for acess procedure
*
actrm  dac  0              trim indicator
*
*      work areas for alloc procedure
*
aldyn  dac  0              amount of dynamic store
allia  dic  +0             dump ia
allsv  dac  0              save wb in alloc
*
*      work areas for alost procedure
*
alsta  dac  0              save wa in alost
*
*      work areas for array function (s$arr)
*
arcdm  dac  0              count dimensions
arnel  dic  +0             count elements
arptr  dac  0              offset ptr into arblk
arsvl  dic  +0             save integer low bound

```

```

*
*      work areas for arref routine
*
arfsi  dic  +0          save current evolving subscript
arfxs  dac  0          save base stack pointer
*
*      work areas for b$efc block routine
*
befof  dac  0          save offset ptr into efbk
*
*      work areas for b$pfc block routine
*
bpfpf  dac  0          save pfbk pointer
bpfsv  dac  0          save old function value
bpfxt  dac  0          pointer to stacked arguments
*
*      work area for collect function (s$col)
*
clsvi  dic  +0          save integer argument
*
*      work areas value for cnrd
*
cnsc  dac  0          pointer to control card string
cnswc  dac  0          word count
cnr$t  dac  0          pointer to r$ttl or r$stl
*
*      work areas for convert function (s$cnv)
*
cnvtp  dac  0          save ptr into scvtb
*
*      work areas for data function (s$dat)
*
datdv  dac  0          save vrbk ptr for datatype name
datxs  dac  0          save initial stack pointer
*
*      work areas for define function (s$def)
*
deflb  dac  0          save vrbk ptr for label
defna  dac  0          count function arguments
defvr  dac  0          save vrbk ptr for function name
defxs  dac  0          save initial stack pointer
*
*      work areas for dump procedure
*
dmarg  dac  0          dump argument
dmrsa  dac  0          preserve wa over prtvl call
if .ccmk
dmrpb  dac  0          preserve wb over syscm call
fi

```

dmpsv	dac	0	general scratch save
dmvch	dac	0	chain pointer for variable blocks
dmpch	dac	0	save sorted vrbk chain pointer
dmpkb	dac	0	dummy kvblk for use in dumpr
dmpkt	dac	0	kvvar trblk ptr (must follow dmpkb)
dmpkn	dac	0	keyword number (must follow dmpkt)
*			
* work area for dtach			
*			
dtcnb	dac	0	name base
dtnm	dac	0	name ptr
*			
* work areas for dupl function (s\$dup)			
*			
dupsi	dic	+0	store integer string length
*			
* work area for endfile (s\$enf)			
*			
enfch	dac	0	for iochk chain head

```

*
*      work areas for ertex
*
ertwa  dac  0      save wa
ertwb  dac  0      save wb
*
*      work areas for evali
*
evlin  dac  0      dummy pattern block pcode
evlis  dac  0      then node (must follow evlin)
evliv  dac  0      value of parm1 (must follow evlis)
evlio  dac  0      ptr to original node
evlif  dac  0      flag for simple/complex argument
*
*      work area for expan
*
expsv  dac  0      save op dope vector pointer
*
*      work areas for gbccl procedure
*
gbcfl  dac  0      garbage collector active flag
gbcclm dac  0      pointer to last move block (pass 3)
gbcnm  dac  0      dummy first move block
gbcns  dac  0      rest of dummy block (follows gbcnm)
if .csed
    if .cepp
        else
gbcmk  dac  0      bias when marking entry point
fi
gbcia  dic  +0      dump ia
gbcscd dac  0      first address beyond sediment
gbcscf dac  0      free space within sediment
fi
gbsva  dac  0      save wa
gbsvb  dac  0      save wb
gbsvc  dac  0      save wc
*
*      work areas for gtnvr procedure
*
gnvhe  dac  0      ptr to end of hash chain
gnvnw  dac  0      number of words in string name
gnvsa  dac  0      save wa
gnvsb  dac  0      save wb
gnvsp  dac  0      pointer into vsrch table
gnvst  dac  0      pointer to chars of string
*
*      work areas for gtarr
*
gtawa  dac  0      save wa

```

```
*  
*      work areas for gtint  
*  
gtina  dac  0      save wa  
gtinb  dac  0      save wb
```

```

*
*      work areas for gtnum procedure
*
gtnnf  dac  0          zero/nonzero for result +/-
gtnsi  dic  +0        general integer save
if .cnra
else
gtndf  dac  0          0/1 for dec point so far no/yes
gtnes  dac  0          zero/nonzero exponent +/-
gtnex  dic  +0        real exponent
gtnsc  dac  0          scale (places after point)
gtnsr  drc  +0.0      general real save
gtnrd  dac  0          flag for ok real number
fi

*
*      work areas for gtpat procedure
*
gtpsb  dac  0          save wb

*
*      work areas for gtstg procedure
*
gtssf  dac  0          0/1 for result +/-
gtsvc  dac  0          save wc
gtsvb  dac  0          save wb
if .cnra
else
  if .cnrc
  else
    gtsses  dac  0          char + or - for exponent +/-
    gtssrs  drc  +0.0      general real save
  fi
fi

*
*      work areas for gtvar procedure
*
gtvrc  dac  0          save wc
if .cnbf
else

*
*      work areas for insbf
*
insab  dac  0          entry wa + entry wb
insln  dac  0          length of insertion string
inssa  dac  0          save entry wa
inssb  dac  0          save entry wb
inssc  dac  0          save entry wc
fi

*

```

```

*          work areas for ioput
*
ioptt  dac  0          type of association
if .cnld
else
*
*          work areas for load function
*
lodfn  dac  0          pointer to vrbk for func name
lodna  dac  0          count number of arguments
fi

if .cnpf
else
*
*          work area for profiler
*
pfsvw  dac  0          to save a w-reg
fi

*
*          work areas for prtnm procedure
*
prnsi  dic  +0          scratch integer loc
*
*          work areas for prtsn procedure
*
prсна  dac  0          save wa
*
*          work areas for prtst procedure
*
prsva  dac  0          save wa
prsvb  dac  0          save wb
prsvc  dac  0          save char counter
*
*          work area for prtnl
*
prtsa  dac  0          save wa
prtsb  dac  0          save wb
*
*          work area for prtv1
*
prvsi  dac  0          save idval
*
*          work areas for pattern match routines
*
psave  dac  0          temporary save for current node ptr
psavc  dac  0          save cursor in p$spn, p$str
if .crel

```

```

*
*      work area for relaj routine
*
rlals  dac  0                                ptr to list of bounds and adjusts
*
*      work area for reldn routine
*
rldcd  dac  0                                save code adjustment
rldst  dac  0                                save static adjustment
rldls  dac  0                                save list pointer
fi

*
*      work areas for retrn routine
*
rtnbp  dac  0                                to save a block pointer
rtnfv  dac  0                                new function value (result)
rtnsv  dac  0                                old function value (saved value)
*
*      work areas for substr function (s$sub)
*
sbssv  dac  0                                save third argument
*
*      work areas for scan procedure
*
scnsa  dac  0                                save wa
scnsb  dac  0                                save wb
scnsc  dac  0                                save wc
scnof  dac  0                                save offset
if .cnsr
else

```



```

*
*      work area used by sorta, sortc, sortf, sorth
*
srtidf  dac  0      datatype field name
srtfd   dac  0      found dfblk address
srtff   dac  0      found field name
srtfo   dac  0      offset to field name
srtnr   dac  0      number of rows
srtof   dac  0      offset within row to sort key
srtrt   dac  0      root offset
srts1   dac  0      save offset 1
srts2   dac  0      save offset 2
srtsc   dac  0      save wc
srtsf   dac  0      sort array first row offset
srtsn   dac  0      save n
srtso   dac  0      offset to a(0)
srtsr   dac  0      0, non-zero for sort, rsort
srtst   dac  0      stride from one row to next
srtwc   dac  0      dump wc
fi

*
*      work areas for stopr routine
*
stpsi   dic  +0      save value of stcount
stpti   dic  +0      save time elapsed

*
*      work areas for tfind procedure
*
tfnsi   dic  +0      number of headers

*
*      work areas for xscan procedure
*
xsqrt   dac  0      save return code
xscwb   dac  0      save register wb

*
*      start of global values in working section
*
g$aaa   dac  0

*
*      global value for alloc procedure
*
alfsf   dic  +0      factor in free store pctage check

*
*      global values for cmpil procedure
*
cmerc   dac  0      count of initial compile errors
cmpln   dac  0      line number of first line of stmt
cmpxs   dac  0      save stack ptr in case of errors
cmpsn   dac  1      number of next statement to compile

```

```

*
*      global values for cncrd
*
if .cinc
cnsil  dac  0          save scnil during include process.
cnind  dac  0          current include file nest level
cnspt  dac  0          save scnpt during include process.
fi

cnttl  dac  0          flag for -title, -stitl
*
*      global flag for suppression of compilation statistics.
*
cpsts  dac  0          suppress comp. stats if non zero
*
*      global values for control card switches
*
cswdb  dac  0          0/1 for -single/-double
cswer  dac  0          0/1 for -errors/-noerrors
cswex  dac  0          0/1 for -execute/-noexecute
cswfl  dac  1          0/1 for -nofail/-fail
cswin  dac  iniln      xxx for -inxxx
cswls  dac  1          0/1 for -nolist/-list
cswno  dac  0          0/1 for -optimise/-noopt
cswpr  dac  0          0/1 for -noprint/-print
*
*      global location used by patst procedure
*
ctmsk  dbc  0          last bit position used in r$ctp
curid  dac  0          current id value

```

```

*
*      global value for cdwrd procedure
*
cwcof  dac  0                      next word offset in current ccbk
if .csed
*
*      global locations for dynamic storage pointers
*
dnams  dac  0                      size of sediment in bauss
fi

*
*      global area for error processing.
*
erich  dac  0                      copy error reports to int.chan if 1
erlst  dac  0                      for listr when errors go to int.ch.
errft  dac  0                      fatal error flag
errsp  dac  0                      error suppression flag
*
*      global flag for suppression of execution stats
*
exsts  dac  0                      suppress exec stats if set
*
*      global values for exfal and return
*
flprt  dac  0                      location of fail offset for return
flptr  dac  0                      location of failure offset on stack
*
*      global location to count garbage collections (gbccl)
*
if .csed
gbsed  dic  +0                      factor in sediment pcentage check
fi

gbcnt  dac  0                      count of garbage collections
*
*      global value for gtcod and gtexp
*
gtcef  dac  0                      save fail ptr in case of error
*
*      global locations for gtstg procedure
*
if .cnra
else
  if .cnrc
  else
    gtsrn  drc  +0.0                rounding factor 0.5*10**-cfp$$
    gtssc  drc  +0.0                scaling value 10**cfp$$
  fi
fi

```

gtswk	dac	0	ptr to work area for gtstg
	*		
	*	global flag for header printing	
	*		
headp	dac	0	header printed flag
	*		
	*	global values for variable hash table	
	*		
hshnb	dic	+0	number of hash buckets
	*		
	*	global areas for init	
	*		
initr	dac	0	save terminal flag

```

*
*      global values for keyword values which are stored as one
*      word integers. these values must be assembled in the
*      following order (as dictated by k$xxx definition values).
*
kvabe  dac  0                      abend
kvanc  dac  0                      anchor
if .culc
kvcas  dac  0                      case
fi

kvcod  dac  0                      code
if .ccmk
kvcom  dac  0                      compare
fi

kvdmp  dac  0                      dump
kverl  dac  0                      errlimit
kvert  dac  0                      errtype
kvftr  dac  0                      ftrace
kvfls  dac  1                      fullscan
kvinp  dac  1                      input
kvmxl  dac  5000                   maxlength
kvoup  dac  1                      output
if .cnpf
else
kvpfl  dac  0                      profile
fi

kvtra  dac  0                      trace
kvtrm  dac  0                      trim
kvfnc  dac  0                      fnclevel
kvlst  dac  0                      lastno
if .csln
kvlln  dac  0                      lastline
kvlin  dac  0                      line
fi

kvstn  dac  0                      stno

*
*      global values for other keywords
*
kvalp  dac  0                      alphabet
kvrtn  dac  nulls                  rtntype (scblk pointer)
if .cs16
kvstl  dic  +32767                 stlimit
kvstc  dic  +32767                 stcount (counts down from stlimit)
else
if .cs32
kvstl  dic  +2147483647            stlimit
kvstc  dic  +2147483647            stcount (counts down from stlimit)
else
kvstl  dic  +50000                 stlimit
kvstc  dic  +50000                 stcount (counts down from stlimit)

```

```

fi
fi

*
*      global values for listr procedure
*

if .cinc
lstid  dac  0          include depth of current image
fi

lstlc  dac  0          count lines on source list page
lstnp  dac  0          max number of lines on page
lstpf  dac  1          set nonzero if current image listed
lstpg  dac  0          current source list page number
lstpo  dac  0          offset to page nnn message
lstsn  dac  0          remember last stmnum listed

*
*      global maximum size of spitbol objects
*

mxlen  dac  0          initialised by sysmx call

*
*      global execution control variable
*

noxeq  dac  0          set non-zero to inhibit execution
if .cnpf
else
*
*      global profiler values locations
*

pfdmp  dac  0          set non-0 if &profile set non-0
pffnc  dac  0          set non-0 if funct just entered
pfstm  dic  +0          to store starting time of stmt
pfetm  dic  +0          to store ending time of stmt
pfnte  dac  0          nr of table entries
pfste  dic  +0          gets int rep of table entry size
fi

*

```

```

*
*      global values used in pattern match routines
*
pmdfl  dac  0          pattern assignment flag
pmhbs  dac  0          history stack base pointer
pmssl  dac  0          length of subject string in chars
if .cpol

*
*      global values for interface polling (syspl)
*
polcs  dac  1          poll interval start value
polct  dac  1          poll interval counter
fi

*
*      global flags used for standard file listing options
*
prich  dac  0          printer on interactive channel
prstd  dac  0          tested by prtpg
prsto  dac  0          standard listing option flag

*
*      global values for print procedures
*
prbuf  dac  0          ptr to print bfr in static
precl  dac  0          extended/compact listing flag
prlen  dac  0          length of print buffer in chars
prlnw  dac  0          length of print buffer in words
profs  dac  0          offset to next location in prbuf
prtef  dac  0          endfile flag

```

```

*
*      global area for readr
*
rdcln  dac  0                      current statement line number
rdnln  dac  0                      next statement line number
*
*      global amount of memory reserved for end of execution
*
rsmem  dac  0                      reserve memory
*
*      global area for stmgo counters
*
stmcs  dac  1                      counter startup value
stmct  dac  1                      counter active value
*
*      adjustable global values
*
*      all the pointers in this section can point to the
*      dynamic or the static region.
*      when a save file is reloaded, these pointers must
*      be adjusted if static or dynamic memory is now
*      at a different address.  see routine reloc for
*      additional information.
*
*      some values cannot be move here because of adjacency
*      constraints.  they are handled specially by reloc et al.
*      these values are kvrtn,
*
*      values gtswk, kvalp, and prbuf are reinitialized by
*      procedure insta, and do not need to appear here.
*
*      values flprt, flptr, gtcef, and stbas point into the
*      stack and are explicitly adjusted by osint's restart
*      procedure.
*
a$aaa  dac  0                      start of adjustable values
cmpss  dac  0                      save subroutine stack ptr
dnamb  dac  0                      start of dynamic area
dnamp  dac  0                      next available loc in dynamic area
dname  dac  0                      end of available dynamic area
hshtb  dac  0                      pointer to start of vrbk hash tabl
hshte  dac  0                      pointer past end of vrbk hash tabl
iniss  dac  0                      save subroutine stack ptr
pftbl  dac  0                      gets adrs of (imag) table base
prnmv  dac  0                      vrbk ptr from last name search
statb  dac  0                      start of static area
state  dac  0                      end of static area
stxvr  dac  nulls                  vrbk pointer or null
*
*      relocatable global values
*

```



```

*      all the pointers in this section can point to blocks in
*      the dynamic storage area and must be relocated by the
*      garbage collector. they are identified by r$xxx names.
*
r$aaa  dac  0      start of relocatable values
r$arfb  dac  0      array block pointer for arref
r$ccb  dac  0      ptr to ccblk being built (cdwrd)
r$cim  dac  0      ptr to current compiler input str
r$cmp  dac  0      copy of r$cim used in cmpil
r$cni  dac  0      ptr to next compiler input string
r$cnt  dac  0      cdblk pointer for setexit continue
r$cod  dac  0      pointer to current cdblk or exblk
r$ctp  dac  0      ptr to current ctblk for patst
r$cts  dac  0      ptr to last string scanned by patst
r$ert  dac  0      trblk pointer for errtype trace
r$etx  dac  nulls  pointer to errtext string
r$exs  dac  0      = save xl in expdm
r$fcbl dac  0      fcbk chain head
r$fnc  dac  0      trblk pointer for fnclevel trace
r$gtc  dac  0      keep code ptr for gtcod,gtexp
if .cinc
r$ici  dac  0      saved r$cim during include process.
  if .csfn
r$ifa  dac  0      array of file names by incl. depth
r$ifl  dac  0      array of line nums by include depth
  fi
r$ifn  dac  0      last include file name
r$inc  dac  0      table of include file names seen
fi
r$io1  dac  0      file arg1 for ioput
r$io2  dac  0      file arg2 for ioput
r$iof  dac  0      fcbk ptr or 0
r$ion  dac  0      name base ptr
r$iop  dac  0      predecessor block ptr for ioput
r$iot  dac  0      trblk ptr for ioput
if .cnbf
else
r$pmb  dac  0      buffer ptr in pattern match
fi
r$pms  dac  0      subject string ptr in pattern match
r$ra2  dac  0      replace second argument last time
r$ra3  dac  0      replace third argument last time
r$rrpt dac  0      ptr to ctblk replace table last used
r$scp  dac  0      save pointer from last scan call
if .csfn
r$sfcb dac  nulls  current source file name
r$sfcb dac  0      ptr to source file name table
fi
r$ssl  dac  0      preserve xl in sortc
r$ssr  dac  0      preserve xr in sorta/sortc
r$stc  dac  0      trblk pointer for stcount trace

```

<code>r\$stl</code>	<code>dac</code>	<code>0</code>	source listing sub-title
<code>r\$src</code>	<code>dac</code>	<code>0</code>	code (cdbl) ptr for setexit trap
<code>r\$ttl</code>	<code>dac</code>	<code>nulls</code>	source listing title
<code>r\$xsc</code>	<code>dac</code>	<code>0</code>	string pointer for xscan

```

*
*      the remaining pointers in this list are used to point
*      to function blocks for normally undefined operators.
*
r$uba  dac  stndo          binary at
r$ubm  dac  stndo          binary ampersand
r$ubn  dac  stndo          binary number sign
r$ubp  dac  stndo          binary percent
r$ubt  dac  stndo          binary not
r$uub  dac  stndo          unary vertical bar
r$uue  dac  stndo          unary equal
r$uun  dac  stndo          unary number sign
r$uup  dac  stndo          unary percent
r$uus  dac  stndo          unary slash
r$uux  dac  stndo          unary exclamation
r$yyy  dac  0              last relocatable location
*
*      global locations used in scan procedure
*
scnbl  dac  0              set non-zero if scanned past blanks
scncc  dac  0              non-zero to scan control card name
scngo  dac  0              set non-zero to scan goto field
scnil  dac  0              length of current input image
scnpt  dac  0              pointer to next location in r$cin
scnrs  dac  0              set non-zero to signal rescan
scnse  dac  0              start of current element
scntp  dac  0              save syntax type from last call
*
*      global value for indicating stage (see error section)
*
stage  dac  0              initial value = initial compile

```

```

*
*      global stack pointer
*
stbas  dac  0                                pointer past stack base
*
*      global values for setexit function (s$stx)
*
stxoc  dac  0                                code pointer offset
stxof  dac  0                                failure offset
*
*      global value for time keeping
*
timsx  dic  +0                                time at start of execution
timup  dac  0                                set when time up occurs
*
*      global values for xscan and xscni procedures
*
xsofs  dac  0                                offset to current location in r$xsc
*
*      label to mark end of working section
*
w$yyy  dac  0

```

spitbol – minimal code

```
      sec  
s$aaa ent bl$$i  
if .crel
```

start of program section
mark start of code

spitbol – relocation

```

*
*      relocation
*      the following section provides services to osint to
*      relocate portions of the workspace.  it is used when
*      a saved memory image must be restarted at a different
*      location.
*
*      relaj -- relocate a list of pointers
*
*      (wa)                ptr past last pointer of list
*      (wb)                ptr to first pointer of list
*      (xl)                list of boundaries and adjustments
*      jsr  relaj           call to process list of pointers
*      (wb)                destroyed
*
relaj  prc  e,0             entry point
       mov  xr,-(xs)        save xr
       mov  wa,-(xs)        save wa
       mov  xl,rlals        save ptr to list of bounds
       mov  wb,xr           ptr to first pointer to process
*
*      merge here to check if done
*
rlaj0  mov  rlals,xl        restore xl
       bne  xr,(xs),rlaj1   proceed if more to do
       mov  (xs)+,wa        restore wa
       mov  (xs)+,xr        restore xr
       exi                  return to caller
*
*      merge here to process next pointer on list
*
rlaj1  mov  (xr),wa         load next pointer on list
       lct  wb,=rnsi$       number of sections of adjusters
*
*      merge here to process next section of stack list
*
rlaj2  bgt  wa,rlend(xl),rlaj3  ok if past end of section
       blt  wa,rlstr(xl),rlaj3  or if before start of section
       add  rladj(xl),wa        within section, add adjustment
       mov  wa,(xr)            return updated ptr to memory
       brn  rlaj4              done with this pointer
*
*      here if not within section
*
rlaj3  add  *rssi$,xl        advance to next section
       bct  wb,rlaj2         jump if more to go

```

```

*
*      here when finished processing one pointer
*
rlaj4  ica  xr          increment to next ptr on list
       brn  rlaj0       jump to check for completion
       enp             end procedure relaj

```

```

*
*      relcr -- create relocation info after save file reload
*
*      (wa)                original s$aaa code section adr
*      (wb)                original c$aaa constant section adr
*      (wc)                original g$aaa working section adr
*      (xr)                ptr to start of static region
*      (cp)                ptr to start of dynamic region
*      (xl)                ptr to area to receive information
*      jsr  relcr          create relocation information
*      (wa,wb,wc,xr)      destroyed
*
*      a block of information is built at (xl) that is used
*      in relocating pointers.  there are rnsi$ instances
*      of a rssi$ word structure.  each instance corresponds
*      to one of the regions that a pointer might point into.
*      the layout of this structure is shown in the definitions
*      section, together with symbolic definitions of the
*      entries as offsets from xl.
*
relcr  prc  e,0            entry point
      add  *rlsi$,xl      point past build area
      mov  wa,-(xl)       save original code address
      mov  =s$aaa,wa      compute adjustment
      sub  (xl),wa        as new s$aaa minus original s$aaa
      mov  wa,-(xl)       save code adjustment
      mov  =s$yyy,wa      end of target code section
      sub  =s$aaa,wa      length of code section
      add  num01(xl),wa   plus original start address
      mov  wa,-(xl)       end of original code section
      mov  wb,-(xl)       save constant section address
      mov  =c$aaa,wb      start of constants section
      mov  =c$yyy,wa      end of constants section
      sub  wb,wa          length of constants section
      sub  (xl),wb        new c$aaa minus original c$aaa
      mov  wb,-(xl)       save constant adjustment
      add  num01(xl),wa   length plus original start adr
      mov  wa,-(xl)       save as end of original constants
      mov  wc,-(xl)       save working globals address
      mov  =g$aaa,wc      start of working globals section
      mov  =w$yyy,wa      end of working section
      sub  wc,wa          length of working globals
      sub  (xl),wc        new g$aaa minus original g$aaa
      mov  wc,-(xl)       save working globals adjustment
      add  num01(xl),wa   length plus original start adr
      mov  wa,-(xl)       save as end of working globals
      mov  statb,wb       old start of static region
      mov  wb,-(xl)       save
      sub  wb,xr          compute adjustment
      mov  xr,-(xl)       save new statb minus old statb
      mov  state,-(xl)    old end of static region
      mov  dnamb,wb       old start of dynamic region
      mov  wb,-(xl)       save

```


scpl	wa	new start of dynamic
sub	wb,wa	compute adjustment
mov	wa,-(x1)	save new dnamb minus old dnamb
mov	dnamp,wc	old end of dynamic region in use
mov	wc,-(x1)	save as end of old dynamic region
exi	wc,-(x1)	save as end of old dynamic region
enp	wc,-(x1)	save as end of old dynamic region

```

*
*      reldn -- relocate pointers in the dynamic region
*
*      (xl)                list of boundaries and adjustments
*      (xr)                ptr to first location to process
*      (wc)                ptr past last location to process
*      jsr  reldn          call to process blocks in dynamic
*      (wa,wb,wc,xr)      destroyed
*
*      processes all blocks in the dynamic region.  within a
*      block, pointers to the code section, constant section,
*      working globals section, static region, and dynamic
*      region are relocated as needed.
*
reldn  prc  e,0            entry point
      mov  rlcda(xl),rldcd  save code adjustment
      mov  rlsta(xl),rldst  save static adjustment
      mov  xl,rldls        save list pointer
*
*      merge here to process the next block in dynamic
*
rld01  add  rldcd,(xr)      adjust block type word
      mov  (xr),xl         load block type word
      lei  xl              load entry point id (bl$xx)
*
*      block type switch. note that blocks with no relocatable
*      fields just return to rld05 to continue to next block.
*
*      note that dfblks do not appear in dynamic, only in static.
*      ccblks and cmbks are not live when a save file is
*      created, and can be skipped.
*
*      further note:  static blocks other than vrblks discovered
*      while scanning dynamic must be adjusted at this time.
*      see processing of ffbk for example.
*

```

```

*
*      reldn (continued)
*
      bsw  x1,bl$$$$                switch on block type
      iff  bl$ar,rld03              arblk
if .cnbf
      iff  bl$bc,rld05              bcbk - dummy to fill out iffs
else
      iff  bl$bc,rld06              bcbk
fi
      iff  bl$bf,rld05              bfbk
      iff  bl$cc,rld05              ccbk
      iff  bl$cd,rld07              cdbk
      iff  bl$cm,rld05              cmbk
      iff  bl$ct,rld05              ctbk
      iff  bl$df,rld05              dfbk
      iff  bl$ef,rld08              efbk
      iff  bl$ev,rld09              evbk
      iff  bl$ex,rld10              exbk
      iff  bl$ff,rld11              ffbk
      iff  bl$ic,rld05              icbk
      iff  bl$kv,rld13              kvbk
      iff  bl$nm,rld13              nmbk
      iff  bl$p0,rld13              p0bk
      iff  bl$p1,rld14              p1bk
      iff  bl$p2,rld14              p2bk
      iff  bl$pd,rld15              pdbk
      iff  bl$pf,rld16              pfbk
if .cnra
else
      iff  bl$rc,rld05              rcbk
fi
      iff  bl$sc,rld05              scbk
      iff  bl$se,rld13              sebk
      iff  bl$tb,rld17              tbbk
      iff  bl$te,rld18              tebk
      iff  bl$tr,rld19              trbk
      iff  bl$vc,rld17              vcbk
      iff  bl$xn,rld05              xnbk
      iff  bl$xr,rld20              xrbk
      esw                          end of jump table

*
*      arblk
*
rld03  mov  arlen(xr),wa            load length
      mov  arofs(xr),wb            set offset to 1st reloc fld (arpro)

*
*      merge here to process pointers in a block
*
*      (xr)                        ptr to current block
*      (wc)                        ptr past last location to process

```

*	(wa)	length (reloc flds + flds at start)
*	(wb)	offset to first reloc field
*		
rld04	add xr,wa	point past last reloc field
	add xr,wb	point to first reloc field
	mov rldls,xl	point to list of bounds
	jsr relaj	adjust pointers

```

*
*      rldn (continued)
*
*
*      merge here to advance to next block
*
*      (xr)                ptr to current block
*      (wc)                ptr past last location to process
*
rld05  mov  (xr),wa          block type word
      jsr  blkln            get length of block
      add  wa,xr            point to next block
      blt  xr,wc,rld01      continue if more to process
      mov  rldls,xl        restore xl
      exi                  return to caller if done
if .cnbf
else
*
*      bcbk
*
rld06  mov  *bcsi$,wa        set length
      mov  *bcbuf,wb        and offset
      brn  rld04            all set
fi
*
*      cdbk
*
rld07  mov  cdlen(xr),wa     load length
      mov  *cdfal,wb        set offset
      bne  (xr),=b$cdc,rld04 jump back if not complex goto
      mov  *cdc cod,wb       do not process cdfal word
      brn  rld04            jump back
*
*      efbk
*
*      if the efcod word points to an xnblk, the xnblk type
*      word will not be adjusted.  since this is implementation
*      dependent, we will not worry about it.
*
rld08  mov  *efrsl,wa        set length
      mov  *efcod,wb        and offset
      brn  rld04            all set
*
*      evbk
*
rld09  mov  *offs3,wa        point past third field
      mov  *evexp,wb        set offset
      brn  rld04            all set
*
*      exbk

```

	*		
rld10	mov	exlen(xr),wa	load length
	mov	*exflc,wb	set offset
	brn	rld04	jump back

```

*
*      reldn (continued)
*
*
*      ffbldk
*
*      this block contains a ptr to a dfblk in the static rgn.
*      because there are multiple ffbldks pointing to the same
*      dfblk (one for each field name), we only process the
*      dfblk when we encounter the ffbldk for the first field.
*      the dfblk in turn contains a pointer to an scblk within
*      static.
*
rld11  bne  ffofs(xr),*pdfld,rld12      skip dfblk if not first field
        mov  xr,-(xs)                  save xr
        mov  ffdfp(xr),xr              load old ptr to dfblk
        add  rldst,xr                  current location of dfblk
        add  rldcd,(xr)                adjust dfblk type word
        mov  dflen(xr),wa              length of dfblk
        mov  *dfnam,wb                offset to dfnam field
        add  xr,wa                    point past last reloc field
        add  xr,wb                    point to first reloc field
        mov  rldls,xl                 point to list of bounds
        jsr  relaj                    adjust pointers
        mov  dfnam(xr),xr              pointer to static scblk
        add  rldcd,(xr)                adjust scblk type word
        mov  (xs)+,xr                 restore ffbldk pointer
*
*      ffbldk (continued)
*
*      merge here to set up for adjustment of ptrs in ffbldk
*
rld12  mov  *ffofs,wa                  set length
        mov  *ffdfp,wb                set offset
        brn  rld04                    all set
*
*      kvblk, nmblk, p0blk, seblk
*
rld13  mov  *offs2,wa                 point past second field
        mov  *offs1,wb                offset is one (only reloc fld is 2)
        brn  rld04                    all set
*
*      p1blk, p2blk
*
*      in p2blks, parm2 contains either a bit mask or the
*      name offset of a variable.  it never requires relocation.
*
rld14  mov  *parm2,wa                 length (parm2 is non-relocatable)
        mov  *pthen,wb                set offset
        brn  rld04                    all set
*

```

```

*      pdblk
*
*      note that the dfblk pointed to by this pdblk was
*      processed when the ffbk was encountered.  because
*      the data function will be called before any records are
*      defined, the ffbk is encountered before any
*      corresponding pdblk.
*
rld15  mov  pddfp(xr),x1      load ptr to dfblk
      add  rldst,x1          adjust for static relocation
      mov  dfpdl(x1),wa      get pdblk length
      mov  *pddfp,wb         set offset
      brn  rld04             all set

```


*		
*	reldn (continued)	
*		
*		
*	pfblk	
*		
rld16	add rldst,pfvbl(xr)	adjust non-contiguous field
	mov pflen(xr),wa	get pfblk length
	mov *pfcod,wb	offset to first reloc
	brn rld04	all set
*		
*	tbblk, vcblk	
*		
rld17	mov offs2(xr),wa	load length
	mov *offs3,wb	set offset
	brn rld04	jump back
*		
*	teblk	
*		
rld18	mov *tesi\$,wa	set length
	mov *tesub,wb	and offset
	brn rld04	all set
*		
*	trblk	
*		
rld19	mov *trsi\$,wa	set length
	mov *trval,wb	and offset
	brn rld04	all set
*		
*	xrblk	
*		
rld20	mov xrln(xr),wa	load length
	mov *xrptra,wb	set offset
	brn rld04	jump back
	enp	end procedure reldn

```

*
*      reloc -- relocate storage after save file reload
*
*      (x1)                list of boundaries and adjustments
*      jsr  reloc           relocate all pointers
*      (wa,wb,wc,xr)        destroyed
*
*      the list of boundaries and adjustments pointed to by
*      register x1 is created by a call to relcr, which should
*      be consulted for information on its structure.
*
reloc  prc   e,0                entry point
       mov  rldys(x1),xr       old start of dynamic
       mov  rldye(x1),wc       old end of dynamic
       add  rldya(x1),xr       create new start of dynamic
       add  rldya(x1),wc       create new end of dynamic
       jsr  reldn              relocate pointers in dynamic
       jsr  relws              relocate pointers in working sect
       jsr  relst              relocate pointers in static
       exi                     return to caller
       enp                     end procedure reloc

```

```

*
*      relst -- relocate pointers in the static region
*
*      (xl)                list of boundaries and adjustments
*      jsr  relst           call to process blocks in static
*      (wa,wb,wc,xr)       destroyed
*
*      only vrbcls on the hash chain and any profile block are
*      processed.  other static blocks (dfblks) are processed
*      during processing of dynamic blocks.
*
*      global work locations will be processed at this point,
*      so pointers there can be relied upon.
*
relst  prc   e,0                entry point
      mov  pftbl,xr            profile table
      bze  xr,rls01            branch if no table allocated
      add  rlcda(xl),(xr)      adjust block type word
*
*      here after dealing with profiler
*
rls01  mov  hshtb,wc           point to start of hash table
      mov  wc,wb               point to first hash bucket
      mov  hshte,wa            point beyond hash table
      jsr  relaj               adjust bucket pointers
*
*      loop through slots in hash table
*
rls02  beq  wc,hshte,rls05     done if none left
      mov  wc,xr               else copy slot pointer
      ica  wc                  bump slot pointer
      sub  *vrnxt,xr           set offset to merge into loop
*
*      loop through vrbcls on one hash chain
*
rls03  mov  vrnxt(xr),xr       point to next vrbcl on chain
      bze  xr,rls02            jump for next bucket if chain end
      mov  *vrlen,wa           offset of first loc past ptr fields
      mov  *vrget,wb           offset of first location in vrbcl
      bnz  vrlen(xr),rls04     jump if not system variable
      mov  *vrsi$,wa           offset to include vrsvp field
*
*      merge here to process fields of vrbcl
*
rls04  add  xr,wa               create end ptr
      add  xr,wb               create start ptr
      jsr  relaj               adjust pointers in vrbcl
      brn  rls03               check for another vrbcl on chain
*
*      here when all vrbcls processed
*

```

rls05 **exi**
 enp

return to caller
end procedure relst

```

*
*      relws -- relocate pointers in the working section
*
*      (xl)                list of boundaries and adjustments
*      jsr  relws          call to process working section
*      (wa,wb,wc,xr)       destroyed
*
*      pointers between a$aaa and r$yyy are examined and
*      adjusted if necessary.  the pointer kvrtn is also
*      adjusted although it lies outside this range.
*      dname is explicitly adjusted because the limits
*      on dynamic region in stack are to the area actively
*      in use (between dnamb and dnamp), and dname is outside
*      this range.
*
relws  prc   e,0           entry point
      mov   =a$aaa,wb     point to start of adjustables
      mov   =r$yyy,wa     point to end of adjustables
      jsr   relaj         relocate adjustable pointers
      add   rldya(xl),dname adjust ptr missed by relaj
      mov   =kvrtn,wb     case of kvrtn
      mov   wb,wa         handled specially
      ica   wa            one value to adjust
      jsr   relaj         adjust kvrtn
      exi                    return to caller
      enp                    end procedure relws

```

fi

spitbol – initialization

```

*
*      initialisation
*      the following section receives control from the system
*      at the start of a run with the registers set as follows.
*
*      (wa)                initial stack pointer
*      (xr)                points to first word of data area
*      (xl)                points to last word of data area
*
start  prc    e,0                entry point
        mov   wa,xs            discard return
        jsr   systm            initialise timer
if .cnbt
        sti   timsx            store time
        mov   xr,statb        start address of static
else
*
*      initialise work area (essential for batched runs)
*
        mov   xr,wb            preserve xr
        mov   =w$yyy,wa        point to end of work area
        sub   =w$aaa,wa        get length of work area
        btw   wa                convert to words
        lct   wa,wa            count for loop
        mov   =w$aaa,xr        set up index register
*
*      clear work space
*
ini01  zer    (xr)+            clear a word
        bct   wa,ini01        loop till done
        mov   =stndo,wa        undefined operators pointer
        mov   =r$yyy,wc        point to table end
        sub   =r$uba,wc        length of undef. operators table
        btw   wc                convert to words
        lct   wc,wc            loop counter
        mov   =r$uba,xr        set up xr
*
*      set correct value into undefined operators table
*
ini02  mov    wa,(xr)+        store value
        bct   wc,ini02        loop till all done
        mov   =num01,wa        get a 1
if .cpol
        mov   wa,polcs        interface polling interval
        mov   wa,polct        interface polling interval
fi

```

```
mov wa,cmpsn
mov wa,cswfl
mov wa,cswls
mov wa,kvinp
mov wa,kvoup
mov wa,lstpf
mov =iniln,wa
mov wa,cswin
```

```
statement no
nofail
list
input
output
nothing for listr yet
input image length
-in72
```

```

        mov  =nulls,wa           get null string pointer
        mov  wa,kvrtn           return
        mov  wa,r$etx           errtext
        mov  wa,r$ttl           title for listing
        mov  wa,stxvr           setexit
        sti   timsx             store time in correct place
        ldi   stlim             get default stlimit
        sti   kvstl             statement limit
        sti   kvstc             statement count
        mov  wb,statb           store start adrs of static
fi

        mov  *e$srs,rsmem       reserve memory
        mov  xs,stbas           store stack base
        sss   iniss             save s-r stack ptr

*
*       now convert free store percentage to a suitable factor
*       for easy testing in alloc routine.
*

        ldi   intvh             get 100
        dvi   alfsp             form 100 / alfsp
        sti   alfsf             store the factor
if .csed
*
*       now convert free sediment percentage to a suitable factor
*       for easy testing in gbcol routine.
*

        ldi   intvh             get 100
        dvi   gbsdsp            form 100 / gbsdsp
        sti   gbsed             store the factor
fi
if .cnra
else
    if .cncr
    else
        *
        *       initialize values for real conversion routine
        *

        lct   wb,=cfp$s         load counter for significant digits
        ldr   reav1             load 1.0

        *
        *       loop to compute 10**(max number significant digits)
        *

ini03  mlr   reavt              * 10.0
        bct   wb,ini03          loop till done
        str   gtssc             store 10**(max sig digits)
        ldr   reap5             load 0.5
        dvr   gtssc             compute 0.5*10**(max sig digits)
        str   gtsrn             store as rounding bias
fi

```


fi

zer **wc**
jsr **prpar**

set to read parameters
read them

```

*
*      now compute starting address for dynamic store and if
*      necessary request more memory.
*
sub    *e$srs,xl          allow for reserve memory
mov    prlen,wa           get print buffer length
add    =cfp$a,wa         add no. of chars in alphabet
add    =nstmx,wa         add chars for gtstg bfr
ctb    wa,8              convert to bytes, allowing a margin
mov    statb,xr          point to static base
add    wa,xr             increment for above buffers
add    *e$hnb,xr         increment for hash table
add    *e$sts,xr        bump for initial static block
jsr    sysmx            get mxlen
mov    wa,kvmxl         provisionally store as maxlngth
mov    wa,mxlen         and as mxlen
bgt    xr,wa,ini06      skip if static hi exceeds mxlen
ctb    wa,1             round up and make bigger than mxlen
mov    wa,xr            use it instead

*
*      here to store values which mark initial division
*      of data area into static and dynamic
*
ini06  mov    xr,dnamb    dynamic base adrs
mov    xr,dnamp         dynamic ptr
bnz    wa,ini07         skip if non-zero mxlen
dca    xr              point a word in front
mov    xr,kvmxl         use as maxlngth
mov    xr,mxlen         and as mxlen

```

```

*
*      loop here if necessary till enough memory obtained
*      so that dname is above dnamb
*
ini07  mov  xl,dname          store dynamic end address
      blt  dnamb,xl,ini09     skip if high enough
      jsr  sysmm             request more memory
      wtb  xr                get as baus (sgd05)
      add  xr,xl             bump by amount obtained
      bnz  xr,ini07          try again

if.cera
      mov  =mxern,wa         insufficient memory for maxlengthh
      zer  wb                no column number info
      zer  wc                no line number info
      mov  =stgic,xr         initial compile stage
if.csfn
      mov  =nulls,xl         no file name
fi

      jsr  sysea             advise of error
      ppm  ini08             cant use error logic yet
      brn  ini08             force termination

*
*      insert text for error 329 in error message table
*
      erb  329,requested maxlngh      too large
fi

ini08  mov  =endmo,xr        point to failure message
      mov  endml,wa         message length
      jsr  syspr            print it (prtst not yet usable)
      ppm                      should not fail
      zer  xl                no fcb chain yet
      mov  =num10,wb        set special code value
      jsr  sysej            pack up (stopr not yet usable)

*
*      initialise structures at start of static region
*
ini09  mov  statb,xr         point to static again
      jsr  insta            initialize static

*
*      initialize number of hash headers
*
      mov  =e$hnb,wa         get number of hash headers
      mti  wa                convert to integer
      sti  hshnb            store for use by gtnvr procedure
      lct  wa,wa            counter for clearing hash table
      mov  xr,hshnb         pointer to hash table

*
*      loop to clear hash table
*
ini11  zer  (xr)+           blank a word

```

	bct wa,ini11	loop
	mov xr,hshte	end of hash table adrs is kept
	mov xr,state	store static end address
<i>if</i> .csfn		
	*	
	*	
	init table to map statement numbers to source file names	
	*	
	mov =num01,wc	table will have only one bucket
	mov =nulls,xl	default table value
	mov xl,r\$sfc	current source file name
	jsr tmake	create table
	mov xr,r\$sfn	save ptr to table
<i>fi</i>		
<i>if</i> .cinc		
	*	
	*	
	initialize table to detect duplicate include file names	
	*	
	mov =num01,wc	table will have only one bucket
	mov =nulls,xl	default table value
	jsr tmake	create table
	mov xr,r\$inc	save ptr to table
<i>if</i> .csfn		
	*	
	*	
	initialize array to hold names of nested include files	
	*	
	mov =ccinm,wa	maximum nesting level
	mov =nulls,xl	null string default value
	jsr vmake	create array
	ppm vmake	create array
	mov xr,r\$ifa	save ptr to array
	*	
	*	
	init array to hold line numbers of nested include files	
	*	
	mov =ccinm,wa	maximum nesting level
	mov =inton,xl	integer one default value
	jsr vmake	create array
	ppm vmake	create array
	mov xr,r\$ifl	save ptr to array
<i>fi</i>		
<i>fi</i>		
	*	
	*	
	initialize variable blocks for input and output	
	*	
	mov =v\$inp,xl	point to string /input/
	mov =trtin,wb	trblk type for input
	jsr inout	perform input association
	mov =v\$outp,xl	point to string /output/
	mov =trtou,wb	trblk type for output
	jsr inout	perform output association

```
mov  initr,wc  
bze  wc,ini13  
jsr  prpar
```

```
terminal flag  
skip if no terminal  
associate terminal
```

<pre> * * check for expiry date * ini13 jsr sysdc mov xs,flptr </pre>	<pre> call date check in case stack overflows in compiler </pre>
<pre> * * now compile source input code * jsr cmpil mov xr,r\$cod mov =nulls,r\$t1 mov =nulls,r\$st1 zer r\$cim zer r\$ccb </pre>	<pre> call compiler set ptr to first code block forget title forget sub-title forget compiler input image forget interim code block </pre>
<pre> if .cinc zer cnind zer lstid fi </pre>	<pre> in case end occurred with include listing include depth </pre>
<pre> zer xl zer wb if .csed zer dnams jsr gbcol mov xr,dnams else jsr gbcol fi </pre>	<pre> clear dud value dont shift dynamic store up collect sediment too clear garbage left from compile record new sediment size clear garbage left from compile </pre>
<pre> bnz cpsts,inx0 jsr prtpg </pre>	<pre> skip if no listing of comp stats eject page </pre>
<pre> * * print compile statistics * jsr prtmm mti cmerc mov =encm3,xr jsr prtmi mti gbcnt sbi intv1 mov =stpm5,xr jsr prtmi jsr systm sbi timsx mov =encm4,xr jsr prtmi add =num05,1stlc </pre>	<pre> print memory usage get count of errors as integer point to /compile errors/ print it garbage collection count adjust for unavoidable collect point to /storage regenerations/ print gbcol count get time get compilation time point to compilation time (msec)/ print message bump line count </pre>
<pre> if .cuej bze headp,inx0 jsr prtpg fi </pre>	<pre> no eject if nothing printed eject printer </pre>

```

*
*      prepare now to start execution
*
*      set default input record length
*
inix0  bgt  cswin,=iniln,inix1      skip if not default -in72 used
      mov  =inils,cswin           else use default record length
*
*      reset timer
*
inix1  jsr  systm                 get time again
      sti  timsx                 store for end run processing
      zer  gbcnt                 initialise collect count
      jsr  sysbx                 call before starting execution
      add  cswex,noxeq           add -noexecute flag
      bnz  noxeq,inix2           jump if execution suppressed
if .cuej
else
      bze  headp,iniy0           no eject if nothing printed (sgd11)
      jsr  prtpg                 eject printer
fi

*
*      merge when listing file set for execution.  also
*      merge here when restarting a save file or load module.
*
inix0  mnz  headp                 mark headers out regardless
      zer  -(xs)                 set failure location on stack
      mov  xs,flptr              save ptr to failure offset word
      mov  r$cod,xr              load ptr to entry code block
      mov  =stgxt,stage          set stage for execute time
if .cpol
      mov  =num01,polcs          reset interface polling interval
      mov  =num01,polct          reset interface polling interval
fi
if .cnpf
else
      mov  cmpsn,pfnte           copy stmts compiled count in case
      mov  kvpfl,pfdmp          start profiling if &profile set
      jsr  systm                 time yet again
      sti  systm                 time yet again
fi
      jsr  stgcc                 compute stmgo countdown counters
      bri  (xr)                  start xeq with first statement

*
*      here if execution is suppressed
*
if .cera
inix2  zer  wa                    set abend value to zero
else
inix2  jsr  prtln                 print a blank line

```

	mov =encm5,xr	point to /execution suppressed/
	jsr prtst	print string
	jsr prtnl	output line
	zer wa	set abend value to zero
<i>fi</i>		
	mov =nini9,wb	set special code value
	zer xl	no fcb chain
	jsr sysej	end of job, exit to system
	enp	end procedure start
	*	
	*	here from osint to restart a save file or load module.
	*	
rstrt	prc e,0	entry point
	mov stbas,xs	discard return
	zer xl	clear xl
	brn iniy0	resume execution
	enp	end procedure rstrt

spitbol – snobol4 operator routines

```
*
*      this section includes all routines which can be accessed
*      directly from the generated code except system functions.
*
*      all routines in this section start with a label of the
*      form o$xxx where xxx is three letters. the generated code
*      contains a pointer to the appropriate entry label.
*
*      since the general form of the generated code consists of
*      pointers to blocks whose first word is the address of the
*      actual entry point label (o$xxx).
*
*      these routines are in alphabetical order by their
*      entry label names (i.e. by the xxx of the o$xxx name)
*
*      these routines receive control as follows
*
*      (cp)                pointer to next code word
*      (xs)                current stack pointer
```

<pre> * * binary plus (addition) * o\$add ent jsr arith err 001,addition left err 002,addition right if .cnra else ppm oadd1 fi </pre>	<pre> entry point fetch arithmetic operands operand is not numeric operand is not numeric jump if real operands </pre>
<pre> * * here to add two integers * adi icval(xl) ino exint erb 003,addition caused if .cnra else * * here to add two reals * oadd1 adr rcval(xl) rno exrea erb 261,addition caused fi </pre>	<pre> add right operand to left return integer if no overflow integer overflow add right operand to left return real if no overflow real overflow </pre>

	*		
	*	unary plus (affirmation)	
	*		
o\$aff	ent		entry point
	mov	(xs)+,xr	load operand
	jsr	gtnum	convert to numeric
	err	004,affirmation operand	is not numeric
	mov	xr,-(xs)	result if converted to numeric
	lcw	xr	get next code word
	bri	(xr)	execute it

```

*
*      binary bar (alternation)
*
o$alt  ent                      entry point
        mov  (xs)+,xr           load right operand
        jsr  gtpat              convert to pattern
        err  005,alternation right operand is not pattern

*
*      merge here from special (left alternation) case
*
oalt1  mov  =p$alt,wb           set pcode for alternative node
        jsr  pbild              build alternative node
        mov  xr,xl              save address of alternative node
        mov  (xs)+,xr           load left operand
        jsr  gtpat              convert to pattern
        err  006,alternation left operand is not pattern
        beq  xr,=p$alt,oalt2    jump if left arg is alternation
        mov  xr,pthen(xl)       set left operand as successor
        mov  xl,-(xs)           stack result
        lcw  xr                 get next code word
        bri  (xr)               execute it

*
*      come here if left argument is itself an alternation
*
*      the result is more efficient if we make the replacement
*
*      (a / b) / c = a / (b / c)
*
oalt2  mov  parm1(xr),pthen(xl) build the (b / c) node
        mov  pthen(xr),-(xs)    set a as new left arg
        mov  xl,xr              set (b / c) as new right arg
        brn  oalt1              merge back to build a / (b / c)

```

```

*
*      array reference (multiple subscripts, by name)
*
o$amn  ent          entry point
        lw  xr      load number of subscripts
        mov xr,wb   set flag for by name
        brn arref   jump to array reference routine

```

```

*
*      array reference (multiple subscripts, by value)
*
o$amv  ent      entry point
      lcw  xr      load number of subscripts
      zer  wb      set flag for by value
      brn  arref   jump to array reference routine

```

```

*
*      array reference (one subscript, by name)
*
o$aon  ent                      entry point
        mov  (xs),xr            load subscript value
        mov  num01(xs),xl       load array value
        mov  (xl),wa            load first word of array operand
        beq  wa,=b$vct,oaon2    jump if vector reference
        beq  wa,=b$tbl,oaon3    jump if table reference

*
*      here to use central array reference routine
*
oaon1   mov  =num01,xr          set number of subscripts to one
        mov  xr,wb              set flag for by name
        brn  arref              jump to array reference routine

*
*      here if we have a vector reference
*
oaon2   bne  (xr),=b$icl,oaon1  use long routine if not integer
        ldi  icval(xr)          load integer subscript value
        mfi  wa,exfal           copy as address int, fail if ovflo
        bze  wa,exfal           fail if zero
        add  =vcvlb,wa          compute offset in words
        wtb  wa                 convert to bytes
        mov  wa,(xs)            complete name on stack
        blt  wa,vclen(xl),oaon4 exit if subscript not too large
        brn  exfal              else fail

*
*      here for table reference
*
oaon3   mnz  wb                 set flag for name reference
        jsr  tfind              locate/create table element
        ppm  exfal              fail if access fails
        mov  xl,num01(xs)       store name base on stack
        mov  wa,(xs)            store name offset on stack

*
*      here to exit with result on stack
*
oaon4   lcw  xr                 result on stack, get code word
        bri  (xr)               execute next code word

```

```

*
*      array reference (one subscript, by value)
*
o$aov  ent                entry point
        mov  (xs)+,xr      load subscript value
        mov  (xs)+,xl      load array value
        mov  (xl),wa       load first word of array operand
        beq  wa,=b$vct,oaov2  jump if vector reference
        beq  wa,=b$tblt,oaov3  jump if table reference

*
*      here to use central array reference routine
*
oaov1  mov  xl,-(xs)        restack array value
        mov  xr,-(xs)        restack subscript
        mov  =num01,xr      set number of subscripts to one
        zer  wb             set flag for value call
        brn  arref          jump to array reference routine

*
*      here if we have a vector reference
*
oaov2  bne  (xr),=b$icl,oaov1  use long routine if not integer
        ldi  icval(xr)        load integer subscript value
        mfi  wa,exfal         move as one word int, fail if ovflo
        bze  wa,exfal         fail if zero
        add  =vcv1b,wa        compute offset in words
        wtb  wa               convert to bytes
        bge  wa,vclen(xl),exfal  fail if subscript too large
        jsr  access           access value
        ppm  exfal            fail if access fails
        mov  xr,-(xs)         stack result
        lcw  xr               get next code word
        bri  (xr)             execute it

*
*      here for table reference by value
*
oaov3  zer  wb               set flag for value reference
        jsr  tfind            call table search routine
        ppm  exfal            fail if access fails
        mov  xr,-(xs)         stack result
        lcw  xr               get next code word
        bri  (xr)             execute it

```



```

*
*      assignment
*
o$ass  ent                                entry point
*
*      o$rpl (pattern replacement) merges here
*
oass0  mov  (xs)+,wb                      load value to be assigned
        mov  (xs)+,wa                      load name offset
        mov  (xs),xl                      load name base
        mov  wb,(xs)                      store assigned value as result
        jsr  assign                      perform assignment
        ppm  exfal                      fail if assignment fails
        lcw  xr                          result on stack, get code word
        bri  (xr)                      execute next code word

```

	*		
	*	compilation error	
	*		
o\$cer	ent		entry point
	erb	007, compilation error	encountered during execution

	*		
	*	unary at (cursor assignment)	
	*		
o\$cas	ent		entry point
	mov	(xs)+,wc	load name offset (parm2)
	mov	(xs)+,xr	load name base (parm1)
	mov	=p\$cas,wb	set pcode for cursor assignment
	jsr	pbild	build node
	mov	xr,-(xs)	stack result
	lcw	xr	get next code word
	bri	(xr)	execute it

```

*
*      concatenation
*
o$cnc  ent          entry point
      mov  (xs),xr    load right argument
      beq  xr,=nulls,ocnc3  jump if right arg is null
      mov  1(xs),xl    load left argument
      beq  xl,=nulls,ocnc4  jump if left argument is null
      mov  =b$sc1,wa    get constant to test for string
      bne  wa,(xl),ocnc2  jump if left arg not a string
      bne  wa,(xr),ocnc2  jump if right arg not a string

*
*      merge here to concatenate two strings
*
ocnc1  mov  sclen(xl),wa    load left argument length
      add  sclen(xr),wa    compute result length
      jsr  alocs          allocate scblk for result
      mov  xr,1(xs)        store result ptr over left argument
      psc  xr              prepare to store chars of result
      mov  sclen(xl),wa    get number of chars in left arg
      plc  xl              prepare to load left arg chars
      mvc              move characters of left argument
      mov  (xs)+,xl        load right arg pointer, pop stack
      mov  sclen(xl),wa    load number of chars in right arg
      plc  xl              prepare to load right arg chars
      mvc              move characters of right argument
      zer  xl              clear garbage value in xl
      lcw  xr              result on stack, get code word
      bri  (xr)            execute next code word

*
*      come here if arguments are not both strings
*
ocnc2  jsr  gtstg          convert right arg to string
      ppm  ocnc5          jump if right arg is not string
      mov  xr,xl          save right arg ptr
      jsr  gtstg          convert left arg to string
      ppm  ocnc6          jump if left arg is not a string
      mov  xr,-(xs)        stack left argument
      mov  xl,-(xs)        stack right argument
      mov  xr,xl          move left arg to proper reg
      mov  (xs),xr        move right arg to proper reg
      brn  ocnc1          merge back to concatenate strings

```

```

*
*      concatenation (continued)
*
*      come here for null right argument
*
ocnc3  ica  xs                remove right arg from stack
        lcw  xr                left argument on stack
        bri  (xr)              execute next code word

*
*      here for null left argument
*
ocnc4  ica  xs                unstack one argument
        mov  xr,(xs)           store right argument
        lcw  xr                result on stack, get code word
        bri  (xr)              execute next code word

*
*      here if right argument is not a string
*
ocnc5  mov  xr,xl              move right argument ptr
        mov  (xs)+,xr          load left arg pointer

*
*      merge here when left argument is not a string
*
ocnc6  jsr  gtpat              convert left arg to pattern
        err  008,concatenation left operand is not a string or pattern
        mov  xr,-(xs)          save result on stack
        mov  xl,xr              point to right operand
        jsr  gtpat              convert to pattern
        err  009,concatenation right operand is not a string or pattern
        mov  xr,xl              move for pconc
        mov  (xs)+,xr          reload left operand ptr
        jsr  pconc              concatenate patterns
        mov  xr,-(xs)          stack result
        lcw  xr                get next code word
        bri  (xr)              execute it

```

	*		
	*	complementation	
	*		
o\$com	ent		entry point
	mov	(xs)+,xr	load operand
	mov	(xr),wa	load type word
	*		
	*	merge back here after conversion	
	*		
ocom1	beq	wa,=\$ic1,ocom2	jump if integer
if.cnra			
else			
	beq	wa,=\$rc1,ocom3	jump if real
fi			
	jsr	gtnum	else convert to numeric
	err	010,negation operand	is not numeric
	brn	ocom1	back to check cases
	*		
	*	here to complement integer	
	*		
ocom2	ldi	icval(xr)	load integer value
	ngi		negate
	ino	exint	return integer if no overflow
	erb	011,negation caused	integer overflow
if.cnra			
else			
	*		
	*	here to complement real	
	*		
ocom3	ldr	rcval(xr)	load real value
	ngr		negate
	brn	exrea	return real result
fi			

<pre> * * binary slash (division) * o\$dvd ent jsr arith err 012,division left err 013,division right if .cnra else ppm odvd2 fi </pre>	<pre> entry point fetch arithmetic operands operand is not numeric operand is not numeric jump if real operands </pre>
<pre> * * here to divide two integers * dvi icval(xl) ino exint erb 014,division caused if .cnra else </pre>	<pre> divide left operand by right result ok if no overflow integer overflow </pre>
<pre> * * here to divide two reals * odvd2 dvr rcval(xl) rno exrea erb 262,division caused fi </pre>	<pre> divide left operand by right return real if no overflow real overflow </pre>

```

*
*      exponentiation
*
o$exp  ent          entry point
        mov  (xs)+,xr  load exponent
        jsr  gtnum     convert to number
        err  015,exponentiation  right operand is not numeric
        mov  xr,xl     move exponent to xl
        mov  (xs)+,xr  load base
        jsr  gtnum     convert to numeric
        err  016,exponentiation  left operand is not numeric

if .cnra
else
        beq  (xl),=b$rcl,oexp7  jump if real exponent
fi

        ldi  icval(xl)  load exponent
        ilt  oex12      jump if negative exponent

if .cnra
else
        beq  wa,=b$rcl,oexp3  jump if base is real
fi

*
*      here to exponentiate an integer base and integer exponent
*
        mfi  wa,oexp2    convert exponent to 1 word integer
        lct  wa,wa       set loop counter
        ldi  icval(xr)   load base as initial value
        bnz  wa,oexp1    jump into loop if non-zero exponent
        ieq  oexp4       error if 0**0
        ldi  intv1       nonzero**0
        brn  exint       give one as result for nonzero**0

*
*      loop to perform exponentiation
*
oex13  mli  icval(xr)    multiply by base
        iov  oexp2       jump if overflow
oexp1  bct  wa,oex13     loop if more to go
        brn  exint       else return integer result

*
*      here if integer overflow
*
oexp2  erb  017,exponentiation  caused integer overflow

```



```

*
*      exponentiation (continued)
if .cnra
else
*
*      here to exponentiate a real to an integer power
*
oexp3  mfi  wa,oexp6          convert exponent to one word
      lct  wa,wa              set loop counter
      ldr  rcval(xr)          load base as initial value
      bnz  wa,oexp5           jump into loop if non-zero exponent
      req  oexp4              error if 0.0**0
      ldr  reav1              nonzero**0
      brn  exrea              return 1.0 if nonzero**zero
fi

*
*      here for error of 0**0 or 0.0**0
*
oexp4  erb  018,exponentiation      result is undefined
if .cnra
else
*
*      loop to perform exponentiation
*
oex14  mlr  rcval(xr)          multiply by base
      rov  oexp6              jump if overflow
oexp5  bct  wa,oex14           loop till computation complete
      brn  exrea              then return real result

*
*      here if real overflow
*
oexp6  erb  266,exponentiation      caused real overflow

*
*      here with real exponent in (x1), numeric base in (xr)
*
if .cmth
oexp7  beq  (xr),=b$rcl,oexp8      jump if base real
      ldi  icval(xr)            load integer base
      itr  itr                  convert to real
      jsr  rcbld                create real in (xr)

*
*      here with real exponent in (x1)
*      numeric base in (xr) and ra
*
oexp8  zer  wb                  set positive result flag
      ldr  rcval(xr)            load base to ra
      rne  oexp9                jump if base non-zero
      ldr  rcval(x1)            base is zero. check exponent
      req  oexp4                jump if 0.0 ** 0.0
      ldr  reav0                0.0 to non-zero exponent yields 0.0

```

```

        brn    exrea                    return zero result
*
*        here with non-zero base in (xr) and ra, exponent in (xl)
*
*        a negative base is allowed if the exponent is integral.
*
oexp9   rgt    oexp10                  jump if base gt 0.0
        ngr                    make base positive
        jsr    rcblld             create positive base in (xr)
        ldr    rcval(xl)          examine exponent
        chp                    chop to integral value
        rti    oexp6              convert to integer, br if too large
        sbr    rcval(xl)          chop(exponent) - exponent
        rne    oex11              non-integral power with neg base
        mfi    wb                 record even/odd exponent
        anb    bits1,wb           odd exponent yields negative result
        ldr    rcval(xr)          restore base to ra
*
*        here with positive base in ra and (xr), exponent in (xl)
*
oex10   lnf                    log of base
        rov    oexp6              too large
        mlr    rcval(xl)          times exponent
        rov    oexp6              too large
        etx                    e ** (exponent * ln(base))
        rov    oexp6              too large
        bze    wb,exrea           if no sign fixup required
        ngr                    negative result needed
        brn                    negative result needed
*
*        here for non-integral exponent with negative base
*
oex11   erb    311,exponentiation    of negative base to non-integral power
        else
oexp7   erb    267,exponentiation    right operand is real not integer
        fi
fi
*
*        here with negative integer exponent in ia
*
if .cmth
oex12   mov    xr,-(xs)             stack base
        itr                    convert to real exponent
        jsr    rcblld             real negative exponent in (xr)
        mov    xr,xl              put exponent in xl
        mov    (xs)+,xr           restore base value
        brn    oexp7              process real exponent
else
oex12   erb    019,exponentiation    right operand is negative
fi

```

```

*
*      failure in expression evaluation
*
*      this entry point is used if the evaluation of an
*      expression, initiated by the evalx procedure, fails.
*      control is returned to an appropriate point in evalx.
*
o$fex  ent      entry point
      brn  evlx6  jump to failure loc in evalx

```

```

*
*      failure during evaluation of a complex or direct goto
*
o$fff  ent      entry point
      erb  020,goto evaluation      failure

```

```

*
*      function call (more than one argument)
*
o$fnc  ent          entry point
      lcw  wa        load number of arguments
      lcw  xr        load function vrbk pointer
      mov  vrfnc(xr),xl  load function pointer
      bne  wa,fargs(xl),cfunc  use central routine if wrong num
      bri  (xl)       jump to function if arg count ok

```

<pre> * * * o\$fne ent lcw wa bne wa,=ornm\$,ofne1 bze num02(xs),evlx3 * * * ofne1 erb 021,function called </pre>	<pre> function name error entry point get next code word fail if not evaluating expression ok if expr. was wanted by value here for error by name returned a value </pre>
---	--

	*		
	*	function call (single argument)	
	*		
o\$fns	ent		entry point
	lcw	xr	load function vrbk pointer
	mov	=num01,wa	set number of arguments to one
	mov	vrfnc(xr),xl	load function pointer
	bne	wa,fargs(xl),cfunc	use central routine if wrong num
	bri	(xl)	jump to function if arg count ok

```

    *      call to undefined function
    *
o$fun  ent
      erb  022,undefined function      entry point
                                         called

```



```

*
*      execute complex goto
*
o$goc  ent          entry point
      mov num01(xs),xr      load name base pointer
      bhi  xr,state,ogoc1   jump if not natural variable
      add  *vrtra,xr        else point to vrtra field
      bri  (xr)             and jump through it

*
*      here if goto operand is not natural variable
*
ogoc1  erb  023,goto operand      is not a natural variable

```

	*		
	*	execute direct goto	
	*		
o\$god	ent		entry point
	mov (xs),xr		load operand
	mov (xr),wa		load first word
	beq wa,=b\$cds,bcds0		jump if code block to code routine
	beq wa,=b\$cdc,bcdc0		jump if code block to code routine
	erb 024,goto operand		in direct goto is not code

```

*
*      set goto failure trap
*
*      this routine is executed at the start of a complex or
*      direct failure goto to trap a subsequent fail (see exfal)
*
o$gof  ent          entry point
      mov flptr,xr   point to fail offset on stack
      ica  (xr)      point failure to o$fif word
      icp           point to next code word
      lcw  xr        fetch next code word
      bri  (xr)      execute it

```

```

*
*      binary dollar (immediate assignment)
*
*      the pattern built by binary dollar is a compound pattern.
*      see description at start of pattern match section for
*      details of the structure which is constructed.
*
o$ima  ent          entry point
        mov  =p$imc,wb      set pcode for last node
        mov  (xs)+,wc       pop name offset (parm2)
        mov  (xs)+,xr       pop name base (parm1)
        jsr  pbild          build p$imc node
        mov  xr,xl          save ptr to node
        mov  (xs),xr        load left argument
        jsr  gtpat          convert to pattern
        err  025,immediate assignment  left operand is not pattern
        mov  xr,(xs)        save ptr to left operand pattern
        mov  =p$ima,wb      set pcode for first node
        jsr  pbild          build p$ima node
        mov  (xs)+,pthen(xr) set left operand as p$ima successor
        jsr  pconc          concatenate to form final pattern
        mov  xr,-(xs)       stack result
        lcw  xr             get next code word
        bri  (xr)           execute it

```

	*		
	*	indirection (by name)	
	*		
o\$inn	ent		entry point
	mnz	wb	set flag for result by name
	brn	indir	jump to common routine

	*		
	*	interrogation	
	*		
o\$int	ent		entry point
	mov	=nulls,(xs)	replace operand with null
	lcw	xr	get next code word
	bri	(xr)	execute next code word

	*		
	*	indirection (by value)	
	*		
o\$inv	ent		entry point
	zer	wb	set flag for by value
	brn	indir	jump to common routine

	*		
	*	keyword reference (by name)	
	*		
o\$kwn	ent		entry point
	jsr	kwnam	get keyword name
	brn	exnam	exit with result name

	*		
	*	keyword reference (by value)	
	*		
o\$kwv	ent		entry point
	jsr	kwnam	get keyword name
	mov	xr,dnamp	delete kvblk
	jsr	acess	access value
	ppm	exnul	dummy (unused) failure return
	mov	xr,-(xs)	stack result
	lcw	xr	get next code word
	bri	(xr)	execute it

	*		
	*	load expression by name	
	*		
o\$lex	ent		entry point
	mov	*evsi\$,wa	set size of evblk
	jsr	alloc	allocate space for evblk
	mov	=b\$evt,(xr)	set type word
	mov	=trbev,evvar(xr)	set dummy trblk pointer
	lcw	wa	load exblk pointer
	mov	wa,evexp(xr)	set exblk pointer
	mov	xr,xl	move name base to proper reg
	mov	*evvar,wa	set name offset = zero
	brn	exnam	exit with name in (xl,wa)

	*		
	*	load pattern value	
	*		
o\$lpt	ent		entry point
	lcw	xr	load pattern pointer
	mov	xr,-(xs)	stack result
	lcw	xr	get next code word
	bri	(xr)	execute it

	*		
	*	load variable name	
	*		
o\$lvn	ent		entry point
	lcw	wa	load vrbk pointer
	mov	wa,-(xs)	stack vrbk ptr (name base)
	mov	*vrval,-(xs)	stack name offset
	lcw	xr	get next code word
	bri	(xr)	execute next code word

<pre> * * binary asterisk (multiplication) * o\$mlt ent jsr arith err 026,multiplication err 027,multiplication if .cnra else ppm omlt1 fi </pre>	<pre> entry point fetch arithmetic operands left operand is not numeric right operand is not numeric jump if real operands </pre>
<pre> * * here to multiply two integers * mli icval(xl) ino exint erb 028,multiplication if .cnra else </pre>	<pre> multiply left operand by right return integer if no overflow caused integer overflow </pre>
<pre> * * here to multiply two reals * omlt1 mlr rcval(xl) rno exrea erb 263,multiplication fi </pre>	<pre> multiply left operand by right return real if no overflow caused real overflow </pre>

	*		
	*	name reference	
	*		
o\$nam	ent		entry point
	mov	*nmsi\$,wa	set length of nmblk
	jsr	alloc	allocate nmblk
	mov	=b\$nm1,(xr)	set name block code
	mov	(xs)+,nmofs(xr)	set name offset from operand
	mov	(xs)+,nmbas(xr)	set name base from operand
	mov	xr,-(xs)	stack result
	lcw	xr	get next code word
	bri	(xr)	execute it

```

*
*      negation
*
*      initial entry
*
o$nta  ent          entry point
        lcw  wa      load new failure offset
        mov  flptr,-(xs)  stack old failure pointer
        mov  wa,-(xs)    stack new failure offset
        mov  xs,flptr    set new failure pointer
        lcw  xr        get next code word
        bri  (xr)       execute next code word

*
*      entry after successful evaluation of operand
*
o$ntb  ent          entry point
        mov  num02(xs),flptr  restore old failure pointer
        brn  exfal        and fail

*
*      entry for failure during operand evaluation
*
o$ntc  ent          entry point
        ica  xs        pop failure offset
        mov  (xs)+,flptr  restore old failure pointer
        brn  exnul      exit giving null result

```

	*		
	*	use of undefined operator	
	*		
o\$oun	ent		entry point
	erb	029,undefined operator	referenced


```

*
*      binary dot (pattern assignment)
*
*      the pattern built by binary dot is a compound pattern.
*      see description at start of pattern match section for
*      details of the structure which is constructed.
*
o$pas  ent          entry point
        mov  =p$pac,wb      load pcode for p$pac node
        mov  (xs)+,wc       load name offset (parm2)
        mov  (xs)+,xr       load name base (parm1)
        jsr  pbild          build p$pac node
        mov  xr,xl          save ptr to node
        mov  (xs),xr        load left operand
        jsr  gtpat          convert to pattern
        err  030,pattern assignment  left operand is not pattern
        mov  xr,(xs)        save ptr to left operand pattern
        mov  =p$paa,wb      set pcode for p$paa node
        jsr  pbild          build p$paa node
        mov  (xs)+,pthen(xr)  set left operand as p$paa successor
        jsr  pconc          concatenate to form final pattern
        mov  xr,-(xs)       stack result
        lcw  xr             get next code word
        bri  (xr)           execute it

```

```

*
*      pattern match (by name, for replacement)
*
o$pmn  ent          entry point
       zer   wb      set type code for match by name
       brn   match   jump to routine to start match

```

```

*
*      pattern match (statement)
*
*      o$pms is used in place of o$pmv when the pattern match
*      occurs at the outer (statement) level since in this
*      case the substring value need not be constructed.
*
o$pms  ent          entry point
      mov  =num02,wb  set flag for statement to match
      brn  match      jump to routine to start match

```

	*		
	*	pattern match (by value)	
	*		
o\$pmv	ent		entry point
	mov	=num01,wb	set type code for value match
	brn	match	jump to routine to start match

	*		
	*	pop top item on stack	
	*		
o\$pop	ent		entry point
	ica	xs	pop top stack entry
	lcw	xr	get next code word
	bri	(xr)	execute next code word

```

*
*      terminate execution (code compiled for end statement)
*
o$stp  ent          entry point
      brn  lend0    jump to end circuit

```

```

*
*      return name from expression
*
*      this entry points is used if the evaluation of an
*      expression, initiated by the evalx procedure, returns
*      a name. control is returned to the proper point in evalx.
*
o$rmn  ent                      entry point
      brn  evlx4                return to evalx procedure

```

```

*
*      pattern replacement
*
*      when this routine gets control, the following stack
*      entries have been made (see end of match routine p$nth)
*
*              subject name base
*              subject name offset
*              initial cursor value
*              final cursor value
*              subject string pointer
*      (xs) ----- replacement value
*
o$rp1  ent          entry point
      jsr   gtstg    convert replacement val to string
      err   031,pattern replacement    right operand is not a string
*
*      get result length and allocate result scblk
*
      mov   (xs),x1          load subject string pointer
if .cnbf
else
      beq   (x1),=b$bct,orpl4    branch if buffer assignment
fi

      add   sclen(x1),wa        add subject string length
      add   num02(xs),wa        add starting cursor
      sub   num01(xs),wa        minus final cursor = total length
      bze   wa,orpl3           jump if result is null
      mov   xr,-(xs)           restack replacement string
      jsr   alocs             allocate scblk for result
      mov   num03(xs),wa        get initial cursor (part 1 len)
      mov   xr,num03(xs)        stack result pointer
      psc   xr                point to characters of result
*
*      move part 1 (start of subject) to result
*
      bze   wa,orpl1           jump if first part is null
      mov   num01(xs),x1        else point to subject string
      plc   x1                 point to subject string chars
      mvc                   move first part to result

```



```

*      pattern replacement (continued)
*
*      now move in replacement value
*
orpl1  mov  (xs)+,x1          load replacement string, pop
      mov  sclen(x1),wa      load length
      bze  wa,orpl2         jump if null replacement
      plc  x1               else point to chars of replacement
      mvc                     move in chars (part 2)

*
*      now move in remainder of string (part 3)
*
orpl2  mov  (xs)+,x1          load subject string pointer, pop
      mov  (xs)+,wc          load final cursor, pop
      mov  sclen(x1),wa      load subject string length
      sub  wc,wa             minus final cursor = part 3 length
      bze  wa,oass0         jump to assign if part 3 is null
      plc  x1,wc            else point to last part of string
      mvc                     move part 3 to result
      brn  oass0            jump to perform assignment

*
*      here if result is null
*
orpl3  add  *num02,xs        pop subject str ptr, final cursor
      mov  =nulls,(xs)      set null result
      brn  oass0            jump to assign null value
if .cnbf
else
*
*      here for buffer substring assignment
*
orpl4  mov  xr,x1            copy scblk replacement ptr
      mov  (xs)+,xr          unstack bcbk ptr
      mov  (xs)+,wb          get final cursor value
      mov  (xs)+,wa          get initial cursor
      sub  wa,wb             get length in wb
      add  *num01,xs         get rid of name offset
      mov  xr,(xs)           store buffer result over name base
      jsr  insbf             insert substring
      ppm                     convert fail impossible
      ppm  exfal             fail if insert fails
      lcw  xr               result on stack, get code word
      bri  (xr)             execute next code word
fi

```

```

*
*      return value from expression
*
*      this entry points is used if the evaluation of an
*      expression, initiated by the evalx procedure, returns
*      a value. control is returned to the proper point in evalx
*
o$rvl  ent          entry point
      brn  evlx3    return to evalx procedure

```

```

*
*      selection
*
*      initial entry
*
o$sla  ent          entry point
      lcw  wa          load new failure offset
      mov  flptr,-(xs)  stack old failure pointer
      mov  wa,-(xs)    stack new failure offset
      mov  xs,flptr    set new failure pointer
      lcw  xr          get next code word
      bri  (xr)        execute next code word

*
*      entry after successful evaluation of alternative
*
o$slb  ent          entry point
      mov  (xs)+,xr    load result
      ica  xs          pop fail offset
      mov  (xs),flptr  restore old failure pointer
      mov  xr,(xs)    restack result
      lcw  wa          load new code offset
      add  r$cod,wa    point to absolute code location
      lcp  wa          set new code pointer
      lcw  xr          get next code word
      bri  (xr)        execute next code word

*
*      entry at start of subsequent alternatives
*
o$slc  ent          entry point
      lcw  wa          load new fail offset
      mov  wa,(xs)    store new fail offset
      lcw  xr          get next code word
      bri  (xr)        execute next code word

*
*      entry at start of last alternative
*
o$sld  ent          entry point
      ica  xs          pop failure offset
      mov  (xs)+,flptr restore old failure pointer
      lcw  xr          get next code word
      bri  (xr)        execute next code word

```

<pre> * * binary minus (subtraction) * o\$sub ent jsr arith err 032,subtraction left err 033,subtraction right if .cnra else ppm osub1 fi </pre>	<pre> entry point fetch arithmetic operands operand is not numeric operand is not numeric jump if real operands </pre>
<pre> * * here to subtract two integers * sbi icval(xl) ino exint erb 034,subtraction caused if .cnra else * * here to subtract two reals * osub1 sbr rcval(xl) rno exrea erb 264,subtraction caused fi </pre>	<pre> subtract right operand from left return integer if no overflow integer overflow subtract right operand from left return real if no overflow real overflow </pre>

```

*
*      dummy operator to return control to trxeq procedure
*
o$txr  ent          entry point
      brn  trxq1     jump into trxeq procedure

```

```

*
*      unexpected failure
*
*      note that if a setexit trap is operating then
*      transfer to system label continue
*      will result in looping here.  difficult to avoid except
*      with a considerable overhead which is not worthwhile or
*      else by a technique such as setting kverl to zero.
*
o$unf  ent      entry point
      erb  035,unexpected failure      in -nofail mode

```

spitbol – block action routines

```
*
*
* the first word of every block in dynamic storage and the
* vrget, vrsto and vrtra fields of a vrbk contain a
* pointer to an entry point in the program. all such entry
* points are in the following section except those for
* pattern blocks which are in the pattern matching segment
* later on (labels of the form p$xxx), and dope vectors
* (d$xxx) which are in the dope vector section following
* the pattern routines (dope vectors are used for cmbks).
*
* the entry points in this section have labels of the
* form b$xy where xx is the two character block type for
* the corresponding block and y is any letter.
*
* in some cases, the pointers serve no other purpose than
* to identify the block type. in this case the routine
* is never executed and thus no code is assembled.
*
* for each of these entry points corresponding to a block
* an entry point identification is assembled (bl$xx).
*
* the exact entry conditions depend on the manner in
* which the routine is accessed and are documented with
* the individual routines as required.
*
* the order of these routines is alphabetical with the
* following exceptions.
*
* the routines for seblk and exblk entries occur first so
* that expressions can be quickly identified from the fact
* that their routines lie before the symbol b$e$.
*
* these are immediately followed by the routine for a trblk
* so that the test against the symbol b$t$ checks for
* trapped values or expression values (see procedure evalp)
*
* the pattern routines lie after this section so that
* patterns are identified with routines starting at or
* after the initial instruction in these routines (p$aaa).
*
* the symbol b$aaa defines the first location for block
* routines and the symbol p$yyy (at the end of the pattern
* match routines section) defines the last such entry point
*
b$aaa ent bl$i entry point of first block routine
```

```

*
*      exblk
*
*      the routine for an exblk loads the expression onto
*      the stack as a value.
*
*      (xr)                pointer to exblk
*
b$ex1  ent   bl$ex          entry point (exblk)
       mov  xr,-(xs)       stack result
       lcw  xr             get next code word
       bri  (xr)           execute it

```



```

*
*      seblk
*
*      the routine for seblk is accessed from the generated
*      code to load the expression value onto the stack.
*
b$sel  ent   bl$se                      entry point (seblk)
        mov  xr,-(xs)                  stack result
        lcw  xr                        get next code word
        bri  (xr)                      execute it
*
*      define symbol which marks end of entries for expressions
*
b$e$$  ent   bl$$i                      entry point

```

```

*
*      trblk
*
*      the routine for a trblk is never executed
*
b$trt  ent   bl$tr                      entry point (trblk)
*
*      define symbol marking end of trap and expression blocks
*
b$t$$  ent   bl$$i                     end of trblk,seblk,exblk entries

```

```

*
*      arblk
*
*      the routine for arblk is never executed
*
b$art  ent  bl$ar                                entry point (arblk)

```

```

*
*      bcbk
*
*      the routine for a bcbk is never executed
*
*      (xr)                pointer to bcbk
*
b$bct  ent  bl$bc                entry point (bcbk)

```

```

*
*      bfblk
*
*      the routine for a bfblk is never executed
*
*      (xr)                pointer to bfblk
*
b$bf  ent  bl$bf                entry point (bfblk)

```

```

*
*      ccblk
*
*      the routine for ccblk is never entered
*
b$cct  ent  bl$cc                                entry point (ccblk)

```

```

*
*      cdblk
*
*      the cdblk routines are executed from the generated code.
*      there are two cases depending on the form of cdfal.
*
*      entry for complex failure code at cdfal
*
*      (xr)                pointer to cdblk
*
b$cdc  ent   bl$cd                entry point (cdblk)
bcd0   mov  flptr,xs            pop garbage off stack
      mov  cdfal(xr),(xs)       set failure offset
      brn  stmgo                enter stmt

```

```

*
*      cdblk (continued)
*
*      entry for simple failure code at cdfal
*
*      (xr)                pointer to cdblk
*
b$cds  ent  bl$cd           entry point (cdblk)
bcds0  mov  flptr,xs       pop garbage off stack
      mov  *cdfal,(xs)    set failure offset
      brn  stmgo          enter stmt

```



```

*
*      cmbblk
*
*      the routine for a cmbblk is never executed
*
b$cmt  ent  bl$cm                      entry point (cmbblk)

```

```

*
*      ctblk
*
*      the routine for a ctblk is never executed
*
b$ctt  ent  bl$ct                      entry point (ctblk)

```

```

*
*      dfblk
*
*      the routine for a dfblk is accessed from the o$fncl entry
*      to call a datatype function and build a pdblk.
*
*      (xl)                pointer to dfblk
*
b$dfcl  ent   bl$df                    entry point
        mov   dfpdl(xl),wa             load length of pdblk
        jsr   alloc                   allocate pdblk
        mov   =b$pdcl,(xr)             store type word
        mov   xl,pddfp(xr)             store dfblk pointer
        mov   xr,wc                    save pointer to pdblk
        add   wa,xr                    point past pdblk
        lct   wa,fargs(xl)             set to count fields
*
*      loop to acquire field values from stack
*
bdfcl   mov   (xs)+,-(xr)              move a field value
        bct   wa,bdfcl                 loop till all moved
        mov   wc,xr                    recall pointer to pdblk
        brn   exsid                     exit setting id field

```

```

*
*      efbk
*
*      the routine for an efbk is passed control form the o$fn
*      entry to call an external function.
*
*      (xl)                pointer to efbk
*
b$efc  ent  bl$ef                entry point (efbk)
if .cnld
else
    mov  fargs(xl),wc            load number of arguments
    wtb  wc                     convert to offset
    mov  xl,-(xs)                save pointer to efbk
    mov  xs,xt                   copy pointer to arguments
*
*      loop to convert arguments
*
befc1  ica  xt                    point to next entry
    mov  (xs),xr                load pointer to efbk
    dca  wc                     decrement eftar offset
    add  wc,xr                  point to next eftar entry
    mov  eftar(xr),xr            load eftar entry
if .cnra
    if .cnlf
        bsw  xr,4                switch on type
    else
        bsw  xr,3                switch on type
    fi
else
    if .cnlf
        bsw  xr,5                switch on type
    else
        bsw  xr,4                switch on type
    fi
fi
    iff  0,befc7                no conversion needed
    iff  1,befc2                string
    iff  2,befc3                integer
if .cnra
    if .cnlf
        iff  3,beff1                file
    fi
else
    iff  3,befc4                real
    if .cnlf
        iff  4,beff1                file
    fi
fi

```

	esw	end of switch on type
<i>if</i>	.cnlf	
	*	
	* here to convert to file	
	*	
befc1	mov xt,-(xs)	save entry pointer
	mov wc,befof	save offset
	mov (xt),-(xs)	stack arg pointer
	jsr ioxcb	convert to fcb
	err 298,external function	argument is not file
	err 298,external function	argument is not file
	err 298,external function	argument is not file
	mov wa,xr	point to fcb
	mov (xs)+,xt	reload entry pointer
	brn befc5	jump to merge
<i>fi</i>		
	*	
	* here to convert to string	
	*	
befc2	mov (xt),-(xs)	stack arg ptr
	jsr gtstg	convert argument to string
	err 039,external function	argument is not a string
	brn befc6	jump to merge

```

*
*      efblk (continued)
*
*      here to convert an integer
*
befc3  mov  (xt),xr          load next argument
      mov  wc,befof         save offset
      jsr  gtint            convert to integer
      err  040,external function argument is not integer
if .cnra
else
      brn  befc5            merge with real case
*
*      here to convert a real
*
befc4  mov  (xt),xr          load next argument
      mov  wc,befof         save offset
      jsr  gtrea            convert to real
      err  265,external function argument is not real
fi

*
*      integer case merges here
*
befc5  mov  befof,wc         restore offset
*
*      string merges here
*
befc6  mov  xr,(xt)          store converted result
*
*      no conversion merges here
*
befc7  bnz  wc,befc1         loop back if more to go
*
*      here after converting all the arguments
*
      mov  (xs)+,xl         restore efblk pointer
      mov  fargs(xl),wa     get number of args
      jsr  sysex            call routine to call external fnc
      ppm  exfal            fail if failure
      err  327,calling external function - not found
      err  326,calling external function - bad argument type
if .cexp
      wtb  wa               convert number of args to bytes
      add  wa,xs            remove arguments from stack
fi

```

```

*
*      efbblk (continued)
*
*      return here with result in xr
*
*      first defend against non-standard null string returned
*
      mov  efrsl(xl),wb          get result type id
      bnz  wb,befa8              branch if not unconverted
      bne  (xr),=b$scl,befc8     jump if not a string
      bze  sclen(xr),exnul       return null if null
*
*      here if converted result to check for null string
*
befa8  bne  wb,=num01,befc8      jump if not a string
      bze  sclen(xr),exnul       return null if null
*
*      return if result is in dynamic storage
*
befc8  blt  xr,dnamb,befc9       jump if not in dynamic storage
      ble  xr,dnamp,exixr       return result if already dynamic
*
*      here we copy a result into the dynamic region
*
befc9  mov  (xr),wa             get possible type word
      bze  wb,bef11             jump if unconverted result
      mov  =b$scl,wa            string
      beq  wb,=num01,bef10      yes jump
      mov  =b$icl,wa            integer
      beq  wb,=num02,bef10      yes jump
if .cnra
else
      mov  =b$rc1,wa            real
fi
*
*      store type word in result
*
bef10  mov  wa,(xr)             stored before copying to dynamic
*
*      merge for unconverted result
*
bef11  beq  (xr),=b$scl,bef12   branch if string result
      jsr  blkln                get length of block
      mov  xr,xl                copy address of old block
      jsr  alloc                allocate dynamic block same size
      mov  xr,-(xs)             set pointer to new block as result
      mvw                      copy old block to dynamic block
      zer  xl                    clear garbage value
      lcw  xr                    get next code word
      bri  (xr)                 execute next code word

```

```

*
*      here to return a string result that was not in dynamic.
*      cannot use the simple word copy above because it will not
*      guarantee zero padding in the last word.
*
bef12  mov  xr,xl                save source string pointer
      mov  sclen(xr),wa          fetch string length
      bze  wa,exnul             return null string if length zero
      jsr  alocs                allocate space for string
      mov  xr,-(xs)             save as result pointer
      psc  xr                   prepare to store chars of result
      plc  xl                   point to chars in source string
      mov  wc,wa                number of characters to copy
      mvc                     move characters to result string
      zer  xl                   clear garbage value
      lcw  xr                   get next code word
      bri  (xr)                 execute next code word

```

fi


```

*
*      evblk
*
*      the routine for an evblk is never executed
*
b$evt  ent  bl$ev                      entry point (evblk)

```

```

*
*      ffbld
*
*      the routine for an ffbld is executed from the o$fn entry
*      to call a field function and extract a field value/name.
*
*      (x1)                pointer to ffbld
*
b$ffc  ent  bl$ff                entry point (ffblk)
        mov  x1,xr                copy ffbld pointer
        lcw  wc                load next code word
        mov  (xs),x1            load pdbld pointer
        bne  (x1),=b$pdtd,bffc2  jump if not pdbld at all
        mov  pddfp(x1),wa        load ddbld pointer from pdbld
*
*      loop to find correct ffbld for this pdbld
*
bffc1  beq  wa,ffdp(xr),bffc3    jump if this is the correct ffbld
        mov  ffnxt(xr),xr        else link to next ffbld on chain
        bnz  xr,bffc1            loop back if another entry to check
*
*      here for bad argument
*
bffc2  erb  041,field function    argument is wrong datatype

```

```

*
*      ffbld (continued)
*
*      here after locating correct ffbld
*
bffc3  mov  ffofs(xr),wa      load field offset
        beq  wc,=ofne$,bffc5  jump if called by name
        add  wa,xl            else point to value field
        mov  (xl),xr          load value
        bne  (xr),=b$trt,bffc4  jump if not trapped
        sub  wa,xl            else restore name base,offset
        mov  wc,(xs)          save next code word over pdblck ptr
        jsr  access          access value
        ppm  exfal            fail if access fails
        mov  (xs),wc          restore next code word

*
*      here after getting value in (xr), xl is garbage
*
bffc4  mov  xr,(xs)          store value on stack (over pdblck)
        mov  wc,xr            copy next code word
        mov  (xr),xl          load entry address
        bri  xl              jump to routine for next code word

*
*      here if called by name
*
bffc5  mov  wa,-(xs)          store name offset (base is set)
        lcw  xr              get next code word
        bri  (xr)            execute next code word

```

```

*
*      icblk
*
*      the routine for icblk is executed from the generated
*      code to load an integer value onto the stack.
*
*      (xr)                pointer to icblk
*
b$icl  ent   bl$ic          entry point (icblk)
       mov  xr,-(xs)       stack result
       lcw  xr             get next code word
       bri  (xr)           execute it

```

```

*
*      kvblk
*
*      the routine for a kvblk is never executed.
*
b$kv    ent    bl$kv                                entry point (kvblk)

```

```

*
*      nmblk
*
*      the routine for a nmblk is executed from the generated
*      code for the case of loading a name onto the stack
*      where the name is that of a natural variable which can
*      be preevaluated at compile time.
*
*      (xr)                pointer to nmblk
*
b$nm1  ent   bl$nm                entry point (nmblk)
        mov  xr,-(xs)            stack result
        lcw  xr                  get next code word
        bri  (xr)                execute it

```

```

*
*      pdblkl
*
*      the routine for a pdblkl is never executed
*
b$pd  ent  bl$pd                                entry point (pdblkl)

```

```

*
*      pfbk
*
*      the routine for a pfbk is executed from the entry o$fn
*      to call a program defined function.
*
*      (xl)                pointer to pfbk
*
*      the following stack entries are made before passing
*      control to the program defined function.
*
*                               saved value of first argument
*                               .
*                               saved value of last argument
*                               saved value of first local
*                               .
*                               saved value of last local
*                               saved value of function name
*                               saved code block ptr (r$cod)
*                               saved code pointer (-r$cod)
*                               saved value of flprt
*                               saved value of flptr
*                               pointer to pfbk
*      flptr ----- zero (to be overwritten with offs)
*
b$pf  ent  bl$pf                entry point (pfbk)
      mov  xl,bpf             save pfbk ptr (need not be reloc)
      mov  xl,xr              copy for the moment
      mov  pfvbl(xr),xl       point to vrbk for function
*
*      loop to find old value of function
*
bpf01  mov  xl,wb              save pointer
      mov  vrval(xl),xl       load value
      beq  (xl),=b$trt,bpf01  loop if trblk
*
*      set value to null and save old function value
*
      mov  xl,bpfsv           save old value
      mov  wb,xl              point back to block with value
      mov  =nulls,vrval(xl)   set value to null
      mov  fargs(xr),wa       load number of arguments
      add  *pfarg,xr           point to pfarg entries
      bze  wa,bpf04           jump if no arguments
      mov  xs,xt              ptr to last arg
      wtb  wa                  convert no. of args to bytes offset
      add  wa,xt              point before first arg
      mov  xt,bpfxt           remember arg pointer

```



```

*
*      pfbblk (continued)
*
*      loop to save old argument values and set new ones
*
bpf02  mov  (xr)+,x1                      load vrbk ptr for next argument
*
*      loop through possible trblk chain to find value
*
bpf03  mov  x1,wc                        save pointer
      mov  vrval(x1),x1                  load next value
      beq  (x1),=b$trt,bpf03            loop back if trblk
*
*      save old value and get new value
*
      mov  x1,wa                        keep old value
      mov  bpfxt,xt                     point before next stacked arg
      mov  -(xt),wb                     load argument (new value)
      mov  wa,(xt)                      save old value
      mov  xt,bpfxt                     keep arg ptr for next time
      mov  wc,x1                        point back to block with value
      mov  wb,vrval(x1)                 set new value
      bne  xs,bpfxt,bpf02              loop if not all done
*
*      now process locals
*
bpf04  mov  bpfpf,x1                    restore pfbk pointer
      mov  pfnlo(x1),wa                 load number of locals
      bze  wa,bpf07                     jump if no locals
      mov  =nulls,wb                    get null constant
      lct  wa,wa                        set local counter
*
*      loop to process locals
*
bpf05  mov  (xr)+,x1                      load vrbk ptr for next local
*
*      loop through possible trblk chain to find value
*
bpf06  mov  x1,wc                        save pointer
      mov  vrval(x1),x1                  load next value
      beq  (x1),=b$trt,bpf06            loop back if trblk
*
*      save old value and set null as new value
*
      mov  x1,-(xs)                     stack old value
      mov  wc,x1                        point back to block with value
      mov  wb,vrval(x1)                 set null as new value
      bct  wa,bpf05                     loop till all locals processed

```

```

*
*      pfbld (continued)
*
*      here after processing arguments and locals
*
if .cnpf
bpf07  mov  r$cod,wa          load old code block pointer
else
bpf07  zer  xr                zero reg xr in case
      bze  kvpfl,bpf7c       skip if profiling is off
      beq  kvpfl,=num02,bpf7a branch on type of profile
*
*      here if &profile = 1
*
      jsr  systm              get current time
      sti  pfetm              save for a sec
      sbi  pfstm              find time used by caller
      jsr  icbld              build into an icblk
      ldi  pfetm              reload current time
      brn  bpf7b              merge
*
*      here if &profile = 2
*
bpf7a  ldi  pfstm              get start time of calling stmt
      jsr  icbld              assemble an icblk round it
      jsr  systm              get now time
*
*      both types of profile merge here
*
bpf7b  sti  pfstm              set start time of 1st func stmt
      mnz  pffnc              flag function entry
*
*      no profiling merges here
*
bpf7c  mov  xr,-(xs)           stack icblk ptr (or zero)
      mov  r$cod,wa           load old code block pointer
fi

      scp  wb                 get code pointer
      sub  wa,wb               make code pointer into offset
      mov  bpfpf,xl           recall pfbld pointer
      mov  bpfsv,-(xs)        stack old value of function name
      mov  wa,-(xs)            stack code block pointer
      mov  wb,-(xs)            stack code offset
      mov  flprt,-(xs)         stack old flprt
      mov  flptr,-(xs)         stack old failure pointer
      mov  xl,-(xs)            stack pointer to pfbld
      zer  -(xs)               dummy zero entry for fail return
      chk                                check for stack overflow
      mov  xs,flptr            set new fail return value
      mov  xs,flprt            set new flprt

```

	mov kvtra,wa	load trace value
	add kvftr,wa	add ftrace value
	bnz wa,bpf09	jump if tracing possible
	icv kvfnc	else bump fnclevel
	* * here to actually jump to function *	
bpf08	mov pfcod(xl),xr	point to vrbk of entry label
	mov vrlbl(xr),xr	point to target code
	beq xr,=stndl,bpf17	test for undefined label
	bne (xr),=b\$trt,bpf8a	jump if not trapped
	mov trlbl(xr),xr	else load ptr to real label code
bpf8a	bri (xr)	off to execute function
	* * here if tracing is possible *	
bpf09	mov pfctr(xl),xr	load possible call trace trblk
	mov pfvbl(xl),xl	load vrbk pointer for function
	mov *vrval,wa	set name offset for variable
	bze kvtra,bpf10	jump if trace mode is off
	bze xr,bpf10	or if there is no call trace
	* * here if call traced *	
	dcv kvtra	decrement trace count
	bze trfnc(xr),bpf11	jump if print trace
	jsr trxeq	execute function type trace

```

*
*      pfbblk (continued)
*
*      here to test for ftrace trace
*
bpf10  bze  kvftr,bpf16      jump if ftrace is off
      dcv  kvftr            else decrement ftrace
*
*      here for print trace
*
bpf11  jsr  prtsn           print statement number
      jsr  prtnm           print function name
      mov  =ch$pp,wa       load left paren
      jsr  prtch           print left paren
      mov  num01(xs),xl    recover pfbblk pointer
      bze  fargs(xl),bpf15 skip if no arguments
      zer  wb              else set argument counter
      brn  bpf13           jump into loop
*
*      loop to print argument values
*
bpf12  mov  =ch$cm,wa      load comma
      jsr  prtch           print to separate from last arg
*
*      merge here first time (no comma required)
*
bpf13  mov  wb,(xs)        save arg ctr (over failoffs is ok)
      wtb  wb              convert to byte offset
      add  wb,xl           point to next argument pointer
      mov  pfarg(xl),xr    load next argument vrbk ptr
      sub  wb,xl           restore pfbblk pointer
      mov  vrval(xr),xr    load next value
      jsr  prtvl          print argument value

```

```

*
*      here after dealing with one argument
*
      mov  (xs),wb          restore argument counter
      icv  wb              increment argument counter
      blt  wb,fargs(xl),bpf12  loop if more to print
*
*      merge here in no args case to print paren
*
bpf15  mov  =ch$rp,wa      load right paren
      jsr  prtch          print to terminate output
      jsr  prtln          terminate print line
*
*      merge here to exit with test for fnclevel trace
*
bpf16  icv  kvfnc          increment fnclevel
      mov  r$fnc,xl        load ptr to possible trblk
      jsr  ktrex          call keyword trace routine
*
*      call function after trace tests complete
*
      mov  num01(xs),xl    restore pfbk pointer
      brn  bpf08          jump back to execute function
*
*      here if calling a function whose entry label is undefined
*
bpf17  mov  num02(xs),flptr  reset so exfal can return to evalx
      erb  286,function call  to undefined entry label
if .cnra
else

```

```

*
*      rcblk
*
*      the routine for an rcblk is executed from the generated
*      code to load a real value onto the stack.
*
*      (xr)                pointer to rcblk
*
b$rc1  ent   bl$rc          entry point (rcblk)
       mov  xr,-(xs)       stack result
       lcw  xr            get next code word
       bri  (xr)          execute it
fi

```

```

*
*      scblk
*
*      the routine for an scblk is executed from the generated
*      code to load a string value onto the stack.
*
*      (xr)                pointer to scblk
*
b$sc1  ent   bl$sc                entry point (scblk)
        mov  xr,-(xs)            stack result
        lcw  xr                  get next code word
        bri  (xr)                execute it

```

```

*
*      tbbblk
*
*      the routine for a tbbblk is never executed
*
b$tbtt  ent  bl$tb                      entry point (tbbblk)

```



```

*
*      teblk
*
*      the routine for a teblk is never executed
*
b$tet  ent  bl$te                      entry point (teblk)

```

```

*
*      vcbk
*
*      the routine for a vcbk is never executed
*
b$vc  ent  bl$vc                      entry point (vcbk)

```

```

*
*      vrblk
*
*      the vrblk routines are executed from the generated code.
*      there are six entries for vrblk covering various cases
*
b$vr$  ent   bl$$i                                mark start of vrblk entry points
*
*      entry for vrget (trapped case). this routine is called
*      from the generated code to load the value of a variable.
*      this entry point is used if an access trace or input
*      association is currently active.
*
*      (xr)                                pointer to vrget field of vrblk
*
b$vra  ent   bl$$i                                entry point
      mov   xr,xl                                copy name base (vrget = 0)
      mov   *vrval,wa                            set name offset
      jsr   aces                                  access value
      ppm   exfal                                fail if access fails
      mov   xr,-(xs)                             stack result
      lcw   xr                                   get next code word
      bri   (xr)                                execute it

```

```

*
*      vrblk (continued)
*
*      entry for vrsto (error case. this routine is called from
*      the executed code for an attempt to modify the value
*      of a protected (pattern valued) natural variable.
*
b$vre  ent      entry point
      erb  042,attempt to change      value of protected variable

```

```

*
*      vrbk (continued)
*
*      entry for vrtra (untrapped case). this routine is called
*      from the executed code to transfer to a label.
*
*      (xr)                pointer to vrtra field of vrbk
*
b$vrq  ent                entry point
      mov  vrlbo(xr),xr    load code pointer
      mov  (xr),x1        load entry address
      bri  x1             jump to routine for next code word

```

```

*
*      vrblk (continued)
*
*      entry for vrget (untrapped case). this routine is called
*      from the generated code to load the value of a variable.
*
*      (xr)                points to vrget field of vrblk
*
b$vr1  ent                entry point
      mov  vrval(xr),-(xs)  load value onto stack (vrget = 0)
      lcw  xr              get next code word
      bri  (xr)            execute next code word

```

```

*
*      vrblk (continued)
*
*      entry for vrsto (untrapped case). this routine is called
*      from the generated code to store the value of a variable.
*
*      (xr)                pointer to vrsto field of vrblk
*
b$vr$ ent                entry point
    mov  (xs),vrvlo(xr)    store value, leave on stack
    lcw  xr                get next code word
    bri  (xr)              execute next code word

```

```

*
*      vrbk (continued)
*
*      vrtra (trapped case). this routine is called from the
*      generated code to transfer to a label when a label
*      trace is currently active.
*
b$virt  ent          entry point
        sub  *vrtra,xr      point back to start of vrbk
        mov  xr,xl          copy vrbk pointer
        mov  *vrval,wa      set name offset
        mov  vrlbl(xl),xr   load pointer to trblk
        bze  kvtra,bvrt2    jump if trace is off
        dcv  kvtra          else decrement trace count
        bze  trfnc(xr),bvrt1  jump if print trace case
        jsr  trxeq          else execute full trace
        brn  bvrt2          merge to jump to label

*
*      here for print trace -- print colon ( label name )
*
bvrt1   jsr  prtzn          print statement number
        mov  xl,xr          copy vrbk pointer
        mov  =ch$cl,wa      colon
        jsr  prtch          print it
        mov  =ch$pp,wa      left paren
        jsr  prtch          print it
        jsr  prtvn          print label name
        mov  =ch$rp,wa      right paren
        jsr  prtch          print it
        jsr  prtnl          terminate line
        mov  vrlbl(xl),xr   point back to trblk

*
*      merge here to jump to label
*
bvrt2   mov  trlbl(xr),xr   load pointer to actual code
        bri  (xr)          execute statement at label

```



```

*
*      vrbk (continued)
*
*      entry for vrsto (trapped case). this routine is called
*      from the generated code to store the value of a variable.
*      this entry is used when a value trace or output
*      association is currently active.
*
*      (xr)                pointer to vrsto field of vrbk
*
b$vrv  ent                entry point
      mov  (xs),wb        load value (leave copy on stack)
      sub  *vrsto,xr      point to vrbk
      mov  xr,xl          copy vrbk pointer
      mov  *vrval,wa      set offset
      jsr  asign          call assignment routine
      ppm  exfal          fail if assignment fails
      lcw  xr             else get next code word
      bri  (xr)           execute next code word

```

```

*
*      xnblk
*
*      the routine for an xnblk is never executed
*
b$xnt  ent  bl$xn                      entry point (xnblk)

```

```

*
*      xrbk
*
*      the routine for an xrbk is never executed
*
b$xrt  ent  bl$xr                      entry point (xrbk)
*
*      mark entry address past last block action routine
*
b$yyy  ent  bl$$i                      last block routine entry point

```

spitbol – pattern matching routines

```

*
* the following section consists of the pattern matching
* routines. all pattern nodes contain a pointer (pcode)
* to one of the routines in this section (p$xxx).
*
* note that this section follows the b$xxx routines to
* enable a fast test for the pattern datatype.
*
p$aaa ent bl$$i entry to mark first pattern
*
*
* the entry conditions to the match routine are as follows
* (see o$pmn, o$pmv, o$pms and procedure match).
*
* stack contents.
*
* name base (o$pmn only)
* name offset (o$pmn only)
* type (0-o$pmn, 1-o$pmv, 2-o$pms)
* pmhbs ----- initial cursor (zero)
* initial node pointer
* xs ----- =ndabo (anchored), =nduna (unanch)
*
* register values.
*
* (xs) set as shown in stack diagram
* (xr) pointer to initial pattern node
* (wb) initial cursor (zero)
*
* global pattern values
*
* r$pms pointer to subject string scblk
* pmssl length of subject string in chars
* pmdfl dot flag, initially zero
* pmhbs set as shown in stack diagram
*
* control is passed by branching through the pcode
* field of the initial pattern node (bri (xr)).

```

```

*
* description of algorithm
*
* a pattern structure is represented as a linked graph
* of nodes with the following structure.
*
*      +-----+
*      i           pcode           i
*      +-----+
*      i           pthen           i
*      +-----+
*      i           parm1           i
*      +-----+
*      i           parm2           i
*      +-----+
*
* pcode is a pointer to the routine which will perform
* the match of this particular node type.
*
* pthen is a pointer to the successor node. i.e. the node
* to be matched if the attempt to match this node succeeds.
* if this is the last node of the pattern pthen points
* to the dummy node ndnth which initiates pattern exit.
*
* parm1, parm2 are parameters whose use varies with the
* particular node. they are only present if required.
*
* alternatives are handled with the special alternative
* node whose parameter points to the node to be matched
* if there is a failure on the successor path.
*
* the following example illustrates the manner in which
* the structure is built up. the pattern is
*
* (a / b / c) (d / e)  where / is alternation
*
* in the diagram, the node marked + represents an
* alternative node and the dotted line from a + node
* represents the parameter pointer to the alternative.
*
*      +---+      +---+      +---+      +---+
*      i + i-----i a i-----i + i-----i d i-----
*      +---+      +---+      i +---+      +---+
*      .           i           .
*      .           i           .
*      +---+      +---+      i +---+
*      i + i-----i b i--i   i e i-----
*      +---+      +---+      i +---+
*      .           i
*      .           i
*      +---+      i
*      i c i-----i
*      +---+

```

```

*
* during the match, the registers are used as follows.
*
* (xr)           points to the current node
* (xl)           scratch
* (xs)           main stack pointer
* (wb)           cursor (number of chars matched)
* (wa,wc)        scratch
*
* to keep track of alternatives, the main stack is used as
* a history stack and contains two word entries.
*
* word 1         saved cursor value
* word 2         node to match on failure
*
* when a failure occurs, the most recent entry on this
* stack is popped off to restore the cursor and point
* to the node to be matched as an alternative. the entry
* at the bottom of the stack points to the following
* special nodes depending on the scan mode.
*
* anchored mode  the bottom entry points to the
*                special node ndabo which causes an
*                abort. the cursor value stored
*                with this entry is always zero.
*
* unanchored mode the bottom entry points to the
*                special node nduna which moves the
*                anchor point and restarts the match
*                the cursor saved with this entry
*                is the number of characters which
*                lie before the initial anchor point
*                (i.e. the number of anchor moves).
*                this entry is three words long and
*                also contains the initial pattern.
*
* entries are made on this history stack by alternative
* nodes and by some special compound patterns as described
* later on. the following global locations are used during
* pattern matching.
*
* r$pms         pointer to subject string
* pmssl         length of subject string
* pmdf1         flag set non-zero for dot patterns
* pmhbs         base ptr for current history stack
*
* the following exit points are available to match routines
*
* succp         success in matching current node
* failp         failure in matching current node

```

```

*
* compound patterns
*
* some patterns have implicit alternatives and their
* representation in the pattern structure consists of a
* linked set of nodes as indicated by these diagrams.
*
* as before, the + represents an alternative node and
* the dotted line from a + node is the parameter pointer
* to the alternative pattern.
*
* arb
* ---
*
*      +---+          this node (p$arb) matches null
*      i b i----- and stacks cursor, successor ptr,
*      +---+          cursor (copy) and a ptr to ndarc.
*
*
*
*
*
*
* bal
* ---
*
*      +---+          the p$bal node scans a balanced
*      i b i----- string and then stacks a pointer
*      +---+          to itself on the history stack.

```

```

*
* compound pattern structures (continued)
*
*
* arbno
* -----
*
*          +---+
* +----i + i-----   this alternative node matches null
* i      +---+         the first time and stacks a pointer
* i      .             to the argument pattern x.
* i      .
* i      +---+         node (p$aba) to stack cursor
* i      i a i         and history stack base ptr.
* i      +---+
* i      i
* i      i
* i      +---+         this is the argument pattern. as
* i      i x i         indicated, the successor of the
* i      +---+         pattern is the p$abc node
* i      i
* i      i
* i      +---+         this node (p$abc) pops pmhbs,
* +----i c i         stacks old pmhbs and ptr to ndabd
*          +---+         (unless optimization has occurred)
*
*
* structure and execution of this pattern resemble those of
* recursive pattern matching and immediate assignment.
* the alternative node at the head of the structure matches
* null initially but on subsequent failure ensures attempt
* to match the argument. before the argument is matched
* p$aba stacks the cursor, pmhbs and a ptr to p$abb. if
* the argument cant be matched , p$abb removes this special
* stack entry and fails.
* if argument is matched , p$abc restores the outer pmhbs
* value (saved by p$aba) . then if the argument has left
* alternatives on stack it stacks the inner value of pmhbs
* and a ptr to ndabd. if argument left nothing on the stack
* it optimises by removing items stacked by p$aba. finally
* a check is made that argument matched more than the null
* string (check is intended to prevent useless looping).
* if so the successor is again the alternative node at the
* head of the structure , ensuring a possible extra attempt
* to match the arg if necessary. if not , the successor to
* alternative is taken so as to terminate the loop. p$abd
* restores inner pmhbs ptr and fails , thus trying to match
* alternatives left by the arbno argument.

```



```

*
* compound patterns (continued)
*
* binary dot (pattern assignment)
* -----
*
*      +---+          this node (p$paa) saves the current
*      i a i          cursor and a pointer to the
*      +---+          special node ndpab on the stack.
*      i
*      i
*      +---+          this is the structure for the
*      i x i          pattern left argument of the
*      +---+          pattern assignment call.
*      i
*      i
*      +---+          this node (p$pac) saves the cursor,
*      i c i-----   a ptr to itself, the cursor (copy)
*      +---+          and a ptr to ndpad on the stack.
*
*
* the function of the match routine for ndpab (p$pab)
* is simply to unstack itself and fail back onto the stack.
*
* the match routine for p$pac also sets the global pattern
* flag pmdfl non-zero to indicate that pattern assignments
* may have occurred in the pattern match
*
* if pmdfl is set at the end of the match (see p$nth), the
* history stack is scanned for matching ndpab-ndpad pairs
* and the corresponding pattern assignments are executed.
*
* the function of the match routine for ndpad (p$pad)
* is simply to remove its entry from the stack and fail.
* this includes removing the special node pointer stored
* in addition to the standard two entries on the stack.

```

```

*
* compound pattern structures (continued)
*
* fence (function)
* -----
*
*      +---+      this node (p$fna) saves the
*      i a i      current history stack and a
*      +---+      pointer to ndfnb on the stack.
*      i
*      i
*      +---+      this is the pattern structure
*      i x i      given as the argument to the
*      +---+      fence function.
*      i
*      i
*      +---+      this node p$fnc restores the outer
*      i c i      history stack ptr saved in p$fna,
*      +---+      and stacks the inner stack base
*                  ptr and a pointer to ndfnd on the
*                  stack.
*
* ndfnb (f$fnb) simply is the failure exit for pattern
* argument failure, and it pops itself and fails onto the
* stack.
*
* the match routine p$fnc allows for an optimization when
* the fence pattern leaves no alternatives. in this case,
* the ndfnb entry is popped, and the match continues.
*
* ndfnd (p$fnd) is entered when the pattern fails after
* going through a non-optimized p$fnc, and it pops the
* stack back past the inner stack base created by p$fna

```

```

*
* compound patterns (continued)
*
* expression patterns (recursive pattern matches)
* -----
*
* initial entry for a pattern node is to the routine p$exa.
* if the evaluated result of the expression is itself a
* pattern, then the following steps are taken to arrange
* for proper recursive processing.
*
* 1) a pointer to the current node (the p$exa node) is
* stored on the history stack with a dummy cursor.
*
* 2) a special history stack entry is made in which the
* node pointer points to ndexb, and the cursor value
* is the saved value of pmhbs on entry to this node.
* the match routine for ndexb (p$exb) restores pmhbs
* from this cursor entry, pops off the p$exa node
* pointer and fails.
*
* 3) the resulting history stack pointer is saved in
* pmhbs to establish a new level of history stack.
*
* after matching a pattern, the end of match routine gets
* control (p$nth). this routine proceeds as follows.
*
* 1) load the current value of pmhbs and recognize the
* outer level case by the fact that the associated
* cursor in this case is the pattern match type code
* which is less than 3. terminate the match in this
* case and continue execution of the program.
*
* 2) otherwise make a special history stack entry in
* which the node pointer points to the special node
* ndexc and the cursor is the current value of pmhbs.
* the match routine for ndexc (p$exc) resets pmhbs to
* this (inner) value and then fails.
*
* 3) using the history stack entry made on starting the
* expression (accessible with the current value of
* pmhbs), restore the p$exa node pointer and the old
* pmhbs setting. take the successor and continue.
*
* an optimization is possible if the expression pattern
* makes no entries on the history stack. in this case,
* instead of building the p$exc node in step 2, it is more
* efficient to simply pop off the p$exb entry and its
* associated node pointer. the effect is the same.

```

```

*
* compound patterns (continued)
*
* binary dollar (immediate assignment)
* -----
*
*      +---+          this node (p$ima) stacks the cursor
*      i a i          pmhbs and a ptr to ndimb and resets
*      +---+          the stack ptr pmhbs.
*      i
*      i
*      +---+          this is the left structure for the
*      i x i          pattern left argument of the
*      +---+          immediate assignment call.
*      i
*      i
*      +---+          this node (p$imc) performs the
*      i c i-----   assignment, pops pmhbs and stacks
*      +---+          the old pmhbs and a ptr to ndimd.
*
*
* the structure and execution of this pattern are similar
* to those of the recursive expression pattern matching.
*
* the match routine for ndimb (p$imb) restores the outer
* level value of pmhbs, unstacks the saved cursor and fails
*
* the match routine p$imc uses the current value of pmhbs
* to locate the p$imb entry. this entry is used to make
* the assignment and restore the outer level value of
* pmhbs. finally, the inner level value of pmhbs and a
* pointer to the special node ndimd are stacked.
*
* the match routine for ndimd (p$imd) restores the inner
* level value of pmhbs and fails back into the stack.
*
* an optimization occurs if the inner pattern makes no
* entries on the history stack. in this case, p$imc pops
* the p$imb entry instead of making a p$imd entry.

```

```

*
*      arbno
*
*      see compound patterns section for stucture and
*      algorithm for matching this node type.
*
*      no parameters
*
p$aba  ent  bl$p0                p0blk
      mov  wb,-(xs)             stack cursor
      mov  xr,-(xs)             stack dummy node ptr
      mov  pmhbs,-(xs)          stack old stack base ptr
      mov  =ndabb,-(xs)         stack ptr to node ndabb
      mov  xs,pmhbs             store new stack base ptr
      brn  succp               succeed

```

```

*
*      arbno (remove p$aba special stack entry)
*
*      no parameters (dummy pattern)
*
p$abb  ent          entry point
      mov  wb,pmhbs  restore history stack base ptr
      brn  flpop     fail and pop dummy node ptr

```

```

*
*      arbno (check if arg matched null string)
*
*      no parameters (dummy pattern)
*
p$abc  ent   bl$p0                                p0blk
        mov   pmhbs,xt                          keep p$abb stack base
        mov   num03(xt),wa                      load initial cursor
        mov   num01(xt),pmhbs                  restore outer stack base ptr
        beq   xt,xs,pabc1                      jump if no history stack entries
        mov   xt,-(xs)                         else save inner pmhbs entry
        mov   =ndabd,-(xs)                    stack ptr to special node ndabd
        brn   pabc2                           merge

*
*      optimise case of no extra entries on stack from arbno arg
*
pabc1  add    *num04,xs                          remove ndabb entry and cursor

*
*      merge to check for matching of null string
*
pabc2  bne    wa,wb,succp                      allow further attempt if non-null
        mov   pthen(xr),xr                   bypass alternative node so as to ...
        brn   succp                          ... refuse further match attempts

```



```

*
*      arbno (try for alternatives in arbno argument)
*
*      no parameters (dummy pattern)
*
p$abd  ent          entry point
      mov  wb,pmhbs  restore inner stack base ptr
      brn  failp     and fail

```

```

*
*      abort
*
*      no parameters
*
p$abo  ent  bl$p0      p0blk
      brn  exfal      signal statement failure

```

	*		
	*	alternation	
	*		
	*	parm1	alternative node
	*		
p\$alt	ent	bl\$p1	p1blk
	mov	wb,-(xs)	stack cursor
	mov	parm1(xr),-(xs)	stack pointer to alternative
	chk		check for stack overflow
	brn	succp	if all ok, then succeed

```

*
*      any (one character argument) (1-char string also)
*
*      parm1                character argument
*
p$ans  ent   bl$p1                p1blk
        beq   wb,pmssl,failp      fail if no chars left
        mov   r$pms,xl           else point to subject string
        plc   xl,wb              point to current character
        lch   wa,(xl)            load current character
        bne   wa,parm1(xr),failp  fail if no match
        icv   wb                 else bump cursor
        brn   succp              and succeed

```

```

*
*      any (multi-character argument case)
*
*      parm1          pointer to ctblk
*      parm2          bit mask to select bit in ctblk
*
p$any  ent  bl$p2                      p2blk
*
*      expression argument case merges here
*
pany1  beq  wb,pmssl,failp             fail if no characters left
      mov  r$pms,xl                   else point to subject string
      plc  xl,wb                       get char ptr to current character
      lch  wa,(xl)                     load current character
      mov  parm1(xr),xl                point to ctblk
      wtb  wa                           change to byte offset
      add  wa,xl                       point to entry in ctblk
      mov  ctchs(xl),wa                load word from ctblk
      anb  parm2(xr),wa                and with selected bit
      zrb  wa,failp                    fail if no match
      icv  wb                          else bump cursor
      brn  succp                       and succeed

```

	*		
	*	any (expression argument)	
	*		
	*	parm1	expression pointer
	*		
p\$ayd	ent	bl\$p1	p1blk
	jsr	evals	evaluate string argument
	err	043,any evaluated	argument is not a string
	ppm	failp	fail if evaluation failure
	ppm	pany1	merge multi-char case if ok

```

*
*      p$arb          initial arb match
*
*      no parameters
*
*      the p$arb node is part of a compound pattern structure
*      for an arb pattern (see description of compound patterns)
*
p$arb  ent   bl$p0          p0blk
        mov  pthen(xr),xr   load successor pointer
        mov  wb,-(xs)       stack dummy cursor
        mov  xr,-(xs)       stack successor pointer
        mov  wb,-(xs)       stack cursor
        mov  =ndarc,-(xs)   stack ptr to special node ndarc
        bri  (xr)           execute next node matching null

```

```

*
*      p$arc                extend arb match
*
*      no parameters (dummy pattern)
*
p$arc  ent                entry point
      beq  wb,pmssl,flpop  fail and pop stack to successor
      icv  wb              else bump cursor
      mov  wb,-(xs)        stack updated cursor
      mov  xr,-(xs)        restack pointer to ndarc node
      mov  num02(xs),xr    load successor pointer
      bri  (xr)            off to reexecute successor node

```



```

*
*      bal
*
*      no parameters
*
*      the p$bal node is part of the compound structure built
*      for bal (see section on compound patterns).
*
p$bal  ent  bl$p0                                p0blk
        zer  wc                                zero parentheses level counter
        mov  r$pms,x1                          point to subject string
        plc  x1,wb                             point to current character
        brn  pbal2                             jump into scan loop
*
*      loop to scan out characters
*
pbal1  lch  wa,(x1)+                            load next character, bump pointer
        icv  wb                                push cursor for character
        beq  wa,=ch$pp,pbal3                   jump if left paren
        beq  wa,=ch$rp,pbal4                   jump if right paren
        bze  wc,pbal5                           else succeed if at outer level
*
*      here after processing one character
*
pbal2  bne  wb,pmssl,pbal1                      loop back unless end of string
        brn  failp                             in which case, fail
*
*      here on left paren
*
pbal3  icv  wc                                bump paren level
        brn  pbal2                             loop back to check end of string
*
*      here for right paren
*
pbal4  bze  wc,failp                          fail if no matching left paren
        dcw  wc                                else decrement level counter
        bnz  wc,pbal2                          loop back if not at outer level
*
*      here after successfully scanning a balanced string
*
pbal5  mov  wb,-(xs)                          stack cursor
        mov  xr,-(xs)                          stack ptr to bal node for extend
        brn  succp                             and succeed

```

```

*
*      break (expression argument)
*
*      parm1          expression pointer
*
p$bkd  ent   bl$p1          p1blk
      jsr   evals          evaluate string expression
      err   044,break evaluated argument is not a string
      ppm   failp          fail if evaluation fails
      ppm   pbrk1          merge with multi-char case if ok

```

```

*
*      break (one character argument)
*
*      parm1                character argument
*
p$bks  ent   bl$p1                p1blk
        mov   pmssl,wc           get subject string length
        sub   wb,wc             get number of characters left
        bze   wc,failp          fail if no characters left
        lct   wc,wc             set counter for chars left
        mov   r$pms,xl          point to subject string
        plc   xl,wb             point to current character

*
*      loop to scan till break character found
*
pbks1  lch   wa,(xl)+            load next char, bump pointer
        beq   wa,parm1(xr),succp succeed if break character found
        icv   wb                else push cursor
        bct   wc,pbks1          loop back if more to go
        brn   failp            fail if end of string, no break chr

```

```

*
*      break (multi-character argument)
*
*      parm1          pointer to ctblk
*      parm2          bit mask to select bit column
*
p$brk  ent  bl$p2                      p2blk
*
*      expression argument merges here
*
pbrk1  mov  pmssl,wc                   load subject string length
      sub  wb,wc                      get number of characters left
      bze  wc,failp                   fail if no characters left
      lct  wc,wc                      set counter for characters left
      mov  r$pms,xl                  else point to subject string
      plc  xl,wb                     point to current character
      mov  xr,psave                  save node pointer
*
*      loop to search for break character
*
pbrk2  lch  wa,(xl)+                  load next char, bump pointer
      mov  parm1(xr),xr              load pointer to ctblk
      wtb  wa                        convert to byte offset
      add  wa,xr                     point to ctblk entry
      mov  ctchs(xr),wa              load ctblk word
      mov  psave,xr                  restore node pointer
      anb  parm2(xr),wa              and with selected bit
      nzb  wa,succp                  succeed if break character found
      icv  wb                        else push cursor
      bct  wc,pbrk2                  loop back unless end of string
      brn  failp                     fail if end of string, no break chr

```

```

*
*      breakx (extension)
*
*      this is the entry which causes an extension of a breakx
*      match when failure occurs. see section on compound
*      patterns for full details of breakx matching.
*
*      no parameters
*
p$bkx  ent  bl$p0          p0blk
       icv  wb          step cursor past previous break chr
       brn  succp       succeed to rematch break

```

```

*
*      breakx (expression argument)
*
*      see section on compound patterns for full structure of
*      breakx pattern. the actual character matching uses a
*      break node. however, the entry for the expression
*      argument case is separated to get proper error messages.
*
*      parm1          expression pointer
*
p$bx d  ent  bl$p1          p1blk
        jsr  evals         evaluate string argument
        err  045,breakx evaluated argument is not a string
        ppm  failp         fail if evaluation fails
        ppm  pbrk1         merge with break if all ok

```

*			
*		cursor assignment	
*			
*	parm1	name base	
*	parm2	name offset	
*			
p\$cas	ent	bl\$p2	p2blk
	mov	xr,-(xs)	save node pointer
	mov	wb,-(xs)	save cursor
	mov	parm1(xr),xl	load name base
	mti	wb	load cursor as integer
	mov	parm2(xr),wb	load name offset
	jsr	icbld	get icblk for cursor value
	mov	wb,wa	move name offset
	mov	xr,wb	move value to assign
	jsr	asinp	perform assignment
	ppm	flpop	fail on assignment failure
	mov	(xs)+,wb	else restore cursor
	mov	(xs)+,xr	restore node pointer
	brn	succp	and succeed matching null

```

*
*      expression node (p$exa, initial entry)
*
*      see compound patterns description for the structure and
*      algorithms for handling expression nodes.
*
*      parm1          expression pointer
*
p$exa  ent  bl$p1          p1blk
      jsr  evalp          evaluate expression
      ppm  failp          fail if evaluation fails
      blo  wa,=p$aaa,pexa1  jump if result is not a pattern
*
*      here if result of expression is a pattern
*
      mov  wb,-(xs)          stack dummy cursor
      mov  xr,-(xs)          stack ptr to p$exa node
      mov  pmhbs,-(xs)       stack history stack base ptr
      mov  =ndexb,-(xs)      stack ptr to special node ndexb
      mov  xs,pmhbs          store new stack base pointer
      mov  xl,xr             copy node pointer
      bri  (xr)              match first node in expression pat
*
*      here if result of expression is not a pattern
*
pexa1  beq  wa,=b$scl,pexa2  jump if it is already a string
      mov  xl,-(xs)          else stack result
      mov  xr,xl             save node pointer
      jsr  gtstg             convert result to string
      err  046,expression does not evaluate to pattern
      mov  xr,wc             copy string pointer
      mov  xl,xr             restore node pointer
      mov  wc,xl             copy string pointer again
*
*      merge here with string pointer in xl
*
pexa2  bze  sclen(xl),succp  just succeed if null string
      brn  pstr1             else merge with string circuit

```



```

*
*      expression node (p$exb, remove ndexb entry)
*
*      see compound patterns description for the structure and
*      algorithms for handling expression nodes.
*
*      no parameters (dummy pattern)
*
p$exb  ent          entry point
      mov  wb,pmhbs  restore outer level stack pointer
      brn  flpop     fail and pop p$exa node ptr

```

```

*
*      expression node (p$exc, remove ndexc entry)
*
*      see compound patterns description for the structure and
*      algorithms for handling expression nodes.
*
*      no parameters (dummy pattern)
*
p$exc  ent          entry point
      mov  wb,pmhbs  restore inner stack base pointer
      brn  failp     and fail into expr pattern alternvs

```

```

*
*      fail
*
*      no parameters
*
p$fal  ent  bl$p0      p0blk
      brn  failp      just signal failure

```

```

*
*      fence
*
*      see compound patterns section for the structure and
*      algorithm for matching this node type.
*
*      no parameters
*
p$fen  ent   bl$p0                p0blk
      mov  wb,-(xs)              stack dummy cursor
      mov  =ndabo,-(xs)          stack ptr to abort node
      brn  succp                 and succeed matching null

```

```

*
*      fence (function)
*
*      see compound patterns comments at start of this section
*      for details of scheme
*
*      no parameters
*
p$fna  ent   bl$p0                p0blk
      mov   pmhbs,-(xs)          stack current history stack base
      mov   =ndfnb,-(xs)        stack indir ptr to p$fnb (failure)
      mov   xs,pmhbs            begin new history stack
      brn   succp              succeed

```

```

*
*      fence (function) (reset history stack and fail)
*
*      no parameters (dummy pattern)
*
p$fnb  ent   bl$p0                                p0blk
        mov  wb,pmhbs                            restore outer pmhbs stack base
        brn  failp                                ...and fail

```

```

*
*      fence (function) (make fence trap entry on stack)
*
*      no parameters (dummy pattern)
*
p$fnc  ent   bl$p0                                p0blk
        mov   pmhbs,xt                            get inner stack base ptr
        mov   num01(xt),pmhbs                      restore outer stack base
        beq   xt,xs,pfnc1                          optimize if no alternatives
        mov   xt,-(xs)                             else stack inner stack base
        mov   =ndfnd,-(xs)                         stack ptr to ndfnd
        brn   succp                                succeed

*
*      here when fence function left nothing on the stack
*
pfnc1  add   *num02,xs                            pop off p$fnb entry
        brn   succp                                succeed

```

```

*
*      fence (function) (skip past alternatives on failure)
*
*      no parameters (dummy pattern)
*
p$fnd  ent   bl$p0
      mov   wb,xs
      brn   flpop
                                p0blk
                                pop stack to fence() history base
                                pop base entry and fail

```



```

*
*      immediate assignment (initial entry, save current cursor)
*
*      see compound patterns description for details of the
*      structure and algorithm for matching this node type.
*
*      no parameters
*
p$ima  ent   bl$p0                p0blk
        mov  wb,-(xs)            stack cursor
        mov  xr,-(xs)            stack dummy node pointer
        mov  pmhbs,-(xs)         stack old stack base pointer
        mov  =ndimb,-(xs)        stack ptr to special node ndimb
        mov  xs,pmhbs            store new stack base pointer
        brn  succp              and succeed

```

```

*
*      immediate assignment (remove cursor mark entry)
*
*      see compound patterns description for details of the
*      structure and algorithms for matching this node type.
*
*      no parameters (dummy pattern)
*
p$imb  ent          entry point
      mov  wb,pmhbs  restore history stack base ptr
      brn  flpop     fail and pop dummy node ptr

```

```

*
*      immediate assignment (perform actual assignment)
*
*      see compound patterns description for details of the
*      structure and algorithms for matching this node type.
*
*      parm1          name base of variable
*      parm2          name offset of variable
*
p$imc  ent  bl$p2                p2blk
        mov  pmhbs,xt            load pointer to p$imb entry
        mov  wb,wa              copy final cursor
        mov  num03(xt),wb        load initial cursor
        mov  num01(xt),pmhbs     restore outer stack base pointer
        beq  xt,xs,pimc1        jump if no history stack entries
        mov  xt,-(xs)           else save inner pmhbs pointer
        mov  =ndimd,-(xs)       and a ptr to special node ndimd
        brn  pimc2              merge

*
*      here if no entries made on history stack
*
pimc1  add  *num04,xs            remove ndimb entry and cursor

*
*      merge here to perform assignment
*
pimc2  mov  wa,-(xs)            save current (final) cursor
        mov  xr,-(xs)            save current node pointer
        mov  r$pms,xl           point to subject string
        sub  wb,wa              compute substring length
        jsr  sbstr              build substring
        mov  xr,wb              move result
        mov  (xs),xr            reload node pointer
        mov  parm1(xr),xl       load name base
        mov  parm2(xr),wa       load name offset
        jsr  asinp              perform assignment
        ppm  flpop              fail if assignment fails
        mov  (xs)+,xr           else restore node pointer
        mov  (xs)+,wb           restore cursor
        brn  succp              and succeed

```

```

*
*      immediate assignment (remove ndimd entry on failure)
*
*      see compound patterns description for details of the
*      structure and algorithms for matching this node type.
*
*      no parameters (dummy pattern)
*
p$imd  ent      entry point
      mov  wb,pmhbs  restore inner stack base pointer
      brn  failp    and fail

```

```

*
*      len (integer argument)
*
*      parm1                integer argument
*
p$len  ent  bl$p1                p1blk
*
*      expression argument case merges here
*
plen1  add  parm1(xr),wb          push cursor indicated amount
      ble  wb,pmssl,succp        succeed if not off end
      brn  failp                 else fail

```

```

*
*      len (expression argument)
*
*      parm1          expression pointer
*
p$lnd  ent   bl$p1          p1blk
      jsr   evali          evaluate integer argument
      err   047,len evaluated argument is not integer
      err   048,len evaluated argument is negative or too large
      ppm   failp          fail if evaluation fails
      ppm   plen1          merge with normal circuit if ok

```

```

*
*      notany (expression argument)
*
*      parm1          expression pointer
*
p$nad  ent   bl$p1          p1blk
      jsr   evals          evaluate string argument
      err   049,notany evaluated argument is not a string
      ppm   failp          fail if evaluation fails
      ppm   pnay1          merge with multi-char case if ok

```

```

*
*      notany (one character argument)
*
*      parm1          character argument
*
p$nas  ent   bl$p1          entry point
        beq   wb,pmssl,failp  fail if no chars left
        mov   r$pms,xl       else point to subject string
        plc   xl,wb          point to current character in strin
        lch   wa,(xl)        load current character
        beq   wa,parm1(xr),failp  fail if match
        icv   wb             else bump cursor
        brn   succp          and succeed

```



```

*
*      notany (multi-character string argument)
*
*      parm1          pointer to ctblk
*      parm2          bit mask to select bit column
*
p$nay  ent  bl$p2                      p2blk
*
*      expression argument case merges here
*
pnay1  beq  wb,pmssl,failp             fail if no characters left
      mov  r$pms,xl                   else point to subject string
      plc  xl,wb                       point to current character
      lch  wa,(xl)                     load current character
      wtb  wa                           convert to byte offset
      mov  parm1(xr),xl                load pointer to ctblk
      add  wa,xl                       point to entry in ctblk
      mov  ctchs(xl),wa                 load entry from ctblk
      anb  parm2(xr),wa                 and with selected bit
      nzb  wa,failp                     fail if character is matched
      icv  wb                           else bump cursor
      brn  succp                         and succeed

```

```

*
*      end of pattern match
*
*      this routine is entered on successful completion.
*      see description of expression patterns in compound
*      pattern section for handling of recursion in matching.
*
*      this pattern also results from an attempt to convert the
*      null string to a pattern via convert()
*
*      no parameters (dummy pattern)
*
p$nth  ent  bl$p0                                p0blk (dummy)
        mov  pmhbs,xt                          load pointer to base of stack
        mov  num01(xt),wa                      load saved pmhbs (or pattern type)
        ble  wa,=num02,pnth2                  jump if outer level (pattern type)
*
*      here we are at the end of matching an expression pattern
*
        mov  wa,pmhbs                          restore outer stack base pointer
        mov  num02(xt),xr                      restore pointer to p$exa node
        beq  xt,xs,pnth1                      jump if no history stack entries
        mov  xt,-(xs)                          else stack inner stack base ptr
        mov  =ndexc,-(xs)                     stack ptr to special node ndexc
        brn  succp                            and succeed
*
*      here if no history stack entries during pattern
*
pnth1  add  *num04,xs                          remove p$exb entry and node ptr
        brn  succp                            and succeed
*
*      here if end of match at outer level
*
pnth2  mov  wb,pmssl                          save final cursor in safe place
        bze  pmdfl,pnth6                     jump if no pattern assignments

```

```

*
*      end of pattern match (continued)
*
*      now we must perform pattern assignments. this is done by
*      scanning the history stack for matching ndpab-ndpad pairs
*
pnth3  dca  xt                      point past cursor entry
      mov  -(xt),wa                load node pointer
      beq  wa,=ndpad,pnth4         jump if ndpad entry
      bne  wa,=ndpab,pnth5         jump if not ndpab entry
*
*      here for ndpab entry, stack initial cursor
*      note that there must be more entries on the stack.
*
      mov  num01(xt),-(xs)         stack initial cursor
      chk                      check for stack overflow
      brn  pnth3                  loop back if ok
*
*      here for ndpad entry. the starting cursor from the
*      matching ndpad entry is now the top stack entry.
*
pnth4  mov  num01(xt),wa           load final cursor
      mov  (xs),wb                load initial cursor from stack
      mov  xt,(xs)                save history stack scan ptr
      sub  wb,wa                  compute length of string
*
*      build substring and perform assignment
*
      mov  r$pms,xl               point to subject string
      jsr  sbstr                  construct substring
      mov  xr,wb                  copy substring pointer
      mov  (xs),xt                reload history stack scan ptr
      mov  num02(xt),xl           load pointer to p$pac node with nam
      mov  parm2(xl),wa           load name offset
      mov  parm1(xl),xl           load name base
      jsr  asinp                  perform assignment
      ppm  exfal                  match fails if name eval fails
      mov  (xs)+,xt              else restore history stack ptr

```

```

*
*      end of pattern match (continued)
*
*      here check for end of entries
*
pnth5  bne  xt,xs,pnth3          loop if more entries to scan
*
*      here after dealing with pattern assignments
*
pnth6  mov  pmhbs,xs            wipe out history stack
      mov  (xs)+,wb            load initial cursor
      mov  (xs)+,wc            load match type code
      mov  pmssl,wa            load final cursor value
      mov  r$pms,xl            point to subject string
      zer  r$pms               clear subject string ptr for gbcol
      bze  wc,pnth7            jump if call by name
      beq  wc,num02,pnth9      exit if statement level call
*
*      here we have a call by value, build substring
*
      sub  wb,wa                compute length of string
      jsr  sbstr                build substring
      mov  xr,-(xs)            stack result
      lcw  xr                   get next code word
      bri  (xr)                execute it
*
*      here for call by name, make stack entries for o$rpl
*
pnth7  mov  wb,-(xs)           stack initial cursor
      mov  wa,-(xs)           stack final cursor
if .cnbf
else
      bze  r$pmb,pnth8         skip if subject not buffer
      mov  r$pmb,xl            else get ptr to bcbk instead
fi
*
*      here with xl pointing to scblk or bcbk
*
pnth8  mov  xl,-(xs)           stack subject pointer
*
*      here to obey next code word
*
pnth9  lcw  xr                   get next code word
      bri  (xr)                execute next code word

```

```

*
*      pos (integer argument)
*
*      parm1                integer argument
*
p$pos  ent  bl$p1                plblk
*
*      optimize pos if it is the first pattern element,
*      unanchored mode, cursor is zero and pos argument
*      is not beyond end of string.  force cursor position
*      and number of unanchored moves.
*
*      this optimization is performed invisible provided
*      the argument is either a simple integer or an
*      expression that is an untraced variable (that is,
*      it has no side effects that would be lost by short-
*      circuiting the normal logic of failing and moving the
*      unanchored starting point.)
*
*      pos (integer argument)
*
*      parm1                integer argument
*
      beq  wb,parm1(xr),succp                succeed if at right location
      bnz  wb,failp                          don't look further if cursor not 0
      mov  pmhbs,xt                          get history stack base ptr
      bne  xr,-(xt),failp                    fail if pos is not first node
*
*      expression argument circuit merges here
*
p$pos2  bne  -(xt),=nduna,failp                fail if not unanchored mode
      mov  parm1(xr),wb                        get desired cursor position
      bgt  wb,pmssl,exfal                      abort if off end
      mov  wb,num02(xt)                        fake number of unanchored moves
      brn  succp                               continue match with adjusted cursor

```

*		
* pos (expression argument)		
*		
* parm1 expression pointer		
*		
p\$psd	ent bl\$p1	p1blk
	jsr evali	evaluate integer argument
	err 050,pos evaluated	argument is not integer
	err 051,pos evaluated	argument is negative or too large
	ppm failp	fail if evaluation fails
	ppm ppos1	process expression case
*		
p\$pos1	beq wb,parm1(xr),succp	succeed if at right location
	bnz wb,failp	don't look further if cursor not 0
	bnz evlif,failp	fail if complex argument
	mov pmhbs,xt	get history stack base ptr
	mov evlio,wa	get original node ptr
	bne wa,-(xt),failp	fail if pos is not first node
	brn ppos2	merge with integer argument code

```

*
*      pattern assignment (initial entry, save cursor)
*
*      see compound patterns description for the structure and
*      algorithms for matching this node type.
*
*      no parameters
*
p$paa  ent   bl$p0                p0blk
      mov   wb,-(xs)             stack initial cursor
      mov   =ndpab,-(xs)         stack ptr to ndpab special node
      brn   succp                and succeed matching null

```

```

*
*      pattern assignment (remove saved cursor)
*
*      see compound patterns description for the structure and
*      algorithms for matching this node type.
*
*      no parameters (dummy pattern)
*
p$pab  ent          entry point
      brn  failp    just fail (entry is already popped)

```



```

*
*      pattern assignment (end of match, make assign entry)
*
*      see compound patterns description for the structure and
*      algorithms for matching this node type.
*
*      parm1          name base of variable
*      parm2          name offset of variable
*
p$pac  ent   bl$p2          p2blk
        mov  wb,-(xs)      stack dummy cursor value
        mov  xr,-(xs)      stack pointer to p$pac node
        mov  wb,-(xs)      stack final cursor
        mov  =ndpad,-(xs)  stack ptr to special ndpad node
        mnz  pmdfl         set dot flag non-zero
        brn  succp         and succeed

```

```

*
*      pattern assignment (remove assign entry)
*
*      see compound patterns description for the structure and
*      algorithms for matching this node type.
*
*      no parameters (dummy node)
*
p$pad  ent          entry point
      brn  flpop      fail and remove p$pac node

```

	*		
	*	rem	
	*		
	*	no parameters	
	*		
p\$rem	ent	bl\$p0	p0blk
	mov	pmssl,wb	point cursor to end of string
	brn	succp	and succeed

```

*
*      rpos (expression argument)
*
*      optimize rpos if it is the first pattern element,
*      unanchored mode, cursor is zero and rpos argument
*      is not beyond end of string.  force cursor position
*      and number of unanchored moves.
*
*      this optimization is performed invisibly provided
*      the argument is either a simple integer or an
*      expression that is an untraced variable (that is,
*      it has no side effects that would be lost by short-
*      circuiting the normal logic of failing and moving the
*      unanchored starting point).
*
*      parm1          expression pointer
*
p$rpdl  ent  bl$pl          plblk
        jsr  evali         evaluate integer argument
        err  052,rpos evaluated argument is not integer
        err  053,rpos evaluated argument is negative or too large
        ppm  failp         fail if evaluation fails
        ppm  prps1         merge with normal case if ok
*
prps1   mov  pmssl,wc       get length of string
        sub  wb,wc         get number of characters remaining
        beq  wc,parm1(xr),succp succeed if at right location
        bnz  wb,failp      don't look further if cursor not 0
        bnz  evlif,failp   fail if complex argument
        mov  pmhbs,xt       get history stack base ptr
        mov  evlio,wa       get original node ptr
        bne  wa,-(xt),failp fail if pos is not first node
        brn  prps2         merge with integer arg code

```

```

*
*      rpos (integer argument)
*
*      parm1                integer argument
*
p$ rps  ent  bl$ p1                p1 blk
*
*      rpos (integer argument)
*
*      parm1                integer argument
*
      mov  pmssl,wc                get length of string
      sub  wb,wc                  get number of characters remaining
      beq  wc,parm1(xr),succp      succeed if at right location
      bnz  wb,failp                don't look further if cursor not 0
      mov  pmhbs,xt                get history stack base ptr
      bne  xr,-(xt),failp          fail if rpos is not first node
*
*      expression argument merges here
*
prps2  bne  -(xt),=nduna,failp      fail if not unanchored mode
      mov  pmssl,wb                point to end of string
      blt  wb,parm1(xr),failp      fail if string not long enough
      sub  parm1(xr),wb            else set new cursor
      mov  wb,num02(xt)            fake number of unanchored moves
      brn  succp                  continue match with adjusted cursor

```

```

*
*      rtab (integer argument)
*
*      parm1                integer argument
*
p$rtb  ent  bl$p1                                p1blk
*
*      expression argument case merges here
*
prtb1  mov  wb,wc                                save initial cursor
        mov  pmssl,wb                            point to end of string
        blt  wb,parm1(xr),failp                 fail if string not long enough
        sub  parm1(xr),wb                       else set new cursor
        bge  wb,wc,succp                         and succeed if not too far already
        brn  failp                              in which case, fail

```

```

*
*      rtab (expression argument)
*
*      parm1          expression pointer
*
p$rtd  ent   bl$p1          p1blk
      jsr   evali          evaluate integer argument
      err   054,rtab evaluated argument is not integer
      err   055,rtab evaluated argument is negative or too large
      ppm   failp          fail if evaluation fails
      ppm   prtbt1         merge with normal case if success

```

```

*
*      span (expression argument)
*
*      parm1          expression pointer
*
p$spd  ent   bl$p1          p1blk
      jsr   evals          evaluate string argument
      err   056,span evaluated argument is not a string
      ppm   failp          fail if evaluation fails
      ppm   pspn1         merge with multi-char case if ok

```



```

*
*      span (multi-character argument case)
*
*      parm1          pointer to ctblk
*      parm2          bit mask to select bit column
*
p$spn  ent  bl$p2                      p2blk
*
*      expression argument case merges here
*
pspn1  mov  pmssl,wc                  copy subject string length
      sub  wb,wc                      calculate number of characters left
      bze  wc,failp                  fail if no characters left
      mov  r$pms,xl                  point to subject string
      plc  xl,wb                      point to current character
      mov  wb,psavc                  save initial cursor
      mov  xr,psave                  save node pointer
      lct  wc,wc                      set counter for chars left
*
*      loop to scan matching characters
*
pspn2  lch  wa,(xl)+                  load next character, bump pointer
      wtb  wa                        convert to byte offset
      mov  parm1(xr),xr              point to ctblk
      add  wa,xr                      point to ctblk entry
      mov  ctchs(xr),wa              load ctblk entry
      mov  psave,xr                  restore node pointer
      anb  parm2(xr),wa              and with selected bit
      zrb  wa,pspn3                  jump if no match
      icv  wb                        else push cursor
      bct  wc,pspn2                  loop back unless end of string
*
*      here after scanning matching characters
*
pspn3  bne  wb,psavc,succp            succeed if chars matched
      brn  failp                     else fail if null string matched

```

```

*
*      span (one character argument)
*
*      parm1                character argument
*
p$sp1  ent   bl$pl           plblk
      mov   pmssl,wc        get subject string length
      sub   wb,wc           calculate number of characters left
      bze   wc,failp        fail if no characters left
      mov   r$pm,xl        else point to subject string
      plc   xl,wb           point to current character
      mov   wb,psavc        save initial cursor
      lct   wc,wc           set counter for characters left

*
*      loop to scan matching characters
*
p$sp1  lch   wa,(xl)+        load next character, bump pointer
      bne   wa,parm1(xr),p$sp2  jump if no match
      icv   wb              else push cursor
      bct   wc,p$sp1        and loop unless end of string

*
*      here after scanning matching characters
*
p$sp2  bne   wb,psavc,succp   succeed if chars matched
      brn   failp           fail if null string matched

```

```

*
*      multi-character string
*
*      note that one character strings use the circuit for
*      one character any arguments (p$an1).
*
*      parm1                pointer to scblk for string arg
*
p$str  ent  bl$p1                p1blk
        mov  parm1(xr),xl        get pointer to string
*
*      merge here after evaluating expression with string value
*
p$stri  mov  xr,psave            save node pointer
        mov  r$pms,xr            load subject string pointer
        plc  xr,wb                point to current character
        add  sclen(xl),wb        compute new cursor position
        bgt  wb,pmssl,failp      fail if past end of string
        mov  wb,psavc            save updated cursor
        mov  sclen(xl),wa        get number of chars to compare
        plc  xl                  point to chars of test string
        cmc  failp,failp        compare, fail if not equal
        mov  psave,xr            if all matched, restore node ptr
        mov  psavc,wb            restore updated cursor
        brn  succp               and succeed

```

```

*
*      succeed
*
*      see section on compound patterns for details of the
*      structure and algorithms for matching this node type
*
*      no parameters
*
p$suc  ent   bl$p0                p0blk
        mov  wb,-(xs)            stack cursor
        mov  xr,-(xs)            stack pointer to this node
        brn  succp              succeed matching null

```

```

*
*      tab (integer argument)
*
*      parm1                integer argument
*
p$tab  ent   bl$p1                                p1blk
*
*      expression argument case merges here
*
ptab1  bgt   wb,parm1(xr),failp                    fail if too far already
        mov  parm1(xr),wb                          else set new cursor position
        ble  wb,pmssl,succp                        succeed if not off end
        brn  failp                                else fail

```

```

*
*      tab (expression argument)
*
*      parm1          expression pointer
*
p$tbdl  ent   bl$p1          p1blk
        jsr   evali         evaluate integer argument
        err   057,tab evaluated argument is not integer
        err   058,tab evaluated argument is negative or too large
        ppm   failp         fail if evaluation fails
        ppm   ptab1        merge with normal case if ok

```

	*	
	*	anchor movement
	*	
	*	no parameters (dummy node)
	*	
p\$una	ent	entry point
	mov wb,xr	copy initial pattern node pointer
	mov (xs),wb	get initial cursor
	beq wb,pmssl,exfal	match fails if at end of string
	icv wb	else increment cursor
	mov wb,(xs)	store incremented cursor
	mov xr,-(xs)	restack initial node ptr
	mov =nduna,-(xs)	restack unanchored node
	bri (xr)	rematch first node

```

*
*      end of pattern match routines
*
*      the following entry point marks the end of the pattern
*      matching routines and also the end of the entry points
*      referenced from the first word of blocks in dynamic store
*
p$yyy  ent  bl$$i                                mark last entry in pattern section

```


spitbol – snobol4 built-in label routines

```
*
*      the following section contains the routines for labels
*      which have a predefined meaning in snobol4.
*
*      control is passed directly to the label name entry point.
*
*      entry names are of the form l$xxx where xxx is the three
*      letter variable name identifier.
*
*      entries are in alphabetical order
```

*		
*	abort	
*		
l\$abo	ent	entry point
*		
*	merge here if execution terminates in error	
*		
labo1	mov kvert,wa	load error code
	bze wa,labo3	jump if no error has occurred
<i>if .csax</i>		
	jsr sysax	call after execution proc
<i>fi</i>		
<i>if .cera</i>		
	<i>if .csfn</i>	
	mov kvstn,wc	current statement
	jsr filnm	obtain file name for this statement
<i>fi</i>		
<i>if .csln</i>		
	mov r\$cod,xr	current code block
	mov cdsln(xr),wc	line number
<i>else</i>		
	zer wc	line number
<i>fi</i>		
	zer wb	column number
	mov wb	column number
	jsr sysea	advise system of error
	ppm stpr4	if system does not want print
<i>fi</i>		
	jsr prtpg	else eject printer
<i>if .cera</i>		
	bze xr,labo2	did sysea request print
	jsr prtst	print text from sysea
<i>fi</i>		
labo2	jsr ermsg	print error message
	zer xr	indicate no message to print
	brn stopr	jump to routine to stop run
*		
*	here if no error had occurred	
*		
labo3	erb 036,goto abort with	no preceding error

```

*
*      continue
*
l$cnt  ent                                entry point
*
*      merge here after execution error
*
lcnt1  mov  r$cnt,xr                      load continuation code block ptr
      bze  xr,lcnt3                      jump if no previous error
      zer  r$cnt                          clear flag
      mov  xr,r$cod                      else store as new code block ptr
      bne  (xr),=b$cdc,lcnt2             jump if not complex go
      mov  stxoc,wa                      get offset of error
      bge  wa,stxof,lcnt4                jump if error in goto evaluation
*
*      here if error did not occur in complex failure goto
*
lcnt2  add  stxof,xr                      add failure offset
      lcp  xr                             load code pointer
      mov  flptr,xs                      reset stack pointer
      lcw  xr                             get next code word
      bri  (xr)                          execute next code word
*
*      here if no previous error
*
lcnt3  icv  errft                          fatal error
      erb  037,goto continue              with no preceding error
*
*      here if error in evaluation of failure goto.
*      cannot continue back to failure goto!
*
lcnt4  icv  errft                          fatal error
      erb  332,goto continue              with error in failure goto

```

```

*
*      end
*
l$end  ent                                entry point
*
*      merge here from end code circuit
*
lend0  mov  =endms,xr                    point to message /normal term.../
      brn  stopr                        jump to routine to stop run

```

	*		
	*	freturn	
	*		
l\$frt	ent		entry point
	mov	=scfrt,wa	point to string /freturn/
	brn	retrn	jump to common return routine

	*		
	*	nreturn	
	*		
l\$nr	ent		entry point
	mov	=scrt,wa	point to string /nreturn/
	brn	retrn	jump to common return routine

	*		
	*	return	
	*		
l\$rtn	ent		entry point
	mov	=scrtn,wa	point to string /return/
	brn	retrn	jump to common return routine

```

*
*      scontinue
*
l$scn  ent          entry point
      mov  r$cnt,xr  load continuation code block ptr
      bze  xr,lscn2  jump if no previous error
      zer  r$cnt      clear flag
      bne  kvert,=nm320,lscn1  error must be user interrupt
      beq  kvert,=nm321,lscn2  detect scontinue loop
      mov  xr,r$cod   else store as new code block ptr
      add  stxoc,xr   add resume offset
      lcp  xr         load code pointer
      lcw  xr         get next code word
      bri  (xr)       execute next code word

*
*      here if no user interrupt
*
lscn1  icv  errft     fatal error
      erb  331,goto scontinue  with no user interrupt

*
*      here if in scontinue loop or if no previous error
*
lscn2  icv  errft     fatal error
      erb  321,goto scontinue  with no preceding error

```



```

*
*      undefined label
*
l$und  ent      entry point
      erb  038,goto undefined  label

```

spitbol – predefined snobol4 functions

```
*
*
*   the following section contains coding for functions
*   which are predefined and available at the snobol level.
*
*   these routines receive control directly from the code or
*   indirectly through the o$fnc, o$fns or cfunc routines.
*   in both cases the conditions on entry are as follows
*
*   the arguments are on the stack. the number of arguments
*   has been adjusted to correspond to the svblk svnar field.
*
*   in certain functions the direct call is not permitted
*   and in these instances we also have.
*
*   (wa)                actual number of arguments in call
*
*   control returns by placing the function result value on
*   on the stack and continuing execution with the next
*   word from the generated code.
*
*   the names of the entry points of these functions are of
*   the form s$xxx where xxx is the three letter code for
*   the system variable name. the functions are in order
*   alphabetically by their entry names.
```

```

if .c370
*
*      abs
*
s$abs  ent                    entry point
      mov  (xs)+,xr          get argument
      jsr  gtnum             make numeric
      err  xxx,abs argument  not numeric
if .cnra
else
      beq  wa,=b$rcl,sabs1    jump if real
fi

      ldi  icval(xr)          load integer value
      ige  exixr             no change if not negative
      ngi                     produce absolute value
      ino  exint             return integer if no overflow
      erb  xxx,abs caused integer overflow
if .cnra
else
*
*      here to process real argument
*
sabs1  ldr  rcval(xr)         load real value
      rge  exixr             no change if not negative
      ngr                     produce absolute value
      rno  exrea            return real if no overflow
      erb  xxx,abs caused real overflow
fi
fi

if .c370
*
*      and
*
s$and  ent                    entry point
      mnz  wb               signal two arguments
      jsr  sbool            call string boolean routine
      err  xxx,and first argument  is not a string
      err  xxx,and second argument  is not a string
      err  xxx,and arguments       not same length
      ppm  exits            null string arguments
*
*      here to process (wc) words.  result is stacked.
*
sand1  mov  (x1)+,wa          get next cfp$c chars from arg 1
      anb  (xr),wa           and with characters from arg 2
      mov  wa,(xr)+          put back in memory
      bct  wc,sand1          loop over all words in string block
      brn  exits            fetch next code word

```

fi

*
*
*

any

s\$any ent
 mov =p\$ans,wb
 mov =p\$any,xl
 mov =p\$ayd,wc
 jsr patst
 err 059,any argument
 mov xr,-(xs)
 lcw xr
 bri (xr)

entry point
set pcode for single char case
pcode for multi-char case
pcode for expression case
call common routine to build node
is not a string or expression
stack result
get next code word
execute it

<i>if .cnbf</i>	
<i>else</i>	
*	
* append	
*	
s\$apn ent	entry point
mov (xs)+,x1	get append argument
mov (xs)+,xr	get bcbk
beq (xr),=b\$bct,sapn1	ok if first arg is bcbk
erb 275,append first	argument is not a buffer
*	
* here to do the append	
*	
sapn1 jsr apndb	do the append
err 276,append second	argument is not a string
ppm exfal	no room - fail
brn exnul	exit with null result

fi

```

*
*      apply
*
*      apply does not permit the direct (fast) call so that
*      wa contains the actual number of arguments passed.
*
s$app  ent                      entry point
      bze  wa,sapp3             jump if no arguments
      dcv  wa                   else get applied func arg count
      mov  wa,wb                copy
      wtb  wb                   convert to bytes
      mov  xs,xt                copy stack pointer
      add  wb,xt                point to function argument on stack
      mov  (xt),xr              load function ptr (apply 1st arg)
      bze  wa,sapp2             jump if no args for applied func
      lct  wb,wa                else set counter for loop

*
*      loop to move arguments up on stack
*
sapp1  dca  xt                  point to next argument
      mov  (xt),num01(xt)       move argument up
      bct  wb,sapp1             loop till all moved

*
*      merge here to call function (wa = number of arguments)
*
sapp2  ica  xs                  adjust stack ptr for apply 1st arg
      jsr  gtnvr                get variable block addr for func
      ppm  sapp3                jump if not natural variable
      mov  vrfnc(xr),xl         else point to function block
      brn  cfunc                go call applied function

*
*      here for invalid first argument
*
sapp3  erb  060,apply first arg is not natural variable name

```

```

*
*      arbno
*
*      arbno builds a compound pattern. see description at
*      start of pattern matching section for structure formed.
*
s$abn  ent          entry point
      zer  xr          set parm1 = 0 for the moment
      mov  =p$alt,wb    set pcode for alternative node
      jsr  pbild        build alternative node
      mov  xr,xl        save ptr to alternative pattern
      mov  =p$abc,wb    pcode for p$abc
      zer  xr          p0blk
      jsr  pbild        build p$abc node
      mov  xl,pthen(xr) put alternative node as successor
      mov  xl,wa        remember alternative node pointer
      mov  xr,xl        copy p$abc node ptr
      mov  (xs),xr      load arbno argument
      mov  wa,(xs)      stack alternative node pointer
      jsr  gtpat        get arbno argument as pattern
      err  061,arbno argument is not pattern
      jsr  pconc        concat arg with p$abc node
      mov  xr,xl        remember ptr to concd patterns
      mov  =p$aab,wb    pcode for p$aab
      zer  xr          p0blk
      jsr  pbild        build p$aab node
      mov  xl,pthen(xr) concatenate nodes
      mov  (xs),xl      recall ptr to alternative node
      mov  xr,parm1(xl) point alternative back to argument
      lcw  xr          get next code word
      bri  (xr)        execute next code word

```

<pre> * * arg * s\$arg ent jsr gtsmi err 062,arg second argument ppm exfal mov xr,wa mov (xs)+,xr jsr gtnvr ppm sarg1 mov vrfnc(xr),xr bne (xr),=b\$pfc,sarg1 bze wa,exfal bgt wa,fargs(xr),exfal wtb wa add wa,xr mov pfagb(xr),xr brn exvnm * * here if 1st argument is bad * sarg1 erb 063,arg first argument </pre>	<pre> entry point get second arg as small integer is not integer fail if out of range or negative save argument number load first argument locate vrbk jump if not natural variable else load function block pointer jump if not program defined fail if arg number is zero fail if arg number is too large else convert to byte offset point to argument selected load argument vrbk pointer exit to build nmbk is not program function name </pre>
--	---


```

*
*      array
*
s$arr  ent          entry point
      mov  (xs)+,x1  load initial element value
      mov  (xs)+,xr  load first argument
      jsr  gtint     convert first arg to integer
      ppm  sar02     jump if not integer

*
*      here for integer first argument, build vcbk
*
      ldi  icval(xr) load integer value
      ile  sar10     jump if zero or neg (bad dimension)
      mfi  wa,sar11  else convert to one word, test ovfl
      jsr  vmake     create vector
      ppm  sar11     fail if too large
      brn  exsid     exit setting idval

```

```

*
*      array (continued)
*
*      here if first argument is not an integer
*
sar02  mov  xr,-(xs)           replace argument on stack
      jsr  xscni             initialize scan of first argument
      err  064,array first argument is not integer or string
      ppm  exnul             dummy (unused) null string exit
      mov  r$psc,-(xs)       save prototype pointer
      mov  xl,-(xs)         save default value
      zer  arcdm             zero count of dimensions
      zer  arptr             zero offset to indicate pass one
      ldi  intv1             load integer one
      sti  arnel             initialize element count

*
*      the following code is executed twice. the first time
*      (arptr eq 0), it is used to count the number of elements
*      and number of dimensions. the second time (arptr gt 0) is
*      used to actually fill in the dim,lbd fields of the arblk.
*
sar03  ldi  intv1             load one as default low bound
      sti  arsvl             save as low bound
      mov  =ch$cl,wc         set delimiter one = colon
      mov  =ch$cm,xl         set delimiter two = comma
      zer  wa                retain blanks in prototype
      jsr  xscan             scan next bound
      bne  wa,=num01,sar04   jump if not colon

*
*      here we have a colon ending a low bound
*
      jsr  gtint             convert low bound
      err  065,array first argument lower bound is not integer
      ldi  icval(xr)         load value of low bound
      sti  arsvl             store low bound value
      mov  =ch$cm,wc         set delimiter one = comma
      mov  wc,xl             and delimiter two = comma
      zer  wa                retain blanks in prototype
      jsr  xscan             scan high bound

```

```

*
*      array (continued)
*
*      merge here to process upper bound
*
sar04  jsr   gtint           convert high bound to integer
      err   066,array first argument   upper bound is not integer
      ldi   icval(xr)        get high bound
      sbi   arsvl           subtract lower bound
      iov   sar10           bad dimension if overflow
      ilt   sar10           bad dimension if negative
      adi   intv1           add 1 to get dimension
      iov   sar10           bad dimension if overflow
      mov   arptr,xl        load offset (also pass indicator)
      bze   xl,sar05        jump if first pass

*
*      here in second pass to store lbd and dim in arblk
*
      add   (xs),xl         point to current location in arblk
      sti   cfp$(xl)        store dimension
      ldi   arsvl           load low bound
      sti   (xl)            store low bound
      add   *ardms,arptr    bump offset to next bounds
      brn   sar06           jump to check for end of bounds

*
*      here in pass 1
*
sar05  icv   arcdm          bump dimension count
      mli   arnel          multiply dimension by count so far
      iov   sar11          too large if overflow
      sti   arnel          else store updated element count

*
*      merge here after processing one set of bounds
*
sar06  bnz   wa,sar03       loop back unless end of bounds
      bnz   arptr,sar09    jump if end of pass 2

```

```

*
*      array (continued)
*
*      here at end of pass one, build arblk
*
      ldi   arnel                get number of elements
      mfi   wb,sar11             get as addr integer, test ovflo
      wtb   wb                   else convert to length in bytes
      mov   *arsl$,wa            set size of standard fields
      lct   wc,arcdm             set dimension count to control loop
*
*      loop to allow space for dimensions
*
sar07  add   *ardms,wa           allow space for one set of bounds
      bct   wc,sar07            loop back till all accounted for
      mov   wa,xl               save size (=arofs)
*
*      now allocate space for arblk
*
      add   wb,wa               add space for elements
      ica   wa                  allow for arpro prototype field
      bgt   wa,mxlen,sar11      fail if too large
      jsr   alloc               else allocate arblk
      mov   (xs),wb             load default value
      mov   xr,(xs)             save arblk pointer
      mov   wa,wc               save length in bytes
      btw   wa                  convert length back to words
      lct   wa,wa               set counter to control loop
*
*      loop to clear entire arblk to default value
*
sar08  mov   wb,(xr)+           set one word
      bct   wa,sar08            loop till all set

```

```

*
*      array (continued)
*
*      now set initial fields of arblk
*
      mov  (xs)+,xr          reload arblk pointer
      mov  (xs),wb           load prototype
      mov  =b$art,(xr)       set type word
      mov  wc,arlen(xr)      store length in bytes
      zer  idval(xr)         zero id till we get it built
      mov  xl,arofs(xr)      set prototype field ptr
      mov  arcdm,arndm(xr)   set number of dimensions
      mov  xr,wc             save arblk pointer
      add  xl,xr             point to prototype field
      mov  wb,(xr)           store prototype ptr in arblk
      mov  *arlbld,arptra    set offset for pass 2 bounds scan
      mov  wb,r$xsc          reset string pointer for xscan
      mov  wc,(xs)           store arblk pointer on stack
      zer  xsofs             reset offset ptr to start of string
      brn  sar03             jump back to rescan bounds
*
*      here after filling in bounds information (end pass two)
*
sar09  mov  (xs)+,xr          reload pointer to arblk
      brn  exsid             exit setting idval
*
*      here for bad dimension
*
sar10  erb  067,array dimension      is zero, negative or out of range
*
*      here if array is too large
*
sar11  erb  068,array size exceeds   maximum permitted

```

if .cmth

*
*
*

atan

s\$atn ent
 mov (xs)+,xr
 jsr gtrea
 err 301,atan argument
 ldr rcval(xr)
 atn
 brn exrea

entry point
get argument
convert to real
not numeric
load accumulator with argument
take arctangent
overflow, out of range not possible

f_t

if .cbsp

	*		
	*	backspace	
	*		
s\$bsp	ent		entry point
	jsr	iofcb	call feblk routine
	err	316,backspace argument	is not a suitable name
	err	316,backspace argument	is not a suitable name
	err	317,backspace file	does not exist
	jsr	sysbs	call backspace file function
	err	317,backspace file	does not exist
	err	318,backspace file	does not permit backspace
	err	319,backspace caused	non-recoverable error
	brn	exnul	return null as result

fi

if .cnbf

else

```

    *
    *      buffer
    *
s$buf  ent      entry point
      mov  (xs)+,xl      get initial value
      mov  (xs)+,xr      get requested allocation
      jsr  gtint          convert to integer
      err  269,buffer first      argument is not integer
      ldi  icval(xr)      get value
      ile  sbf01          branch if negative or zero
      mfi  wa,sbf02       move with overflow check
      jsr  alobf          allocate the buffer
      jsr  apndb          copy it in
      err  270,buffer second      argument is not a string or buffer
      err  271,buffer initial      value too big for allocation
      brn  exsid          exit setting idval

    *
    *      here for invalid allocation size
    *
sbf01  erb  272,buffer first      argument is not positive

    *
    *      here for allocation size integer overflow
    *
sbf02  erb  273,buffer size exceeds      value of maxlngh keyword
```

fi

*		
*	break	
*		
s\$brk	ent	entry point
	mov =p\$bks,wb	set pcode for single char case
	mov =p\$brk,xl	pcode for multi-char case
	mov =p\$bkd,wc	pcode for expression case
	jsr patst	call common routine to build node
	err 069,break argument	is not a string or expression
	mov xr,-(xs)	stack result
	lcw xr	get next code word
	bri (xr)	execute it

```

*
*      breakx
*
*      breakx is a compound pattern. see description at start
*      of pattern matching section for structure formed.
*
s$bkx  ent                      entry point
        mov  =p$bks,wb          pcode for single char argument
        mov  =p$brk,xl          pcode for multi-char argument
        mov  =p$bxd,wc          pcode for expression case
        jsr  patst              call common routine to build node
        err  070,breakx argument is not a string or expression
*
*      now hook breakx node on at front end
*
        mov  xr,-(xs)           save ptr to break node
        mov  =p$bkx,wb          set pcode for breakx node
        jsr  pbild              build it
        mov  (xs),pthen(xr)     set break node as successor
        mov  =p$alt,wb          set pcode for alternation node
        jsr  pbild              build (parml=alt=breakx node)
        mov  xr,wa              save ptr to alternation node
        mov  (xs),xr            point to break node
        mov  wa,pthen(xr)       set alternate node as successor
        lcw  xr                 result on stack
        bri  (xr)               execute next code word

```

<pre> * * char * s\$chr ent jsr gtsmi err 281,char argument ppm schr1 bge wc,=cfp\$a,schr1 mov =num01,wa mov wc,wb jsr alocs mov xr,xl psc xl sch wb,(xl) csc xl zer xl mov xr,-(xs) lcw xr bri (xr) * * here if char argument is out of range * schr1 erb 282,char argument </pre>	<pre> entry point convert arg to integer not integer too big error exit see if out of range of host set if not set scblk allocation save char code allocate 1 bau scblk copy scblk pointer get set to stuff char stuff it complete store character clear slop in xl stack result get next code word execute it not in range </pre>
--	---

if .cmth

*

*

chop

*

s\$chp

ent

mov (xs)+,xr

jsr gtrea

err 302,chop argument

ldr rcval(xr)

chp

brn exrea

entry point

get argument

convert to real

not numeric

load accumulator with argument

truncate to integer valued real

no overflow possible

fi

```

*
*      clear
*
s$clr  ent          entry point
      jsr  xscni     initialize to scan argument
      err  071,clear argument  is not a string
      ppm  sclr2     jump if null
*
*      loop to scan out names in first argument. variables in
*      the list are flagged by setting vrget of vrbk to zero.
*
sclr1  mov  =ch$cm,wc  set delimiter one = comma
      mov  wc,xl       delimiter two = comma
      mnz  wa         skip/trim blanks in prototype
      jsr  xscan       scan next variable name
      jsr  gtnvr       locate vrbk
      err  072,clear argument  has null variable name
      zer  vrget(xr)   else flag by zeroing vrget field
      bnz  wa,sclr1    loop back if stopped by comma
*
*      here after flagging variables in argument list
*
sclr2  mov  hshtb,wb   point to start of hash table
*
*      loop through slots in hash table
*
sclr3  beq  wb,hshte,exnul  exit returning null if none left
      mov  wb,xr         else copy slot pointer
      ica  wb            bump slot pointer
      sub  *vrnxt,xr     set offset to merge into loop
*
*      loop through vrbks on one hash chain
*
sclr4  mov  vrnxt(xr),xr  point to next vrbk on chain
      bze  xr,sclr3      jump for next bucket if chain end
      bnz  vrget(xr),sclr5  jump if not flagged

```

```

*
*      clear (continued)
*
*      here for flagged variable, do not set value to null
*
      jsr  setvr                      for flagged var, restore vrget
      brn  sclr4                      and loop back for next vrbk
*
*      here to set value of a variable to null
*      protected variables (arb, etc) are exempt
*
sclr5  beq  vrsto(xr),=b$vre,sclr4    check for protected variable
      mov  xr,xl                     copy vrbk pointer
*
*      loop to locate value at end of possible trblk chain
*
sclr6  mov  xl,wa                     save block pointer
      mov  vrval(xl),xl               load next value field
      beq  (xl),=b$trt,sclr6          loop back if trapped
*
*      now store the null value
*
      mov  wa,xl                     restore block pointer
      mov  =nulls,vrval(xl)           store null constant value
      brn  sclr4                      loop back for next vrbk

```

	*		
	*	code	
	*		
s\$cod	ent		entry point
	mov	(xs)+,xr	load argument
	jsr	gtcod	convert to code
	ppm	exfal	fail if conversion is impossible
	mov	xr,-(xs)	stack result
	zer	r\$ccb	forget interim code block
	lcw	xr	get next code word
	bri	(xr)	execute it

*		
*	collect	
*		
s\$col	ent	entry point
	mov (xs)+,xr	load argument
	jsr gtint	convert to integer
	err 073,collect argument	is not integer
	ldi icval(xr)	load collect argument
	sti clsvi	save collect argument
	zer wb	set no move up
	zer r\$ccb	forget interim code block
<i>if .csed</i>		
	zer dnams	collect sediment too
	jsr gbcol	perform garbage collection
	mov xr,dnams	record new sediment size
<i>else</i>		
	jsr gbcol	perform garbage collection
<i>fi</i>		
	mov dname,wa	point to end of memory
	sub dnamp,wa	subtract next location
	btw wa	convert bytes to words
	mti wa	convert words available as integer
	sbi clsvi	subtract argument
	iov exfal	fail if overflow
	ilt exfal	fail if not enough
	adi clsvi	else recompute available
	brn exint	and exit with integer result

if .c370

<pre> * * compl * s\$cmp ent zer wb jsr sbool ppm err xxx,compl argument ppm ppm exits * * here to process (wa) characters. result is stacked. * lct wc,wa plc xl psc xr scmp1 lch wa,(xl)+ cmb wa sch wa,(xr)+ bct wc,scmp1 csc brn exits </pre>	<pre> entry point signal one argument call string boolean routine only one argument, cannot get here is not a string cannot have two strings unequal null string argument prepare count prepare to load chars from (xl) prepare to store chars into (xr) get next char from arg 1 complement store into result loop over all chars in string block complete store character fetch next code word. </pre>
---	---

```

fi
*
*      convert
*
s$cnv  ent          entry point
      jsr  gtstg     convert second argument to string
      ppm  scv29     error if second argument not string
      bze  wa,scv29  or if null string
if .culc
      jsr  flstg     fold lower case to upper case
fi

      mov  (xs),xl   load first argument
      bne  (xl),=b$pd,scv01  jump if not program defined
*
*      here for program defined datatype
*
      mov  pddfp(xl),xl  point to dfblk
      mov  dfnam(xl),xl  load datatype name
      jsr  ident        compare with second arg
      ppm  exits        exit if ident with arg as result
      brn  exfal        else fail
*
*      here if not program defined datatype
*
scv01  mov  xr,-(xs)    save string argument
      mov  =svctb,xl   point to table of names to compare
      zer  wb          initialize counter
      mov  wa,wc       save length of argument string
*
*      loop through table entries
*
scv02  mov  (xl)+,xr    load next table entry, bump pointer
      bze  xr,exfal    fail if zero marking end of list
      bne  wc,sclen(xr),scv05  jump if wrong length
      mov  xl,cnvtp    else store table pointer
      plc  xr          point to chars of table entry
      mov  (xs),xl     load pointer to string argument
      plc  xl          point to chars of string arg
      mov  wc,wa       set number of chars to compare
      cmc  scv04,scv04 compare, jump if no match

```

```

*
*      convert (continued)
*
*      here we have a match
*
scv03  mov  wb,xl          copy entry number
      ica  xs             pop string arg off stack
      mov  (xs)+,xr        load first argument
      bsw  xl,cnvtt        jump to appropriate routine
      iff  0,scv06         string
      iff  1,scv07         integer
      iff  2,scv09         name
      iff  3,scv10         pattern
      iff  4,scv11         array
      iff  5,scv19         table
      iff  6,scv25         expression
      iff  7,scv26         code
      iff  8,scv27         numeric

if .cnra
else
      iff  cnvrt,scv08     real
fi

if .cnbf
else
      iff  cnvbt,scv28     buffer
fi

      esw                 end of switch table

*
*      here if no match with table entry
*
scv04  mov  cnvtp,xl       restore table pointer, merge
*
*      merge here if lengths did not match
*
scv05  icv  wb             bump entry number
      brn  scv02           loop back to check next entry

*
*      here to convert to string
*
scv06  mov  xr,-(xs)        replace string argument on stack
      jsr  gtstg           convert to string
      ppm  exfal           fail if conversion not possible
      mov  xr,-(xs)        stack result
      lcw  xr              get next code word
      bri  (xr)            execute it

```

```

*
*      convert (continued)
*
*      here to convert to integer
*
scv07  jsr  gtint          convert to integer
        ppm  exfal        fail if conversion not possible
        mov  xr,-(xs)      stack result
        lcw  xr           get next code word
        bri  (xr)         execute it

if .cnra
else
*
*      here to convert to real
*
scv08  jsr  gtrea          convert to real
        ppm  exfal        fail if conversion not possible
        mov  xr,-(xs)      stack result
        lcw  xr           get next code word
        bri  (xr)         execute it

fi
*
*      here to convert to name
*
scv09  beq  (xr),=b$nm1,exixr  return if already a name
        jsr  gtnvr        else try string to name convert
        ppm  exfal        fail if conversion not possible
        brn  exvnm        else exit building nmbk for vrbk

*
*      here to convert to pattern
*
scv10  jsr  gtpat          convert to pattern
        ppm  exfal        fail if conversion not possible
        mov  xr,-(xs)      stack result
        lcw  xr           get next code word
        bri  (xr)         execute it

*
*      convert to array
*
*      if the first argument is a table, then we go through
*      an intermediate array of addresses that is sorted to
*      provide a result ordered by time of entry in the
*      original table.  see c3.762.
*
scv11  mov  xr,-(xs)      save argument on stack
        zer  wa           use table chain block addresses
        jsr  gtarr        get an array
        ppm  exfal        fail if empty table
        ppm  exfal        fail if not convertible
        mov  (xs)+,x1     reload original arg

```

	bne (x1),=b\$tbtt,exsid	exit if original not a table
	mov xr,-(xs)	sort the intermediate array
	mov =nulls,-(xs)	on first column
	zer wa	sort ascending
	jsr sorta	do sort
	ppm exfal	if sort fails, so shall we
	mov xr,wb	save array result
	ldi ardim(xr)	load dim 1 (number of elements)
	mfi wa	get as one word integer
	lct wa,wa	copy to control loop
	add *arv12,xr	point to first element in array
	 *	
	 * here for each row of this 2-column array	
	 *	
scv12	mov (xr),x1	get teblk address
	mov tesub(x1),(xr)+	replace with subscript
	mov teval(x1),(xr)+	replace with value
	bct wa,scv12	loop till all copied over
	mov wb,xr	retrieve array address
	brn exsid	exit setting id field
	 *	
	 * convert to table	
	 *	
scv19	mov (xr),wa	load first word of block
	mov xr,-(xs)	replace arblk pointer on stack
	beq wa,=b\$tbtt,exits	return arg if already a table
	bne wa,=b\$art,exfal	else fail if not an array

```

*
*      convert (continued)
*
*      here to convert an array to table
*
    bne  arndm(xr),=num02,exfal      fail if not 2-dim array
    ldi  ardm2(xr)                  load dim 2
    sbi  intv2                      subtract 2 to compare
    ine  exfal                      fail if dim2 not 2
*
*      here we have an arblk of the right shape
*
    ldi  ardim(xr)                  load dim 1 (number of elements)
    mfi  wa                        get as one word integer
    lct  wb,wa                     copy to control loop
    add  =tbsi$,wa                 add space for standard fields
    wtb  wa                        convert length to bytes
    jsr  alloc                     allocate space for tbbk
    mov  xr,wc                     copy tbbk pointer
    mov  xr,-(xs)                  save tbbk pointer
    mov  =b$tb, (xr)+              store type word
    zer  (xr)+                     store zero for idval for now
    mov  wa, (xr)+                 store length
    mov  =nulls, (xr)+             null initial lookup value
*
*      loop to initialize bucket ptrs to point to table
*
scv20  mov  wc, (xr)+              set bucket ptr to point to tbbk
       bct  wb,scv20              loop till all initialized
       mov  *arv12,wb             set offset to first arblk element
*
*      loop to copy elements from array to table
*
scv21  mov  num01(xs),x1           point to arblk
       beq  wb,arlen(x1),scv24    jump if all moved
       add  wb,x1                 else point to current location
       add  *num02,wb             bump offset
       mov  (x1),xr              load subscript name
       dca  x1                   adjust ptr to merge (trval=1+1)

```

```

*
*      convert (continued)
*
*      loop to chase down trblk chain for value
*
scv22  mov  trval(xl),xl          point to next value
      beq  (xl),=b$trt,scv22      loop back if trapped
*
*      here with name in xr, value in xl
*
scv23  mov  xl,-(xs)              stack value
      mov  num01(xs),xl          load tbbk pointer
      jsr  tfind                 build teblk (note wb gt 0 by name)
      ppm  exfal                 fail if access fails
      mov  (xs)+,teval(xl)       store value in teblk
      brn  scv21                 loop back for next element
*
*      here after moving all elements to tbbk
*
scv24  mov  (xs)+,xr              load tbbk pointer
      ica  xs                    pop arblk pointer
      brn  exsid                 exit setting idval
*
*      convert to expression
*
if .cevb
scv25  zer  wb                    by value
      jsr  gtexp                 convert to expression
else
scv25  jsr  gtexp                 convert to expression
fi

      ppm  exfal                 fail if conversion not possible
      zer  r$ccb                 forget interim code block
      mov  xr,-(xs)              stack result
      lcw  xr                    get next code word
      bri  (xr)                  execute it
*
*      convert to code
*
scv26  jsr  gtcod                 convert to code
      ppm  exfal                 fail if conversion is not possible
      zer  r$ccb                 forget interim code block
      mov  xr,-(xs)              stack result
      lcw  xr                    get next code word
      bri  (xr)                  execute it
*
*      convert to numeric
*
scv27  jsr  gtnum                 convert to numeric
      ppm  exfal                 fail if unconvertible

```



```
scv31  mov  xr,-(xs)
        lw   xr
        bri  (xr)
```

```
stack result
get next code word
execute it
```

```

if .cnbf
else
    *
    *      convert to buffer
    *
scv28  mov  xr,-(xs)          stack first arg for procedure
      jsr  gtstb             get string or buffer
      ppm  exfal            fail if conversion not possible
      bnz  wb,scv30         jump if already a buffer
      mov  xr,xl            save string pointer
      jsr  alobf            allocate buffer of same size
      jsr  apndb            copy in the string
      ppm                      already string - cant fail to cnv
      ppm                  must be enough room
      brn  exsid            exit setting idval field

    *
    *      here if argument is already a buffer
    *
scv30  mov  wb,xr            return buffer without conversion
      brn  scv31            merge to return result

```

fi

```

*
*      second argument not string or null
*
scv29  erb  074,convert second          argument is not a string
*
*      copy
*
s$cop  ent          entry point
      jsr  copyb    copy the block
      ppm  exits    return if no idval field
      brn  exsid    exit setting id value
```

if .cmth

*
*
*

cos

s\$cos ent
 mov (xs)+,xr
 jsr gtrea
 err 303,cos argument
 ldr rcval(xr)
 cos
 rno exrea
 erb 322,cos argument

entry point
get argument
convert to real
not numeric
load accumulator with argument
take cosine
if no overflow, return result in ra
is out of range

fi

```

*
*      data
*
s$dat  ent          entry point
      jsr   xscni    prepare to scan argument
      err   075,data argument  is not a string
      err   076,data argument  is null

*
*      scan out datatype name
*
      mov   =ch$pp,wc    delimiter one = left paren
      mov   wc,xl        delimiter two = left paren
      mnz   wa          skip/trim blanks in prototype
      jsr   xscan        scan datatype name
      bnz   wa,sdat1     skip if left paren found
      erb   077,data argument  is missing a left paren

*
*      here after scanning datatype name
*

if .culc
sdat1  mov   sclen(xr),wa    get length
      bze   wa,sdt1a        avoid folding if null string
      jsr   flstg           fold lower case to upper case
sdt1a  mov   xr,xl          save name ptr
else
sdat1  mov   xr,xl          save name ptr
fi

      mov   sclen(xr),wa    get length
      ctb   wa,scsi$        compute space needed
      jsr   alast          request static store for name
      mov   xr,-(xs)        save datatype name
      mvw                   copy name to static
      mov   (xs),xr         get name ptr
      zer   xl             scrub dud register
      jsr   gtnvr          locate vrbk for datatype name
      err   078,data argument  has null datatype name
      mov   xr,datdv       save vrbk pointer for datatype
      mov   xs,datxs       store starting stack value
      zer   wb             zero count of field names

*
*      loop to scan field names and stack vrbk pointers
*

sdat2  mov   =ch$rp,wc    delimiter one = right paren
      mov   =ch$cm,xl    delimiter two = comma
      mnz   wa          skip/trim blanks in prototype
      jsr   xscan        scan next field name
      bnz   wa,sdat3     jump if delimiter found
      erb   079,data argument  is missing a right paren
```

```

*
*      here after scanning out one field name
*
sdat3  jsr   gtnvr           locate vrbk for field name
      err   080,data argument   has null field name
      mov   xr,-(xs)          stack vrbk pointer
      icv   wb                increment counter
      beq   wa,=num02,sdat2    loop back if stopped by comma

```

```

*
*      data (continued)
*
*      now build the dfblk
*
      mov  =dfsi$,wa      set size of dfblk standard fields
      add  wb,wa           add number of fields
      wtb  wa             convert length to bytes
      mov  wb,wc           preserve no. of fields
      jsr  alast          allocate space for dfblk
      mov  wc,wb           get no of fields
      mov  datxs,xt        point to start of stack
      mov  (xt),wc         load datatype name
      mov  xr,(xt)         save dfblk pointer on stack
      mov  =b$dfc,(xr)+    store type word
      mov  wb,(xr)+        store number of fields (fargs)
      mov  wa,(xr)+        store length (dflen)
      sub  *pddfs,wa       compute pdblk length (for dfpdl)
      mov  wa,(xr)+        store pdblk length (dfpdl)
      mov  wc,(xr)+        store datatype name (dfnam)
      lct  wc,wb           copy number of fields
*
*      loop to move field name vrbk pointers to dfblk
*
sdat4  mov  -(xt),(xr)+    move one field name vrbk pointer
      bct  wc,sdat4        loop till all moved
*
*      now define the datatype function
*
      mov  wa,wc           copy length of pdblk for later loop
      mov  datdv,xr        point to vrbk
      mov  datxs,xt        point back on stack
      mov  (xt),xl         load dfblk pointer
      jsr  dffnc           define function

```

```

*
*      data (continued)
*
*      loop to build ffblds
*
*
*      notice that the ffblds are constructed in reverse order
*      so that the required offsets can be obtained from
*      successive decrementation of the pdblk length (in wc).
*
sdat5  mov  *ffsi$,wa          set length of ffbld
      jsr  alloc             allocate space for ffbld
      mov  =b$ffc,(xr)       set type word
      mov  =num01,fargs(xr)  store fargs (always one)
      mov  datxs,xt          point back on stack
      mov  (xt),ffdfp(xr)    copy dfblk ptr to ffbld
      dca  wc               decrement old dfpdl to get next ofs
      mov  wc,ffofs(xr)      set offset to this field
      zer  ffnxt(xr)         tentatively set zero forward ptr
      mov  xr,xl             copy ffbld pointer for dffnc
      mov  (xs),xr           load vrbld pointer for field
      mov  vrfnc(xr),xr      load current function pointer
      bne  (xr),=b$ffc,sdat6 skip if not currently a field func
*
*      here we must chain an old ffbld ptr to preserve it in the
*      case of multiple field functions with the same name
*
      mov  xr,ffnxt(xl)      link new ffbld to previous chain
*
*      merge here to define field function
*
sdat6  mov  (xs)+,xr         load vrbld pointer
      jsr  dffnc             define field function
      bne  xs,datxs,sdat5    loop back till all done
      ica  xs                pop dfblk pointer
      brn  exnul             return with null result

```


	*		
	*	datatype	
	*		
s\$ntp	ent		entry point
	mov	(xs)+,xr	load argument
	jsr	dtype	get datatype
	mov	xr,-(xs)	stack result
	lcw	xr	get next code word
	bri	(xr)	execute it

	*		
	*	date	
	*		
s\$dte	ent		entry point
	mov	(xs)+,xr	load argument
	jsr	gtint	convert to an integer
	err	330,date argument	is not integer
	jsr	sysdt	call system date routine
	mov	num01(xl),wa	load length for sbstr
	bze	wa,exnul	return null if length is zero
	zer	wb	set zero offset
	jsr	sbstr	use sbstr to build scblk
	mov	xr,-(xs)	stack result
	lcw	xr	get next code word
	bri	(xr)	execute it

```

*
*      define
*
s$def  ent          entry point
      mov  (xs)+,xr  load second argument
      zer  deflb     zero label pointer in case null
      beq  xr,=nulls,sdf01  jump if null second argument
      jsr  gtnvr     else find vrbk for label
      ppm  sdf12     jump if not a variable name
      mov  xr,deflb  else set specified entry

*
*      scan function name
*
sdf01  jsr  xscni     prepare to scan first argument
      err  081,define first  argument is not a string
      err  082,define first  argument is null
      mov  =ch$pp,wc   delimiter one = left paren
      mov  wc,xl       delimiter two = left paren
      mnz  wa          skip/trim blanks in prototype
      jsr  xscan       scan out function name
      bnz  wa,sdf02     jump if left paren found
      erb  083,define first  argument is missing a left paren

*
*      here after scanning out function name
*
sdf02  jsr  gtnvr     get variable name
      err  084,define first  argument has null function name
      mov  xr,defvr   save vrbk pointer for function nam
      zer  wb         zero count of arguments
      mov  xs,defxs   save initial stack pointer
      bnz  deflb,sdf03  jump if second argument given
      mov  xr,deflb   else default is function name

*
*      loop to scan argument names and stack vrbk pointers
*
sdf03  mov  =ch$rp,wc  delimiter one = right paren
      mov  =ch$cm,xl  delimiter two = comma
      mnz  wa          skip/trim blanks in prototype
      jsr  xscan       scan out next argument name
      bnz  wa,sdf04     skip if delimiter found
      erb  085,null arg name  or missing ) in define first arg.

```

```

*
*      define (continued)
*
*      here after scanning an argument name
*
sdf04  bne  xr,=nulls,sdf05          skip if non-null
      bze  wb,sdf06                  ignore null if case of no arguments
*
*      here after dealing with the case of no arguments
*
sdf05  jsr  gtnvr                    get vrbk pointer
      ppm  sdf03                    loop back to ignore null name
      mov  xr,-(xs)                  stack argument vrbk pointer
      icv  wb                        increment counter
      beq  wa,=num02,sdf03           loop back if stopped by a comma
*
*      here after scanning out function argument names
*
sdf06  mov  wb,defna                 save number of arguments
      zer  wb                        zero count of locals
*
*      loop to scan local names and stack vrbk pointers
*
sdf07  mov  =ch$cm,wc                set delimiter one = comma
      mov  wc,xl                    set delimiter two = comma
      mnz  wa                        skip/trim blanks in prototype
      jsr  xscan                     scan out next local name
      bne  xr,=nulls,sdf08           skip if non-null
      bze  wa,sdf09                  exit scan if end of string
*
*      here after scanning out a local name
*
sdf08  jsr  gtnvr                    get vrbk pointer
      ppm  sdf07                    loop back to ignore null name
      icv  wb                        if ok, increment count
      mov  xr,-(xs)                  stack vrbk pointer
      bnz  wa,sdf07                  loop back if stopped by a comma

```

```

*
*      define (continued)
*
*      here after scanning locals, build pfbld
*
sdf09  mov  wb,wa                copy count of locals
      add  defna,wa            add number of arguments
      mov  wa,wc              set sum args+locals as loop count
      add  =pfsi$,wa          add space for standard fields
      wtb  wa                 convert length to bytes
      jsr  alloc              allocate space for pfbld
      mov  xr,xl              save pointer to pfbld
      mov  =b$pfcr,(xr)+      store first word
      mov  defna,(xr)+        store number of arguments
      mov  wa,(xr)+           store length (pfen)
      mov  defvr,(xr)+        store vrbld ptr for function name
      mov  wb,(xr)+           store number of locals
      zer  (xr)+              deal with label later
      zer  (xr)+              zero pfctr
      zer  (xr)+              zero pftrr
      bze  wc,sdf11           skip if no args or locals
      mov  xl,wa              keep pfbld pointer
      mov  defxs,xt           point before arguments
      lct  wc,wc              get count of args+locals for loop

*
*      loop to move locals and args to pfbld
*
sdf10  mov  -(xt),(xr)+       store one entry and bump pointers
      bct  wc,sdf10          loop till all stored
      mov  wa,xl              recover pfbld pointer

```

	*		
	*	define (continued)	
	*		
	*	now deal with label	
	*		
sdf11	mov	defxs,xs	pop stack
	mov	deflb,pfcod(xl)	store label vrbk in pfbk
	mov	defvr,xr	point back to vrbk for function
	jsr	dffnc	define function
	brn	exnul	and exit returning null
	*		
	*	here for erroneous label	
	*		
sdf12	erb	086,define function	entry point is not defined label

	*		
	*	detach	
	*		
s\$det	ent		entry point
	mov	(xs)+,xr	load argument
	jsr	gtvar	locate variable
	err	087,detach argument	is not appropriate name
	jsr	dtach	detach i/o association from name
	brn	exnul	return null result

	*		
	*	differ	
	*		
s\$dif	ent		entry point
	mov	(xs)+,xr	load second argument
	mov	(xs)+,xl	load first argument
	jsr	ident	call ident comparison routine
	ppm	exfal	fail if ident
	brn	exnul	return null if differ

	*		
	*	dump	
	*		
s\$dmp	ent		entry point
	jsr	gtsmi	load dump arg as small integer
	err	088,dump argument	is not integer
	err	089,dump argument	is negative or too large
	jsr	dumpr	else call dump routine
	brn	exnul	and return null as result

*		
*	dupl	
*		
s\$dup	ent	entry point
	jsr gtsmi	get second argument as small integer
	err 090,dupl second argument	is not integer
	ppm sdup7	jump if negative or too big
	mov xr,wb	save duplication factor
	jsr gtstg	get first arg as string
	ppm sdup4	jump if not a string
*		
*	here for case of duplication of a string	
*		
	mti wa	acquire length as integer
	sti dupsi	save for the moment
	mti wb	get duplication factor as integer
	mli dupsi	form product
	iov sdup3	jump if overflow
	ieq exnul	return null if result length = 0
	mfi wa,sdup3	get as addr integer, check ovflo
*		
*	merge here with result length in wa	
*		
sdup1	mov xr,xl	save string pointer
	jsr alocs	allocate space for string
	mov xr,-(xs)	save as result pointer
	mov xl,wc	save pointer to argument string
	psc xr	prepare to store chars of result
	lct wb,wb	set counter to control loop
*		
*	loop through duplications	
*		
sdup2	mov wc,xl	point back to argument string
	mov sclen(xl),wa	get number of characters
	plc xl	point to chars in argument string
	mvc	move characters to result string
	bct wb,sdup2	loop till all duplications done
	zer xl	clear garbage value
	lcw xr	get next code word
	bri (xr)	execute next code word

```

*
*      dupl (continued)
*
*      here if too large, set max length and let alocs catch it
*
sdup3  mov  dname,wa          set impossible length for alocs
      brn  sdup1             merge back
*
*      here if not a string
*
sdup4  jsr  gtpat             convert argument to pattern
      err  091,dupl first argument  is not a string or pattern
*
*      here to duplicate a pattern argument
*
      mov  xr,-(xs)           store pattern on stack
      mov  =ndnth,xr          start off with null pattern
      bze  wb,sdup6           null pattern is result if dupfac=0
      mov  wb,-(xs)           preserve loop count
*
*      loop to duplicate by successive concatenation
*
sdup5  mov  xr,xl             copy current value as right argumnt
      mov  num01(xs),xr       get a new copy of left
      jsr  pconc              concatenate
      decv (xs)               count down
      bnz  (xs),sdup5         loop
      ica  xs                 pop loop count
*
*      here to exit after constructing pattern
*
sdup6  mov  xr,(xs)           store result on stack
      lcw  xr                 get next code word
      bri  (xr)               execute next code word
*
*      fail if second arg is out of range
*
sdup7  ica  xs                 pop first argument
      brn  exfal              fail

```

```

*
*      eject
*
s$ejc  ent      entry point
      jsr      ioxcb      call fcblk routine
      err      092,eject argument      is not a suitable name
      ppm      sejc1      null argument
      err      093,eject file does      not exist
      jsr      sysef      call eject file function
      err      093,eject file does      not exist
      err      094,eject file does      not permit page eject
      err      095,eject caused      non-recoverable output error
      brn      exnul      return null as result

*
*      here to eject standard output file
*
sejc1  jsr      sysep      call routine to eject printer
      brn      exnul      exit with null result

```

*		
*	endfile	
*		
s\$enf	ent	entry point
	jsr iofcb	call fcbk routine
	err 096,endfile argument	is not a suitable name
	err 097,endfile argument	is null
	err 098,endfile file	does not exist
	jsr sysen	call endfile routine
	err 098,endfile file	does not exist
	err 099,endfile file	does not permit endfile
	err 100,endfile caused	non-recoverable output error
	mov xl,wb	remember vrbk ptr from iofcb call
	mov xl,xr	copy pointer
*		
*	loop to find trtrf block	
*		
senf1	mov xr,xl	remember previous entry
	mov trval(xr),xr	chain along
	bne (xr),=b\$trt,exnul	skip out if chain end
	bne trtyp(xr),=trtfc,senf1	loop if not found
	mov trval(xr),trval(xl)	remove trtrf
	mov trtrf(xr),enfch	point to head of iochn
	mov trfpt(xr),wc	point to fcbk
	mov wb,xr	filearg1 vrbk from iofcb
	jsr setvr	reset it
	mov =r\$fcb,xl	ptr to head of fcbk chain
	sub *num02,xl	adjust ready to enter loop
*		
*	find fcbk	
*		
senf2	mov xl,xr	copy ptr
	mov num02(xl),xl	get next link
	bze xl,senf4	stop if chain end
	beq num03(xl),wc,senf3	jump if fcbk found
	brn senf2	loop
*		
*	remove fcbk	
*		
senf3	mov num02(xl),num02(xr)	delete fcbk from chain
*		
*	loop which detaches all vbks on iochn chain	
*		
senf4	mov enfch,xl	get chain head
	bze xl,exnul	finished if chain end
	mov trtrf(xl),enfch	chain along
	mov ionmo(xl),wa	name offset
	mov ionmb(xl),xl	name base
	jsr dtach	detach name
	brn senf4	loop till done

	*		
	*	eq	
	*		
s\$eqf	ent		entry point
	jsr	acom	call arithmetic comparison routine
	err	101,eq first argument	is not numeric
	err	102,eq second argument	is not numeric
	ppm	exfal	fail if lt
	ppm	exnul	return null if eq
	ppm	exfal	fail if gt

<pre> * * eval * s\$evl ent mov (xs)+,xr if .cevb else jsr gtexp err 103,eval argument fi lcw wc bne wc,=ofne\$,sevl1 scp xl mov (xl),wa bne wa,=ornm\$,sevl2 bnz num01(xs),sevl2 * * here if called by value * sevl1 zer wb if .cevb mov wc,-(xs) jsr gtexp err 103,eval argument zer r\$ccb zer wb else mov wc,-(xs) fi jsr evalx ppm exfal mov xr,xl mov (xs),xr mov xl,(xs) bri (xr) * * here if called by name * sevl2 mov =num01,wb if .cevb jsr gtexp err 103,eval argument zer r\$ccb mov =num01,wb fi jsr evalx ppm exfal brn exnam if .cnex else </pre>	<pre> entry point load argument convert to expression is not expression load next code word jump if called by value copy code pointer get next code word by name unless expression jump if by name set flag for by value save code word convert to expression is not expression forget interim code block set flag for by value save code word evaluate expression by value fail if evaluation fails copy result reload next code word stack result jump to execute next code word set flag for by name convert to expression is not expression forget interim code block set flag for by name evaluate expression by name fail if evaluation fails exit with name </pre>
---	--

*		
*	exit	
*		
s\$ext	ent	entry point
	zer wb	clear amount of static shift
	zer r\$ccb	forget interim code block
<i>if .csed</i>		
	zer dnams	collect sediment too
	jsr gbcol	compact memory by collecting
	mov xr, dnams	record new sediment size
<i>else</i>		
	jsr gbcol	compact memory by collecting
<i>fi</i>		
	jsr gbcol	compact memory by collecting
	err 288, exit second argument	is not a string
	mov xr, xl	copy second arg string pointer
	jsr gtstg	convert arg to string
	err 104, exit first argument	is not suitable integer or string
	mov xl, -(xs)	save second argument
	mov xr, xl	copy first arg string ptr
	jsr gtint	check it is integer
	ppm sext1	skip if unconvertible
	zer xl	note it is integer
	ldi icval(xr)	get integer arg
*		
*	merge to call osint exit routine	
*		
sext1	mov r\$fcb, wb	get fcbk chain header
	mov =headv, xr	point to v.v string
	mov (xs)+, wa	provide second argument scblk
	jsr sysxi	call external routine
	err 105, exit action not	available in this implementation
	err 106, exit action caused	irrecoverable error
	ieq exnul	return if argument 0
	igt sext2	skip if positive
	ngi	make positive
*		
*	check for option respecification	
*		
*	sysxi returns 0 in wa when a file has been resumed,	
*	1 when this is a continuation of an exit(4) or exit(-4)	
*	action.	
*		
sext2	mfi wc	get value in work reg
	add wc, wa	prepare to test for continue
	beq wa, =num05, sext5	continued execution if 4 plus 1
	zer gbcnt	resuming execution so reset
	bge wc, =num03, sext3	skip if was 3 or 4
	mov wc, -(xs)	save value
	zer wc	set to read options
	jsr prpar	read syspp options


```

        mov  (xs)+,wc                restore value
*
*      deal with header option (fiddled by prpar)
*
sext3  mnz  headp                    assume no headers
      bne  wc,=num01,sext4           skip if not 1
      zer  headp                     request header printing
*
*      almost ready to resume running
*
sext4  jsr  systm                    get execution time start (sgd11)
      sti  timsx                     save as initial time
      ldi  kvstc                     reset to ensure ...
      sti  kvstl                     ... correct execution stats
      jsr  stgcc                     recompute countdown counters
      brn  exnul                     resume execution
*
*      here after exit(4) or exit(-4) -- create save file
*      or load module and continue execution.
*
*      return integer 1 to signal the continuation of the
*      original execution.
*
sext5  mov  =inton,xr                integer one
      brn  exixr                     return as result
fi

```

if .cmth

*
*
*

exp

s\$exp ent
 mov (xs)+,xr
 jsr gtrea
 err 304,exp argument
 ldr rcval(xr)
 etx
 rno exrea
 erb 305,exp produced

entry point
get argument
convert to real
not numeric
load accumulator with argument
take exponential
if no overflow, return result in ra
real overflow

fi

```

*
*      field
*
s$fld  ent          entry point
      jsr  gtsmi      get second argument (field number)
      err  107,field second argument is not integer
      ppm  exfal      fail if out of range
      mov  xr,wb       else save integer value
      mov  (xs)+,xr    load first argument
      jsr  gtnvr      point to vrbk
      ppm  sfld1      jump (error) if not variable name
      mov  vrfnc(xr),xr else point to function block
      bne  (xr),=b$dfc,sfld1 error if not datatype function

*
*      here if first argument is a datatype function name
*
      bze  wb,exfal    fail if argument number is zero
      bgt  wb,fargs(xr),exfal fail if too large
      wtb  wb          else convert to byte offset
      add  wb,xr        point to field name
      mov  dfflb(xr),xr load vrbk pointer
      brn  exvnm       exit to build nmbk

*
*      here for bad first argument
*
sfld1  erb  108,field first argument is not datatype name

```

	*		
	*	fence	
	*		
s\$fnc	ent		entry point
	mov	=p\$fnc,wb	set pcode for p\$fnc
	zer	xr	p0blk
	jsr	pbild	build p\$fnc node
	mov	xr,xl	save pointer to it
	mov	(xs)+,xr	get argument
	jsr	gtpat	convert to pattern
	err	259,fence argument	is not pattern
	jsr	pconc	concatenate to p\$fnc node
	mov	xr,xl	save ptr to concatenated pattern
	mov	=p\$fna,wb	set for p\$fna pcode
	zer	xr	p0blk
	jsr	pbild	construct p\$fna node
	mov	xl,pthen(xr)	set pattern as pthen
	mov	xr,-(xs)	set as result
	lcw	xr	get next code word
	bri	(xr)	execute next code word

	*		
	*	ge	
	*		
s\$gef	ent		entry point
	jsr	acomp	call arithmetic comparison routine
	err	109,ge first argument	is not numeric
	err	110,ge second argument	is not numeric
	ppm	exfal	fail if lt
	ppm	exnul	return null if eq
	ppm	exnul	return null if gt

	*		
	*	gt	
	*		
s\$gtf	ent		entry point
	jsr	acomp	call arithmetic comparison routine
	err	111,gt first argument	is not numeric
	err	112,gt second argument	is not numeric
	ppm	exfal	fail if lt
	ppm	exfal	fail if eq
	ppm	exnul	return null if gt

<pre> * * host * s\$hst ent mov (xs)+,wc mov (xs)+,wb mov (xs)+,xr mov (xs)+,xl mov (xs)+,wa jsr syshs err 254,erroneous argument err 255,error during ppm shst1 ppm exnul ppm exixr ppm exfal ppm shst3 ppm shst4 </pre>	<pre> entry point get fifth arg get fourth arg get third arg get second arg get first arg enter syshs routine for host execution of host store host string return null result return xr fail return store actual string return copy of xr </pre>
<pre> * * return host string * shst1 bze xl,exnul mov sclen(xl),wa zer wb </pre>	<pre> null string if syshs uncooperative length zero offset </pre>
<pre> * * copy string and return * shst2 jsr sbstr mov xr,-(xs) lcw xr bri (xr) </pre>	<pre> build copy of string stack the result load next code word execute it </pre>
<pre> * * return actual string pointed to by xl * shst3 zer wb sub =cfp\$f,wb brn shst2 </pre>	<pre> treat xl like an scblk ptr by creating a negative offset join to copy string </pre>
<pre> * * return copy of block pointed to by xr * shst4 mov xr,-(xs) jsr copyb ppm exits brn exsid </pre>	<pre> stack results make copy of block if not an aggregate structure set current id value otherwise </pre>

	*		
	*	ident	
	*		
s\$idn	ent		entry point
	mov	(xs)+,xr	load second argument
	mov	(xs)+,xl	load first argument
	jsr	ident	call ident comparison routine
	ppm	exnul	return null if ident
	brn	exfal	fail if differ

	*		
	*	input	
	*		
s\$inp	ent		entry point
	zer	wb	input flag
	jsr	ioput	call input/output assoc. routine
	err	113,input third argument	is not a string
	err	114,inappropriate	second argument for input
	err	115,inappropriate	first argument for input
	err	116,inappropriate	file specification for input
	ppm	exfal	fail if file does not exist
	err	117,input file cannot	be read
	err	289,input channel	currently in use
	brn	exnul	return null string

<i>if .cnbf</i>		
<i>else</i>		
	*	
	*	insert
	*	
s\$ins	ent	entry point
	mov (xs)+,xl	get string arg
	jsr gtsmi	get replace length
	err 277,insert third	argument not integer
	ppm exfal	fail if out of range
	mov wc,wb	copy to proper reg
	jsr gtsmi	get replace position
	err 278,insert second	argument not integer
	ppm exfal	fail if out of range
	bze wc,exfal	fail if zero
	dcb wc	decrement to get offset
	mov wc,wa	put in proper register
	mov (xs)+,xr	get buffer
	beq (xr),=b\$bct,sins1	press on if type ok
	erb 279,insert first	argument is not a buffer
	*	
	*	here when everything loaded up
	*	
sins1	jsr insbf	call to insert
	err 280,insert fourth	argument is not a string
	ppm exfal	fail if out of range
	brn exnul	else ok - exit with null

fi

	*	
	*	integer
	*	
s\$int	ent	entry point
	mov (xs)+,xr	load argument
	jsr gtnum	convert to numeric
	ppm exfal	fail if non-numeric
	beq wa,=b\$ic1,exnul	return null if integer
	brn exfal	fail if real

```

*
*      item
*
*      item does not permit the direct (fast) call so that
*      wa contains the actual number of arguments passed.
*
s$itm  ent                      entry point
*
*      deal with case of no args
*
      bnz  wa,sitm1              jump if at least one arg
      mov  =nulls,-(xs)          else supply garbage null arg
      mov  =num01,wa             and fix argument count
*
*      check for name/value cases
*
sitm1  scp  xr                  get current code pointer
      mov  (xr),xl              load next code word
      dcw  wa                   get number of subscripts
      mov  wa,xr                copy for arref
      beq  xl,=ofne$,sitm2      jump if called by name
*
*      here if called by value
*
      zer  wb                   set code for call by value
      brn  arref                off to array reference routine
*
*      here for call by name
*
sitm2  mnz  wb                  set code for call by name
      lcw  wa                   load and ignore ofne$ call
      brn  arref                off to array reference routine

```

	*		
	*	le	
	*		
s\$lef	ent		entry point
	jsr	acom	call arithmetic comparison routine
	err	118,le first argument	is not numeric
	err	119,le second argument	is not numeric
	ppm	exnul	return null if lt
	ppm	exnul	return null if eq
	ppm	exfal	fail if gt

	*		
	*	len	
	*		
s\$len	ent		entry point
	mov	=p\$len,wb	set pcode for integer arg case
	mov	=p\$lnd,wa	set pcode for expr arg case
	jsr	patin	call common routine to build node
	err	120,len argument	is not integer or expression
	err	121,len argument	is negative or too large
	mov	xr,-(xs)	stack result
	lcw	xr	get next code word
	bri	(xr)	execute it

	*		
	*	leq	
	*		
s\$leq	ent		entry point
	jsr	lcomp	call string comparison routine
	err	122,leq first argument	is not a string
	err	123,leq second argument	is not a string
	ppm	exfal	fail if llt
	ppm	exnul	return null if leq
	ppm	exfal	fail if lgt

	*		
	*	lge	
	*		
s\$lge	ent		entry point
	jsr	lcomp	call string comparison routine
	err	124,lge first argument	is not a string
	err	125,lge second argument	is not a string
	ppm	exfal	fail if llt
	ppm	exnul	return null if leq
	ppm	exnul	return null if lgt

	*		
	*	lgt	
	*		
s\$lgt	ent		entry point
	jsr	lcomp	call string comparison routine
	err	126,lgt first argument	is not a string
	err	127,lgt second argument	is not a string
	ppm	exfal	fail if llt
	ppm	exfal	fail if leq
	ppm	exnul	return null if lgt

	*		
	*	lle	
	*		
s\$lle	ent		entry point
	jsr	lcomp	call string comparison routine
	err	128,lle first argument	is not a string
	err	129,lle second argument	is not a string
	ppm	exnul	return null if llt
	ppm	exnul	return null if leq
	ppm	exfal	fail if lgt

	*		
	*	llt	
	*		
s\$llt	ent		entry point
	jsr	lcomp	call string comparison routine
	err	130,llt first argument	is not a string
	err	131,llt second argument	is not a string
	ppm	exnul	return null if llt
	ppm	exfal	fail if leq
	ppm	exfal	fail if lgt

	*		
	*	lne	
	*		
s\$lne	ent		entry point
	jsr	lcomp	call string comparison routine
	err	132,lne first argument	is not a string
	err	133,lne second argument	is not a string
	ppm	exnul	return null if llt
	ppm	exfal	fail if leq
	ppm	exnul	return null if lgt

<i>if .cmth</i>		
	*	
	*	ln
	*	
s\$lnf	ent	entry point
	mov (xs)+,xr	get argument
	jsr gtrea	convert to real
	err 306,ln argument not	numeric
	ldr rcval(xr)	load accumulator with argument
	req slnf1	overflow if argument is 0
	rlt slnf2	error if argument less than 0
	lnf	take natural logarithm
	rno exrea	if no overflow, return result in ra
slnf1	erb 307,ln produced real	overflow
	*	
	*	here for bad argument
	*	
slnf2	erb 307,ln produced realreal	

fi

```

*
*      local
*
s$loc  ent          entry point
      jsr  gtsmi     get second argument (local number)
      err  134,local second argument is not integer
      ppm  exfal     fail if out of range
      mov  xr,wb      save local number
      mov  (xs)+,xr   load first argument
      jsr  gtnvr     point to vrbk
      ppm  sloc1     jump if not variable name
      mov  vrfnc(xr),xr else load function pointer
      bne  (xr),=b$pfc,sloc1 jump if not program defined

*
*      here if we have a program defined function name
*
      bze  wb,exfal   fail if second arg is zero
      bgt  wb,pfnlo(xr),exfal or too large
      add  fargs(xr),wb else adjust offset to include args
      wtb  wb         convert to bytes
      add  wb,xr      point to local pointer
      mov  pfagb(xr),xr load vrbk pointer
      brn  exvnm      exit building nmbk

*
*      here if first argument is no good
*
sloc1  erb  135,local first arg is not a program function name
if .cnld
else

```

```

*
*      load
*
s$lod  ent      entry point
      jsr  gtstg  load library name
      err  136,load second argument  is not a string
      mov  xr,xl  save library name
      jsr  xscni  prepare to scan first argument
      err  137,load first argument   is not a string
      err  138,load first argument   is null
      mov  xl,-(xs) stack library name
      mov  =ch$pp,wc set delimiter one = left paren
      mov  wc,xl  set delimiter two = left paren
      mnz  wa    skip/trim blanks in prototype
      jsr  xscan  scan function name
      mov  xr,-(xs) save ptr to function name
      bnz  wa,slod1 jump if left paren found
      erb  139,load first argument   is missing a left paren

*
*      here after successfully scanning function name
*
slod1  jsr  gtnvr  locate vrbk
      err  140,load first argument   has null function name
      mov  xr,lodfn save vrbk pointer
      zer  lodna  zero count of arguments

*
*      loop to scan argument datatype names
*
slod2  mov  =ch$rp,wc  delimiter one is right paren
      mov  =ch$cm,xl  delimiter two is comma
      mnz  wa    skip/trim blanks in prototype
      jsr  xscan  scan next argument name
      icv  lodna  bump argument count
      bnz  wa,slod3 jump if ok delimiter was found
      erb  141,load first argument   is missing a right paren

```

```

*
*      load (continued)
*
*      come here to analyze the datatype pointer in (xr). this
*      code is used both for arguments (wa=1,2) and for the
*      result datatype (with wa set to zero).
*
if .culc
slod3  mov  wa,wb                save scan mode
      mov  sclen(xr),wa          datatype length
      bze  wa,sld3a              bypass if null string
      jsr  flstg                 fold to upper case
sld3a  mov  wb,wa                restore scan mode
      mov  xr,-(xs)              stack datatype name pointer
else
slod3  mov  xr,-(xs)              stack datatype name pointer
fi

      mov  =num01,wb             set string code in case
      mov  =scstr,xl             point to /string/
      jsr  ident                 check for match
      ppm  slod4                 jump if match
      mov  (xs),xr               else reload name
      add  wb,wb                 set code for integer (2)
      mov  =scint,xl             point to /integer/
      jsr  ident                 check for match
      ppm  slod4                 jump if match
if .cnra
else
      mov  (xs),xr               else reload string pointer
      icv  wb                     set code for real (3)
      mov  =screa,xl             point to /real/
      jsr  ident                 check for match
      ppm  slod4                 jump if match
fi
if .cnlf
      mov  (xs),xr               reload string pointer
      icv  wb                     code for file (4, or 3 if no reals)
      mov  =scfil,xl             point to /file/
      jsr  ident                 check for match
      ppm  slod4                 jump if match
fi

      zer  wb                     else get code for no convert
*
*      merge here with proper datatype code in wb
*
slod4  mov  wb,(xs)              store code on stack
      beq  wa,=num02,slod2        loop back if arg stopped by comma
      bze  wa,slod5              jump if that was the result type
*
*      here we scan out the result type (arg stopped by ) )

```


*

```
mov  mxlen,wc
mov  wc,xl
mnz  wa
jsr  xscan
zer  wa
brn  slod3
```

```
set dummy (impossible) delimiter 1
and delimiter two
skip/trim blanks in prototype
scan result name
set code for processing result
jump back to process result name
```

```

*
*      load (continued)
*
*      here after processing all args and result
*
slod5  mov  lodna,wa           get number of arguments
      mov  wa,wc              copy for later
      wtb  wa                 convert length to bytes
      add  *efsi$,wa          add space for standard fields
      jsr  alloc              allocate efbk
      mov  =b$efc,(xr)        set type word
      mov  wc,fargs(xr)       set number of arguments
      zer  efuse(xr)          set use count (dffnc will set to 1)
      zer  efcod(xr)          zero code pointer for now
      mov  (xs)+,efrsl(xr)     store result type code
      mov  lodfn,efvar(xr)     store function vrbk pointer
      mov  wa,eflen(xr)       store efbk length
      mov  xr,wb              save efbk pointer
      add  wa,xr              point past end of efbk
      lct  wc,wc              set number of arguments for loop

*
*      loop to set argument type codes from stack
*
slod6  mov  (xs)+,-(xr)        store one type code from stack
      bct  wc,slod6           loop till all stored

*
*      now load the external function and perform definition
*
      mov  (xs)+,xr           load function string name
if .culc
      mov  sclen(xr),wa        function name length
      jsr  flstg              fold to upper case
fi

      mov  (xs),xl            load library name
      mov  wb,(xs)            store efbk pointer
      jsr  sysld              call function to load external func
      err  142,load function   does not exist
      err  143,load function   caused input error during load
      err  328,load function   - insufficient memory
      mov  (xs)+,xl            recall efbk pointer
      mov  xr,efcod(xl)        store code pointer
      mov  lodfn,xr            point to vrbk for function
      jsr  dffnc              perform function definition
      brn  exnul              return null result
fi

```

```

*
*      lpad
*
s$lpd  ent      entry point
      jsr      gtstg      get pad character
      err      144,lpad third argument      is not a string
      plc      xr      point to character (null is blank)
      lch      wb,(xr)      load pad character
      jsr      gtsmi      get pad length
      err      145,lpad second argument      is not integer
      ppm      slpd4      skip if negative or large

*
*      merge to check first arg
*
slpd1  jsr      gtstg      get first argument (string to pad)
      err      146,lpad first argument      is not a string
      bge      wa,wc,exixr      return 1st arg if too long to pad
      mov      xr,xl      else move ptr to string to pad

*
*      now we are ready for the pad
*
*      (xl)      pointer to string to pad
*      (wb)      pad character
*      (wc)      length to pad string to
*
      mov      wc,wa      copy length
      jsr      alocs      allocate scblk for new string
      mov      xr,-(xs)      save as result
      mov      sclen(xl),wa      load length of argument
      sub      wa,wc      calculate number of pad characters
      psc      xr      point to chars in result string
      lct      wc,wc      set counter for pad loop

*
*      loop to perform pad
*
slpd2  sch      wb,(xr)+      store pad character, bump ptr
      bct      wc,slpd2      loop till all pad chars stored
      csc      xr      complete store characters

*
*      now copy string
*
      bze      wa,slpd3      exit if null string
      plc      xl      else point to chars in argument
      mvc      move characters to result string
      zer      xl      clear garbage xl

*
*      here to exit with result on stack
*
slpd3  lcw      xr      load next code word
      bri      (xr)      execute it

```

```

*
*      here if 2nd arg is negative or large
*
slpd4  zer  wc      zero pad count
      brn  slpd1    merge

```

	*		
	*	lt	
	*		
s\$ltf	ent		entry point
	jsr	acomp	call arithmetic comparison routine
	err	147,lt first argument	is not numeric
	err	148,lt second argument	is not numeric
	ppm	exnul	return null if lt
	ppm	exfal	fail if eq
	ppm	exfal	fail if gt

	*		
	*	ne	
	*		
s\$nef	ent		entry point
	jsr	acomp	call arithmetic comparison routine
	err	149,ne first argument	is not numeric
	err	150,ne second argument	is not numeric
	ppm	exnul	return null if lt
	ppm	exfal	fail if eq
	ppm	exnul	return null if gt

<pre> * * notany * s\$nay ent mov =p\$nas,wb mov =p\$nay,xl mov =p\$nad,wc jsr patst err 151,notany argument mov xr,-(xs) lcw xr bri (xr) </pre>	<pre> entry point set pcode for single char arg pcode for multi-char arg set pcode for expr arg call common routine to build node is not a string or expression stack result get next code word execute it </pre>
--	---

```

*
*      opsyn
*
s$ops  ent          entry point
      jsr   gtsmi    load third argument
      err   152,opsyn third argument    is not integer
      err   153,opsyn third argument    is negative or too large
      mov   wc,wb     if ok, save third argumnet
      mov   (xs)+,xr  load second argument
      jsr   gtnvr     locate variable block
      err   154,opsyn second            arg is not natural variable name
      mov   vrfnc(xr),xl    if ok, load function block pointer
      bnz   wb,sops2      jump if operator opsyn case

*
*      here for function opsyn (third arg zero)
*
      mov   (xs)+,xr    load first argument
      jsr   gtnvr       get vrbk pointer
      err   155,opsyn first arg    is not natural variable name

*
*      merge here to perform function definition
*
sops1  jsr   dffnc      call function definer
      brn   exnul       exit with null result

*
*      here for operator opsyn (third arg non-zero)
*
sops2  jsr   gtstg      get operator name
      ppm   sops5       jump if not string
      bne   wa,=num01,sops5    error if not one char long
      plc   xr          else point to character
      lch   wc,(xr)     load character name

```



```

*
*      opsyn (continued)
*
*      now set to search for matching unary or binary operator
*      name as appropriate. note that there are =opbun undefined
*      binary operators and =opuun undefined unary operators.
*
      mov  =r$uub,wa           point to unop pointers in case
      mov  =opnsu,xr           point to names of unary operators
      add  =opbun,wb           add no. of undefined binary ops
      beq  wb,=opuun,sops3      jump if unop (third arg was 1)
      mov  =r$uba,wa           else point to binary operator ptrs
      mov  =opsnb,xr           point to names of binary operators
      mov  =opbun,wb           set number of undefined binops
*
*      merge here to check list (wb = number to check)
*
sops3  lct   wb,wb              set counter to control loop
*
*      loop to search for name match
*
sops4  beq  wc,(xr),sops6      jump if names match
      ica  wa                  else push pointer to function ptr
      ica  xr                  bump pointer
      bct  wb,sops4            loop back till all checked
*
*      here if bad operator name
*
sops5  erb  156,opsyn first arg is not correct operator name
*
*      come here on finding a match in the operator name table
*
sops6  mov  wa,xr              copy pointer to function block ptr
      sub  *vrfnc,xr           make it look like dummy vrbk
      brn  sops1              merge back to define operator

```

if .c370

```

*
*      or
*
s$orf  ent          entry point
      mnz  wb       signal two arguments
      jsr  sbool     call string boolean routine
      err  xxx,or first argument    is not a string
      err  xxx,or second argument   is not a string
      err  xxx,or arguments         not same length
      ppm  exits      null string arguments

*
*      here to process (wc) words.  result is stacked.
*
sorf1  mov  (xl)+,wa    get next cfp$c chars from arg 1
      orb  (xr),wa      or with characters from arg 2
      mov  wa,(xr)+     put back in memory
      bct  wc,sorf1     loop over all words in string block
      brn  exits        fetch next code word
```

fi

	*		
	*	output	
	*		
s\$oup	ent		entry point
	mov	=num03,wb	output flag
	jsr	ioput	call input/output assoc. routine
	err	157,output third	argument is not a string
	err	158,inappropriate	second argument for output
	err	159,inappropriate	first argument for output
	err	160,inappropriate	file specification for output
	ppm	exfal	fail if file does not exist
	err	161,output file cannot	be written to
	err	290,output channel	currently in use
	brn	exnul	return null string

	*		
	*	pos	
	*		
s\$pos	ent		entry point
	mov	=p\$pos,wb	set pcode for integer arg case
	mov	=p\$psd,wa	set pcode for expression arg case
	jsr	patin	call common routine to build node
	err	162,pos argument	is not integer or expression
	err	163,pos argument	is negative or too large
	mov	xr,-(xs)	stack result
	lcw	xr	get next code word
	bri	(xr)	execute it

<pre> * * prototype * s\$pro ent mov (xs)+,xr mov tble(xr),wb btw wb mov (xr),wa beq wa,=\$art,spro4 beq wa,=\$tbt,spro1 beq wa,=\$vct,spro3 if .cnbf else beq wa,=\$bct,spr05 fi erb 164,prototype argument * * here for table * spro1 sub =tbsi\$,wb * * merge for vector * spro2 mti wb brn exint * * here for vector * spro3 sub =vcsi\$,wb brn spro2 * * here for array * spro4 add arofs(xr),xr mov (xr),xr mov xr,-(xs) lcw xr bri (xr) if .cnbf else * * here for buffer * spr05 mov bcbuf(xr),xr mti bfalc(xr) brn exint fi </pre>	<pre> entry point load argument length if table, vector (=vcen) convert to words load type word of argument block jump if array jump if table jump if vector jump if buffer is not valid object subtract standard fields convert to integer exit with integer result subtract standard fields merge point to prototype field load prototype stack result get next code word execute it point to bfbk load allocated length exit with integer allocation </pre>
--	---

<pre> * * remdr * s\$rm d ent if .cmth jsr arith err 166,remdr first argument err 165,remdr second ppm srm06 else mov (xs),xr jsr gtint err 165,remdr second mov xr,(xs) jsr arith ppm srm04 ppm if .cnra else ppm srm01 fi fi </pre>	<pre> entry point get two integers or two reals is not numeric argument is not numeric if real load second argument convert to integer argument is not integer place converted arg in stack convert args first arg not integer second arg checked above first arg real </pre>
<pre> * * both arguments integer * zer wb ldi icval(xr) ige srm01 mnz wb srm01 rmi icval(xl) iov srm05 </pre>	<pre> set positive flag load left argument value jump if positive set negative flag get remainder error if overflow </pre>
<pre> * * make sign of result match sign of first argument * bze wb,srm03 ile exint srm02 ngi brn exint srm03 ilt srm02 brn exint </pre>	<pre> if result should be positive if should be negative, and is adjust sign of result return result should be pos, and result negative should be positive, and is </pre>
<pre> * * fail first argument * srm04 erb 166,remdr first argument </pre>	<pre> is not numeric </pre>
<pre> * * fail if overflow * srm05 erb 167,remdr caused if .cmth </pre>	<pre> integer overflow </pre>

```

*
*      here with 1st argument in (xr), 2nd in (xl), both real
*
*      result = n1 - chop(n1/n2)*n2
*
srm06  zer  wb          set positive flag
      ldr  rcval(xr)    load left argument value
      rge  srm07        jump if positive
      mnz  wb          set negative flag
srm07  dvr  rcval(xl)    compute n1/n2
      rov  srm10        jump if overflow
      chp                chop result
      mlr  rcval(xl)    times n2
      sbr  rcval(xr)    compute difference

*
*      make sign of result match sign of first argument
*      -result is in ra at this point
*
      bze  wb,srm09      if result should be positive
      rle  exrea         if should be negative, and is
srm08  ngr                adjust sign of result
      brn  exrea         return result
srm09  rlt  srm08        should be pos, and result negative
      brn  exrea         should be positive, and is

*
*      fail if overflow
*
srm10  erb  312,remdr caused  real overflow
fi

```

```

*
*      replace
*
*      the actual replace operation uses an scblk whose cfp$a
*      chars contain the translated versions of all the chars.
*      the table pointer is remembered from call to call and
*      the table is only built when the arguments change.
*
*      we also perform an optimization gleaned from spitbol 370.
*      if the second argument is &alphabet, there is no need to
*      to build a replace table.  the third argument can be
*      used directly as the replace table.
*
s$rp1  ent                      entry point
      jsr  gtstg                load third argument as string
      err  168,replace third    argument is not a string
      mov  xr,xl                save third arg ptr
      jsr  gtstg                get second argument
      err  169,replace second    argument is not a string
*
*      check to see if this is the same table as last time
*
      bne  xr,r$a2,srp11        jump if 2nd argument different
      beq  xl,r$a3,srp14        jump if args same as last time
*
*      here we build a new replace table (note wa = 2nd arg len)
*
srp11  mov  sclen(xl),wb         load 3rd argument length
      bne  wa,wb,srp16          jump if arguments not same length
      beq  xr,kvalp,srp15       jump if 2nd arg is alphabet string
      bze  wb,srp16             jump if null 2nd argument
      mov  xl,r$a3              save third arg for next time in
      mov  xr,r$a2              save second arg for next time in
      mov  kvalp,xl             point to alphabet string
      mov  sclen(xl),wa         load alphabet scblk length
      mov  r$rpt,xr             point to current table (if any)
      bnz  xr,srp12             jump if we already have a table
*
*      here we allocate a new table
*
      jsr  alocs                allocate new table
      mov  wc,wa                keep scblk length
      mov  xr,r$rpt             save table pointer for next time
*
*      merge here with pointer to new table block in (xr)
*
srp12  ctb  wa,scsi$            compute length of scblk
      mvw                                copy to get initial table values

```



```

*
*      replace (continued)
*
*      now we must plug selected entries as required. note that
*      we are short of index registers for the following loop.
*      hence the need to repeatedly re-initialise char ptr x1
*
      mov  r$ra2,x1          point to second argument
      lct  wb,wb             number of chars to plug
      zer  wc                zero char offset
      mov  r$ra3,xr          point to 3rd arg
      plc  xr                get char ptr for 3rd arg
*
*      loop to plug chars
*
srpl3  mov  r$ra2,x1          point to 2nd arg
      plc  x1,wc             point to next char
      icv  wc                increment offset
      lch  wa,(x1)           get next char
      mov  r$rpt,x1          point to translate table
      psc  x1,wa             convert char to offset into table
      lch  wa,(xr)+          get translated char
      sch  wa,(x1)           store in table
      csc  x1                complete store characters
      bct  wb,srpl3          loop till done

```

```

*
*      replace (continued)
*
*      here to use r$rpt as replace table.
*
srpl4  mov  r$rpt,xl                      replace table to use
*
*      here to perform translate using table in xl.
*
if .cnbf
srpl5  jsr  gtstg                          get first argument
      err  170,replace first              argument is not a string
else
*
*      if first arg is a buffer, perform translate in place.
*
srpl5  jsr  gtstb                          get first argument
      err  170,replace first              argument is not a string or buffer
      bnz  wb,srpl7                       branch if buffer
fi
      bze  wa,exnul                       return null if null argument
      mov  xl,-(xs)                       stack replace table to use
      mov  xr,xl                          copy pointer
      mov  wa,wc                          save length
      ctb  wa,schar                       get scblk length
      jsr  alloc                          allocate space for copy
      mov  xr,wb                          save address of copy
      mvw                                     move scblk contents to copy
      mov  (xs)+,xr                       unstack replace table
      plc  xr                             point to chars of table
      mov  wb,xl                          point to string to translate
      plc  xl                             point to chars of string
      mov  wc,wa                          set number of chars to translate
      trc                                     perform translation
srpl8  mov  wb,-(xs)                       stack result
      lcw  xr                             load next code word
      bri  (xr)                           execute it
*
*      error point
*
srpl6  erb  171,null or unequally          long 2nd, 3rd args to replace
if .cnbf
else
*
*      here to perform replacement within buffer
*
srpl7  bze  wa,srpl8                       return buffer unchanged if empty
      mov  xr,wc                          copy bfbk pointer to wc
      mov  xl,xr                          translate table to xr
      plc  xr                             point to chars of table

```

fi

```
mov  wc,x1
plc   x1
trc
brn   srpl8
```

```
point to string to translate
point to chars of string
perform translation
stack result and exit
```

	*		
	*	rewind	
	*		
s\$rew	ent		entry point
	jsr	iofcb	call fcbk routine
	err	172,rewind argument	is not a suitable name
	err	173,rewind argument	is null
	err	174,rewind file does	not exist
	jsr	sysrw	call system rewind function
	err	174,rewind file does	not exist
	err	175,rewind file does	not permit rewind
	err	176,rewind caused	non-recoverable error
	brn	exnul	exit with null result if no error

```

*
*      reverse
*
s$rvs  ent                      entry point
if .cnbf
    jsr  gtstg                  load string argument
    err  177,reverse argument  is not a string
else
    jsr  gtstb                  load string or buffer argument
    err  177,reverse argument  is not a string or buffer
    bnz  wb,srvs3               branch if buffer
fi

    bze  wa,exixr              return argument if null
    mov  xr,xl                 else save pointer to string arg
    jsr  alocs                 allocate space for new scblk
    mov  xr,-(xs)              store scblk ptr on stack as result
    psc  xr                    prepare to store in new scblk
    plc  xl,wc                 point past last char in argument
    lct  wc,wc                 set loop counter

*
*      loop to move chars in reverse order
*
srvs1  lch  wb,-(xl)            load next char from argument
        sch  wb,(xr)+          store in result
        bct  wc,srvs1          loop till all moved

*
*      here when complete to execute next code word
*
srvs4  csc  xr                  complete store characters
        zer  xl                 clear garbage xl
srvs2  lcw  xr                  load next code word
        bri  (xr)              execute it
if .cnbf
else
*
*      here if argument is a buffer.  perform reverse in place.
*
srvs3  mov  wb,-(xs)           stack buffer as result
        bze  wa,srvs2          return buffer unchanged if empty
        mov  xr,xl             copy bfbk pointer to xl
        psc  xr                prepare to store at first char
        plc  xl,wa             point past last char in argument
        rsh  wa,1              operate on half the string
        lct  wc,wa             set loop counter

*
*      loop to swap chars from end to end.  note that in the
*      case of an odd count, the middle char is not touched.
*
srvs5  lch  wb,-(xl)           load next char from end
        lch  wa,(xr)           load next char from front

```

fi

```
sch  wb,(xr)+  
sch  wa,(x1)  
bct  wc,srvs5  
brn  srvs4
```

```
store end char in front  
store front char at end  
loop till all moved  
complete store
```

```

*
*      rpad
*
s$rpdl  ent      entry point
        jsr      gtstg      get pad character
        err      178,rpad third argument      is not a string
        plc      xr      point to character (null is blank)
        lch      wb,(xr)      load pad character
        jsr      gtsmi      get pad length
        err      179,rpad second argument      is not integer
        ppm      srpd3      skip if negative or large

*
*      merge to check first arg.
*
srpd1  jsr      gtstg      get first argument (string to pad)
        err      180,rpad first argument      is not a string
        bge      wa,wc,exixr      return 1st arg if too long to pad
        mov      xr,xl      else move ptr to string to pad

*
*      now we are ready for the pad
*
*      (xl)      pointer to string to pad
*      (wb)      pad character
*      (wc)      length to pad string to
*
        mov      wc,wa      copy length
        jsr      alocs      allocate scblk for new string
        mov      xr,-(xs)      save as result
        mov      sclen(xl),wa      load length of argument
        sub      wa,wc      calculate number of pad characters
        psc      xr      point to chars in result string
        lct      wc,wc      set counter for pad loop

*
*      copy argument string
*
        bze      wa,srpd2      jump if argument is null
        plc      xl      else point to argument chars
        mvc      move characters to result string
        zer      xl      clear garbage xl

*
*      loop to supply pad characters
*
srpd2  sch      wb,(xr)+      store pad character, bump ptr
        bct      wc,srpd2      loop till all pad chars stored
        csc      xr      complete character storing
        lcw      xr      load next code word
        bri      (xr)      execute it

*
*      here if 2nd arg is negative or large
*
srpd3  zer      wc      zero pad count

```

brn srpd1

merge

	*		
	*	rtab	
	*		
s\$rtb	ent		entry point
	mov	=p\$rtb,wb	set pcode for integer arg case
	mov	=p\$rtd,wa	set pcode for expression arg case
	jsr	patin	call common routine to build node
	err	181,rtab argument	is not integer or expression
	err	182,rtab argument	is negative or too large
	mov	xr,-(xs)	stack result
	lcw	xr	get next code word
	bri	(xr)	execute it

<i>if .cust</i>		
*		
*	set	
*		
s\$set	ent	entry point
	mov (xs)+,r\$io2	save third arg (whence)
<i>if .cusr</i>		
	mov (xs)+,xr	get second arg (offset)
	jsr gtrea	convert to real
	err 324,set second argument	not numeric
	ldr rcval(xr)	load accumulator with argument
<i>else</i>		
	mov (xs)+,r\$io1	save second arg (offset)
<i>fi</i>		
	jsr ioxcb	call fcbk routine
	err 291,set first argument	is not a suitable name
	err 292,set first argument	is null
	err 295,set file does	not exist
<i>if .cusr</i>		
<i>else</i>		
	mov r\$io1,wb	load second arg
<i>fi</i>		
	mov r\$io2,wc	load third arg
	jsr sysst	call system set routine
	err 293,inappropriate	second argument to set
	err 294,inappropriate	third argument to set
	err 295,set file does	not exist
	err 296,set file does	not permit setting file pointer
	err 297,set caused non-recoverable	i/o error
<i>if .cusr</i>		
	rti exrea	return real position if not able
	brn exint	to return integer position
<i>else</i>		
	brn exint	otherwise return position
<i>fi</i>		

fi

*		
*	tab	
*		
s\$tab	ent	entry point
	mov =p\$tab,wb	set pcode for integer arg case
	mov =p\$tbdb,wa	set pcode for expression arg case
	jsr patin	call common routine to build node
	err 183,tab argument	is not integer or expression
	err 184,tab argument	is negative or too large
	mov xr,-(xs)	stack result
	lcw xr	get next code word
	bri (xr)	execute it

<pre> * * rpos * s\$rps ent mov =p\$rps,wb mov =p\$rpdc,wa jsr patin err 185,rpos argument err 186,rpos argument mov xr,-(xs) lcw xr bri (xr) if .cnsr else </pre>	<pre> entry point set pcode for integer arg case set pcode for expression arg case call common routine to build node is not integer or expression is negative or too large stack result get next code word execute it </pre>
--	--

	*		
	*	rsort	
	*		
s\$rsr	ent		entry point
	mnz	wa	mark as rsort
	jsr	sorta	call sort routine
	ppm	exfal	if conversion fails, so shall we
	brn	exsid	return, setting idval
<i>fi</i>			

<pre> * * setexit * s\$stx ent mov (xs)+,xr mov stxvr,wa zer x1 beq xr,=nulls,sstx1 jsr gtnvr ppm sstx2 mov vrlbl(xr),x1 beq x1,=stndl,sstx2 bne (x1),=b\$trt,sstx1 mov trlbl(x1),x1 </pre>	<pre> entry point load argument load old vrbk pointer load zero in case null arg jump if null argument (reset call) else get specified vrbk jump if not natural variable else load label jump if label is not defined jump if not trapped else load ptr to real label code </pre>
<pre> * * here to set/reset setexit trap * sstx1 mov xr,stxvr mov x1,r\$exc beq wa,=nulls,exnul mov wa,xr brn exvnm </pre>	<pre> store new vrbk pointer (or null) store new code ptr (or zero) return null if null result else copy vrbk pointer and return building nmbk </pre>
<pre> * * here if bad argument * sstx2 erb 187,setexit argument if.cmth </pre>	<pre> is not label name or null </pre>
<pre> * * sin * s\$sin ent mov (xs)+,xr jsr gtrea err 308,sin argument ldr rcval(xr) sin rno exrea erb 323,sin argument </pre>	<pre> entry point get argument convert to real not numeric load accumulator with argument take sine if no overflow, return result in ra is out of range </pre>

fi

if .cmth

*

* sqrt

*

s\$sqr ent

 mov (xs)+,xr

 jsr gtrea

 err 313,sqrt argument

 ldr rcval(xr)

 rlt ssqr1

 sqr

 brn exrea

entry point

get argument

convert to real

not numeric

load accumulator with argument

negative number

take square root

no overflow possible, result in ra

*

* here if bad argument

*

ssqr1 erb 314,sqrt argument

negative

```
fi  
if .cnsr  
else
```


	*		
	*	sort	
	*		
s\$srt	ent		entry point
	zer	wa	mark as sort
	jsr	sorta	call sort routine
	ppm	exfal	if conversion fails, so shall we
	brn	exsid	return, setting idval
<i>fi</i>			

	*		
	*	span	
	*		
s\$spn	ent		entry point
	mov	=p\$sps,wb	set pcode for single char arg
	mov	=p\$spn,xl	set pcode for multi-char arg
	mov	=p\$spd,wc	set pcode for expression arg
	jsr	patst	call common routine to build node
	err	188,span argument	is not a string or expression
	mov	xr,-(xs)	stack result
	lcw	xr	get next code word
	bri	(xr)	execute it

```

*
*      size
*
s$si$  ent          entry point
if .cnbf
    jsr  gtstg      load string argument
    err  189,size argument is not a string
else
    jsr  gtstb      load string argument
    err  189,size argument is not a string or buffer
fi

*
*      merge with bfbk or scbk ptr in xr.  wa has length.
*
mti  wa          load length as integer
brn  exint       exit with integer result

```

	*		
	*	stoptr	
	*		
s\$stt	ent		entry point
	zer	xl	indicate stoptr case
	jsr	trace	call trace procedure
	err	190,stoptr first	argument is not appropriate name
	err	191,stoptr second	argument is not trace type
	brn	exnul	return null

	*		
	*	substr	
	*		
s\$sub	ent		entry point
	jsr	gtsmi	load third argument
	err	192,substr third	argument is not integer
	ppm	exfal	jump if negative or too large
	mov	xr,sbssv	save third argument
	jsr	gtsmi	load second argument
	err	193,substr second	argument is not integer
	ppm	exfal	jump if out of range
	mov	xr,wc	save second argument
	bze	wc,exfal	jump if second argument zero
	dcb	wc	else decrement for ones origin
if .cnbf			
	jsr	gtstg	load first argument
	err	194,substr first	argument is not a string
else			
	jsr	gtstb	load first argument
	err	194,substr first	argument is not a string or buffer
fi			
	*		
	*	merge with bfbk or scblk ptr in xr. wa has length	
	*		
	mov	wc,wb	copy second arg to wb
	mov	sbssv,wc	reload third argument
	bnz	wc,ssub2	skip if third arg given
	mov	wa,wc	else get string length
	bgt	wb,wc,exfal	fail if improper
	sub	wb,wc	reduce by offset to start
	*		
	*	merge	
	*		
ssub2	mov	wa,xl	save string length
	mov	wc,wa	set length of substring
	add	wb,wc	add 2nd arg to 3rd arg
	bgt	wc,xl,exfal	jump if improper substring
	mov	xr,xl	copy pointer to first arg
	jsr	sbstr	build substring
	mov	xr,-(xs)	stack result
	lcw	xr	get next code word
	bri	(xr)	execute it

```

*
*      table
*
s$tbl1  ent          entry point
        mov  (xs)+,x1    get initial lookup value
        ica  xs          pop second argument
        jsr  gtsmi       load argument
        err  195,table argument  is not integer
        err  196,table argument  is out of range
        bnz  wc,stbl1    jump if non-zero
        mov  =tbnbk,wc   else supply default value

*
*      merge here with number of headers in wc
*
stbl1   jsr  tmake       make table
        brn  exsid       exit setting idval

```

if .cmth

*
*
*

tan

s\$tan ent
 mov (xs)+,xr
 jsr gtrea
 err 309,tan argument
 ldr rcval(xr)
 tan
 rno exrea
 erb 310,tan produced

entry point
get argument
convert to real
not numeric
load accumulator with argument
take tangent
if no overflow, return result in ra
real overflow or argument is out of range

fi

*

*

*

s\$tim **ent**
 jsr systm
 sbi timsx
 brn exint

entry point
get timer value
subtract starting time
exit with integer value

*			
*		trace	
*			
s\$tra	ent		entry point
	beq num03(xs),=nulls,str02		jump if first argument is null
	mov (xs)+,xr		load fourth argument
	zer xl		tentatively set zero pointer
	beq xr,=nulls,str01		jump if 4th argument is null
	jsr gtnvr		else point to vrbk
	ppm str03		jump if not variable name
	mov xr,xl		else save vrbk in trfnc
*			
*		here with vrbk or zero in xl	
*			
str01	mov (xs)+,xr		load third argument (tag)
	zer wb		set zero as trtyp value for now
	jsr trblk		build trblk for trace call
	mov xr,xl		move trblk pointer for trace
	jsr trace		call trace procedure
	err 198,trace first argument		is not appropriate name
	err 199,trace second		argument is not trace type
	brn exnul		return null
*			
*		here to call system trace toggle routine	
*			
str02	jsr systt		call it
	add *num04,xs		pop trace arguments
	brn exnul		return
*			
*		here for bad fourth argument	
*			
str03	erb 197,trace fourth		arg is not function name or null

```

*
*      trim
*
s$trm  ent                      entry point
if .cnbf
    jsr  gtstg                  load argument as string
    err  200,trim argument     is not a string
else
    jsr  gtstb                  load argument as string
    err  200,trim argument     is not a string or buffer
    bnz  wb,strm0               branch if buffer
fi

    bze  wa,exnul               return null if argument is null
    mov  xr,xl                  copy string pointer
    ctb  wa,schar               get block length
    jsr  alloc                  allocate copy same size
    mov  xr,wb                  save pointer to copy
    mvw                      copy old string block to new
    mov  wb,xr                  restore ptr to new block
    jsr  trimr                  trim blanks (wb is non-zero)
    mov  xr,-(xs)               stack result
    lcw  xr                     get next code word
    bri  (xr)                   execute it
if .cnbf
else
*
*      argument is a buffer, perform trim in place.
*
strm0  mov  wb,-(xs)             stack buffer as result
    bze  wa,strm6               return buffer unchanged if empty
    mov  xr,xl                  get bfbk ptr
    mov  wb,xr                  copy bcbk ptr to xr
    plc  xl,wa                  point past last character
    mov  =ch$bl,wc              load blank character
*
*      loop through characters from right to left
*
strm1  lch  wb,-(xl)             load next character
    if .caht
        beq  wb,=ch$ht,strm2     jump if horizontal tab
    fi

    bne  wb,wc,strm3             jump if non-blank found
strm2  dcw  wa                   else decrement character count
    bnz  wa,strm1               loop back if more to check
*
*      here when buffer trim complete
*
strm3  mov  wa,bclen(xr)         set new length in bcbk
    mov  bcbuf(xr),xr           get bfbk ptr
    mov  wa,wb                  copy length

```

	ctb	wb,0	words needed converted to bytes
	sub	wa,wb	number of zeros needed
	psc	xr,wa	ready for storing zeros
	zer	wc	set zero char
	*		
	*	loop to zero pad last word of characters	
	*		
strm4	bze	wb,strm5	loop while more to be done
	sch	wc,(xr)+	store zero character
	dcv	wb	decrement count
	brn	strm4	continue loop
strm5	csc	xr	complete store characters
strm6	lcw	xr	get next code word
	bri	(xr)	execute it

fi

<pre> * * unload * s\$unl ent mov (xs)+,xr jsr gtnvr err 201,unload argument mov =stndf,xl jsr dffnc brn exnul if .c370 </pre>	<pre> entry point load argument point to vrbk is not natural variable name get ptr to undefined function undefine named function return null as result </pre>
--	---

```

*
*      xor
*
s$xor  ent          entry point
      mnz  wb       signal two arguments
      jsr  sbool     call string boolean routine
      err  xxx,xor first argument    is not a string
      err  xxx,xor second argument   is not a string
      err  xxx,xor arguments         not same length
      ppm  exits      null string arguments

*
*      here to process (wc) words.  result is stacked.
*
sxor1  mov  (xl)+,wa  get next cfp$c chars from arg 1
      xob  (xr),wa    xor with characters from arg 2
      mov  wa,(xr)+   put back in memory
      bct  wc,sxor1   loop over all words in string block
      brn  exits      fetch next code word

```

fi

spitbol – utility routines

*
* the following section contains utility routines used for
* various purposes throughout the system. these differ
* from the procedures in the utility procedures section in
* they are not in procedure form and they do not return
* to their callers. they are accessed with a branch type
* instruction after setting the registers to appropriate
* parameter values.
*
* the register values required for each routine are
* documented at the start of each routine. registers not
* mentioned may contain any values except that xr,xl
* can only contain proper collectable pointers.
*
* some of these routines will tolerate garbage pointers
* in xl,xr on entry. this is always documented and in
* each case, the routine clears these garbage values before
* exiting after completing its task.
*
* the routines have names consisting of five letters
* and are assembled in alphabetical order.

```

*      arref -- array reference
*
*      (xl)          may be non-collectable
*      (xr)          number of subscripts
*      (wb)          set zero/nonzero for value/name
*                   the value in wb must be collectable
*      stack         subscripts and array operand
*      brn arref     jump to call function
*
*      arref continues by executing the next code word with
*      the result name or value placed on top of the stack.
*      to deal with the problem of accessing subscripts in the
*      order of stacking, xl is used as a subscript pointer
*      working below the stack pointer.
*
arref  rtn  exits
      mov  xr,wa          copy number of subscripts
      mov  xs,xt          point to stack front
      wtb  xr             convert to byte offset
      add  xr,xt          point to array operand on stack
      ica  xt            final value for stack popping
      mov  xt,arfxs       keep for later
      mov  -(xt),xr       load array operand pointer
      mov  xr,r$arf       keep array pointer
      mov  xt,xr          save pointer to subscripts
      mov  r$arf,xl       point xl to possible vcbblk or tbbblk
      mov  (xl),wc        load first word
      beq  wc,=b$art,arf01  jump if arblk
      beq  wc,=b$vct,arf07  jump if vcbblk
      beq  wc,=b$tbtt,arf10  jump if tbbblk
      erb  235,subscripted operand  is not table or array
*
*      here for array (arblk)
*
arf01  bne  wa,arndm(xl),arf09  jump if wrong number of dims
      ldi  intv0             get initial subscript of zero
      mov  xr,xt            point before subscripts
      zer  wa              initial offset to bounds
      brn  arf03           jump into loop
*
*      loop to compute subscripts by multiplications
*
arf02  mli  ardm2(xr)        multiply total by next dimension
*
*      merge here first time
*
arf03  mov  -(xt),xr        load next subscript
      sti  arfsi           save current subscript
      ldi  icval(xr)       load integer value in case
      beq  (xr),=b$ic1,arf04  jump if it was an integer

```

```

*
*      arref (continued)
*
*
*      jsr  gtint          convert to integer
*      ppm  arf12          jump if not integer
*      ldi  icval(xr)      if ok, load integer value
*
*      here with integer subscript in (ia)
*
arf04  mov  r$arf,xr        point to array
*      add  wa,xr          offset to next bounds
*      sbi  arlbd(xr)      subtract low bound to compare
*      iov  arf13          out of range fail if overflow
*      ilt  arf13          out of range fail if too small
*      sbi  ardim(xr)      subtract dimension
*      ige  arf13          out of range fail if too large
*      adi  ardim(xr)      else restore subscript offset
*      adi  arfsi          add to current total
*      add  *ardms,wa       point to next bounds
*      bne  xt,xs,arf02     loop back if more to go
*
*      here with integer subscript computed
*
*      mfi  wa             get as one word integer
*      wtb  wa             convert to offset
*      mov  r$arf,xl        point to arblk
*      add  arofs(xl),wa    add offset past bounds
*      ica  wa             adjust for arpro field
*      bnz  wb,arf08        exit with name if name call
*
*      merge here to get value for value call
*
arf05  jsr  acess          get value
*      ppm  arf13          fail if acess fails
*
*      return value
*
arf06  mov  arfxs,xs       pop stack entries
*      zer  r$arf          finished with array pointer
*      mov  xr,-(xs)       stack result
*      lcw  xr             get next code word
*      bri  (xr)           execute it

```


<pre> * * arref (continued) * * here for vector * arf07 bne wa,=num01,arf09 mov (xs),xr jsr gtint ppm arf12 ldi icval(xr) sbi intv1 mfi wa,arf13 add =vcvls,wa wtb wa bge wa,vclen(xl),arf13 bze wb,arf05 </pre>	<pre> error if more than 1 subscript else load subscript convert to integer error if not integer else load integer value subtract for ones offset get subscript as one word add offset for standard fields convert offset to bytes fail if out of range subscript back to get value if value call </pre>
<pre> * * return name * arf08 mov arfxs,xs zer r\$arf brn exnam </pre>	<pre> pop stack entries finished with array pointer else exit with name </pre>
<pre> * * here if subscript count is wrong * arf09 erb 236,array referenced </pre>	<pre> with wrong number of subscripts </pre>
<pre> * * table * arf10 bne wa,=num01,arf11 mov (xs),xr jsr tfind ppm arf13 bnz wb,arf08 brn arf06 </pre>	<pre> error if more than 1 subscript else load subscript call table search routine fail if failed exit with name if name call else exit with value </pre>
<pre> * * here for bad table reference * arf11 erb 237,table referenced </pre>	<pre> with more than one subscript </pre>
<pre> * * here for bad subscript * arf12 erb 238,array subscript </pre>	<pre> is not integer </pre>
<pre> * * here to signal failure * arf13 zer r\$arf brn exfal </pre>	<pre> finished with array pointer fail </pre>

```

*
*      cfunc -- call a function
*
*      cfunc is used to call a snobol level function. it is
*      used by the apply function (s$app), the function
*      trace routine (trxeq) and the main function call entry
*      (o$fnc, o$fns). in the latter cases, cfunc is used only
*      if the number of arguments is incorrect.
*
*      (xl)                pointer to function block
*      (wa)                actual number of arguments
*      (xs)                points to stacked arguments
*      brn  cfunc          jump to call function
*
*      cfunc continues by executing the function
*
cfunc  rtn   exfal
      blt   wa,fargs(xl),cfnc1          jump if too few arguments
      beq   wa,fargs(xl),cfnc3          jump if correct number of args
*
*      here if too many arguments supplied, pop them off
*
      mov   wa,wb                      copy actual number
      sub   fargs(xl),wb              get number of extra args
      wtb   wb                        convert to bytes
      add   wb,xs                      pop off unwanted arguments
      brn   cfnc3                     jump to go off to function
*
*      here if too few arguments
*
cfnc1  mov   fargs(xl),wb              load required number of arguments
      beq   wb,=nini9,cfnc3          jump if case of var num of args
      sub   wa,wb                     calculate number missing
      lct   wb,wb                     set counter to control loop
*
*      loop to supply extra null arguments
*
cfnc2  mov   =nulls,-(xs)              stack a null argument
      bct   wb,cfnc2                 loop till proper number stacked
*
*      merge here to jump to function
*
cfnc3  bri   (xl)                     jump through fcode field

```

```

*
*      exfal -- exit signalling snobol failure
*
*      (xl,xr)          may be non-collectable
*      brn  exfal        jump to fail
*
*      exfal continues by executing the appropriate fail goto
*
exfal  rtn   (xl)
       mov  flptr,xs          pop stack
       mov  (xs),xr          load failure offset
       add  r$cod,xr         point to failure code location
       lcp  xr               set code pointer
       lcw  xr               load next code word
       mov  (xr),xl          load entry address
       bri  xl               jump to execute next code word

```

```

*
*      exint -- exit with integer result
*
*      (xl,xr)          may be non-collectable
*      (ia)             integer value
*      brn  exint       jump to exit with integer
*
*      exint continues by executing the next code word
*      which it does by falling through to exixr
*
exint  rtn   xl
      zer   xl          clear dud value
      jsr   icbld       build icblk

```

```

*      exixr -- exit with result in (xr)
*
*      (xr)                result
*      (xl)                may be non-collectable
*      brn  exixr          jump to exit with result in (xr)
*
*      exixr continues by executing the next code word
*      which it does by falling through to exits.
exixr  rtn  icbld          which it does by falling through to exits.
*
*      mov  xr,-(xs)        stack result
*
*
*      exits -- exit with result if any stacked
*
*      (xr,xl)             may be non-collectable
*
*      brn  exits          enter exits routine
*
exits  rtn  xr,-(xs)
      lcw  xr                load next code word
      mov  (xr),xl          load entry address
      bri  xl                jump to execute next code word

```

```

*
*      exnam -- exit with name in (xl,wa)
*
*      (xl)          name base
*      (wa)          name offset
*      (xr)          may be non-collectable
*      brn  exnam     jump to exit with name in (xl,wa)
*
*      exnam continues by executing the next code word
*
exnam  rtn   xl
      mov  xl,-(xs)          stack name base
      mov  wa,-(xs)          stack name offset
      lcw  xr                load next code word
      bri  (xr)              execute it

```

```

*
*      exnul -- exit with null result
*
*      (xl,xr)          may be non-collectable
*      brn  exnul       jump to exit with null value
*
*      exnul continues by executing the next code word
*
exnul  rtn   (xr)
       mov  =nulls,-(xs)          stack null value
       lcw  xr                   load next code word
       mov  (xr),xl              load entry address
       bri  xl                   jump to execute next code word

```

if **.cnra**

else

```
*
*      exrea -- exit with real result
*
*      (xl,xr)          may be non-collectable
*      (ra)             real value
*      brn  exrea       jump to exit with real value
*
*      exrea continues by executing the next code word
*
```

```
exrea  rtn   xl
        zer   xl                clear dud value
        jsr   rcbld            build rcbld
        brn   exixr            jump to exit with result in xr
```

fi


```

*
*      exsid -- exit setting id field
*
*      exsid is used to exit after building any of the following
*      blocks (arblk, tbblk, pdblk, vcblk). it sets the idval.
*
*      (xr)                ptr to block with idval field
*      (xl)                may be non-collectable
*      brn  exsid          jump to exit after setting id field
*
*      exsid continues by executing the next code word
*
exsid  rtn  exixr
       mov  curid,wa          load current id value
       bne  wa,=cfp$m,exsi1   jump if no overflow
       zer  wa               else reset for wraparound
*
*      here with old idval in wa
*
exsi1  icv  wa               bump id value
       mov  wa,curid         store for next time
       mov  wa,idval(xr)     store id value
       brn  exixr           exit with result in (xr)

```

```

*
*      exvnm -- exit with name of variable
*
*      exvnm exits after stacking a value which is a nmblok
*      referencing the name of a given natural variable.
*
*      (xr)                vrblok pointer
*      (xl)                may be non-collectable
*      brn  exvnm          exit with vrblok pointer in xr
*
exvnm  rtn  exixr
       mov  xr,xl          copy name base pointer
       mov  *nmsi$,wa      set size of nmblok
       jsr  alloc          allocate nmblok
       mov  =b$nm1,(xr)    store type word
       mov  xl,nmbas(xr)   store name base
       mov  *vrval,nmofs(xr) store name offset
       brn  exixr          exit with result in xr

```

```

*
*      flpop -- fail and pop in pattern matching
*
*      flpop pops the node and cursor on the stack and then
*      drops through into failp to cause pattern failure
*
*      (xl,xr)                may be non-collectable
*      brn  flpop              jump to fail and pop stack
*
flpop  rtn  exixr
      add  *num02,xs                pop two entries off stack

```

```

*
*      failp -- failure in matching pattern node
*
*      failp is used after failing to match a pattern node.
*      see pattern match routines for details of use.
*
*      (xl,xr)                may be non-collectable
*      brn  failp              signal failure to match
*
*      failp continues by matching an alternative from the stack
*
failp  rtn  *num02,xs
      mov  (xs)+,xr              load alternative node pointer
      mov  (xs)+,wb              restore old cursor
      mov  (xr),xl              load pcode entry pointer
      bri  xl                    jump to execute code for node

```

```

*
*      indir -- compute indirect reference
*
*      (wb)                nonzero/zero for by name/value
*      brn  indir          jump to get indirect ref on stack
*
*      indir continues by executing the next code word
*
indir  rtn   xl
      mov   (xs)+,xr          load argument
      beq   (xr),=b$nm1,indr2  jump if a name
      jsr   gtnvr            else convert to variable
      err   239,indirection operand is not name
      bze   wb,indr1         skip if by value
      mov   xr,-(xs)          else stack vrbk ptr
      mov   *vrval,-(xs)      stack name offset
      lcw   xr                load next code word
      mov   (xr),xl           load entry address
      bri   xl                jump to execute next code word

*
*      here to get value of natural variable
*
indr1  bri   (xr)            jump through vrget field of vrbk

*
*      here if operand is a name
*
indr2  mov   nmbas(xr),xl     load name base
      mov   nmofs(xr),wa     load name offset
      bnz   wb,exnam         exit if called by name
      jsr   acess            else get value first
      ppm   exfal            fail if access fails
      brn   exixr           else return with value in xr

```

```

*
*      match -- initiate pattern match
*
*      (wb)                match type code
*      brn  match          jump to initiate pattern match
*
*      match continues by executing the pattern match. see
*      pattern match routines (p$xxx) for full details.
*
match  rtn  exixr
        mov  (xs)+,xr      load pattern operand
        jsr  gtpat        convert to pattern
        err  240,pattern match  right operand is not pattern
        mov  xr,xl        if ok, save pattern pointer
        bnz  wb,mtch1     jump if not match by name
        mov  (xs),wa      else load name offset
        mov  xl,-(xs)     save pattern pointer
        mov  num02(xs),xl load name base
        jsr  acess        access subject value
        ppm  exfal        fail if access fails
        mov  (xs),xl      restore pattern pointer
        mov  xr,(xs)      stack subject string val for merge
        zer  wb           restore type code

*
*      merge here with subject value on stack
*
if .cnbf
mtch1  jsr  gtstg          convert subject to string
        err  241,pattern match  left operand is not a string
        mov  wb,-(xs)        stack match type code

else
mtch1  mov  wb,wc          save match type in wc
        jsr  gtstb          convert subject to string
        err  241,pattern match  left operand is not a string or buffer
        mov  wb,r$pmb       set to zero/bcblk if string/buffer
        mov  wc,-(xs)        stack match type code

fi

        mov  xr,r$pms       if ok, store subject string pointer
        mov  wa,pmssl       and length
        zer  -(xs)          stack initial cursor (zero)
        zer  wb            set initial cursor
        mov  xs,pmhbs       set history stack base ptr
        zer  pmdfl         reset pattern assignment flag
        mov  xl,xr          set initial node pointer
        bnz  kvanc,mtch2    jump if anchored

*
*      here for unanchored
*
        mov  xr,-(xs)       stack initial node pointer
        mov  =nduna,-(xs)   stack pointer to anchor move node
        bri  (xr)           start match of first node

```

	*		
	*	here in anchored mode	
	*		
mtch2	zer	-(xs)	dummy cursor value
	mov	=ndabo,-(xs)	stack pointer to abort node
	bri	(xr)	start match of first node

```

*
*      retrn -- return from function
*
*      (wa)                string pointer for return type
*      brn  retrn          jump to return from (snobol) func
*
*      retrn continues by executing the code at the return point
*      the stack is cleaned of any garbage left by other
*      routines which may have altered flptr since function
*      entry by using flprt, reserved for use only by
*      function call and return.
*
retrn  rtn   (xr)
      bnz   kvfnc,rtn01          jump if not level zero
      erb   242,function return  from level zero
*
*      here if not level zero return
*
rtn01  mov   flprt,xs           pop stack
      ica   xs                 remove failure offset
      mov   (xs)+,xr           pop pfbk pointer
      mov   (xs)+,flptr        pop failure pointer
      mov   (xs)+,flprt        pop old flprt
      mov   (xs)+,wb           pop code pointer offset
      mov   (xs)+,wc           pop old code block pointer
      add   wc,wb              make old code pointer absolute
      lcp   wb                 restore old code pointer
      mov   wc,r$cod           restore old code block pointer
      dcv   kvfnc              decrement function level
      mov   kvtra,wb           load trace
      add   kvftr,wb           add ftrace
      bze   wb,rtn06           jump if no tracing possible
*
*      here if there may be a trace
*
      mov   wa,-(xs)           save function return type
      mov   xr,-(xs)           save pfbk pointer
      mov   wa,kvrtn           set rtn type for trace function
      mov   r$fnc,xl           load fnclevel trblk ptr (if any)
      jsr   ktrex              execute possible fnclevel trace
      mov   pfvbl(xr),xl        load vrbk ptr (sgd13)
      bze   kvtra,rtn02         jump if trace is off
      mov   pfrtr(xr),xr        else load return trace trblk ptr
      bze   xr,rtn02            jump if not return traced
      dcv   kvtra              else decrement trace count
      bze   trfnc(xr),rtn03     jump if print trace
      mov   *vrval,wa           else set name offset
      mov   num01(xs),kvrtn     make sure rtn type is set right
      jsr   trxeq              execute full trace

```



```

*
*      retrn (continued)
*
*      here to test for ftrace
*
rtn02  bze  kvftr,rtn05          jump if ftrace is off
      dcw  kvftr                else decrement ftrace
*
*      here for print trace of function return
*
rtn03  jsr  prtsn                print statement number
      mov  num01(xs),xr          load return type
      jsr  prtst                print it
      mov  =ch$bl,wa            load blank
      jsr  prtch                print it
      mov  0(xs),xl             load pfbk ptr
      mov  pfvbl(xl),xl         load function vrbk ptr
      mov  *vrval,wa            set vrbk name offset
      bne  xr,=scftr,rtn04      jump if not freturn case
*
*      for freturn, just print function name
*
      jsr  prtnm                print name
      jsr  prtnl                terminate print line
      brn  rtn05                merge
*
*      here for return or nreturn, print function name = value
*
rtn04  jsr  prtnv                print name = value
*
*      here after completing trace
*
rtn05  mov  (xs)+,xr            pop pfbk pointer
      mov  (xs)+,wa            pop return type string
*
*      merge here if no trace required
*
rtn06  mov  wa,kvrtn            set rtntype keyword
      mov  pfvbl(xr),xl        load pointer to fn vrbk

```

```

*      retrn (continued)
*
*      get value of function
*
rtn07  mov  xl,rtnbp          save block pointer
      mov  vrval(xl),xl      load value
      beq  (xl),=b$trt,rtn07 loop back if trapped
      mov  xl,rtnfv          else save function result value
      mov  (xs)+,rtnsv       save original function value
if .cnpf
      mov  fargs(xr),wb      get number of arguments
else
      mov  (xs)+,xl          pop saved pointer
      bze  xl,rtn7c          no action if none
      bze  kvpfl,rtn7c       jump if no profiling
      jsr  prflu             else profile last func stmt
      beq  kvpfl,=num02,rtn7a branch on value of profile keywd

*
*      here if &profile = 1. start time must be frigged to
*      appear earlier than it actually is, by amount used before
*      the call.
*
      ldi  pfstm             load current time
      sbi  icval(xl)         frig by subtracting saved amount
      brn  rtn7b             and merge

*
*      here if &profile = 2
*
rtn7a  ldi  icval(xl)         load saved time

*
*      both profile types merge here
*
rtn7b  sti  pfstm             store back correct start time

*
*      merge here if no profiling
*
rtn7c  mov  fargs(xr),wb      get number of args
fi
      add  pfnlo(xr),wb      add number of locals
      bze  wb,rtn10          jump if no args/locals
      lct  wb,wb             else set loop counter
      add  pflen(xr),xr      and point to end of pfbk

*
*      loop to restore functions and locals
*
rtn08  mov  -(xr),xl          load next vrblk pointer

*
*      loop to find value block
*
rtn09  mov  xl,wa             save block pointer

```

	mov vrval(xl),xl	load pointer to next value
	beq (xl),=b\$trt,rtn09	loop back if trapped
	mov wa,xl	else restore last block pointer
	mov (xs)+,vrval(xl)	restore old variable value
	bct wb,rtn08	loop till all processed
	 *	
	* now restore function value and exit	
	* 	
rtn10	mov rtnbp,xl	restore ptr to last function block
	mov rtnsv,vrval(xl)	restore old function value
	mov rtnfv,xr	reload function result
	mov r\$cod,xl	point to new code block
	mov kvstn,kvlst	set lastno from stno
	mov cdstm(xl),kvstn	reset proper stno value
<i>if</i> .csln	 	
	mov kvlin,kvlln	set lastline from line
	mov cdsln(xl),kvlin	reset proper line value
<i>fi</i>	 	
	mov kvrtn,wa	load return type
	beq wa,=scrtn,exixr	exit with result in xr if return
	beq wa,=scfrt,exfal	fail if freturn

```

*
*      retrn (continued)
*
*      here for nreturn
*
      beq  (xr),=b$nml,rtn11      jump if is a name
      jsr  gtnvr                  else try convert to variable name
      err  243,function result    in nreturn is not name
      mov  xr,xl                  if ok, copy vrbk (name base) ptr
      mov  *vrval,wa              set name offset
      brn  rtn12                  and merge
*
*      here if returned result is a name
*
rtn11  mov  nmbas(xr),xl          load name base
      mov  nmofs(xr),wa          load name offset
*
*      merge here with returned name in (xl,wa)
*
rtn12  mov  xl,xr                preserve xl
      lcw  wb                    load next word
      mov  xr,xl                  restore xl
      beq  wb,=ofne$,exnam        exit if called by name
      mov  wb,-(xs)               else save code word
      jsr  acess                  get value
      ppm  exfal                  fail if access fails
      mov  xr,xl                  if ok, copy result
      mov  (xs),xr                reload next code word
      mov  xl,(xs)                store result on stack
      mov  (xr),xl                load routine address
      bri  xl                     jump to execute next code word

```

```

*
*      stcov -- signal statement counter overflow
*
*      brn  stcov          jump to signal statement count oflo
*
*      permit up to 10 more statements to be obeyed so that
*      setexit trap can regain control.
*      stcov continues by issuing the error message
*
stcov  rtn   xl
      icv   errft          fatal error
      ldi   intvt          get 10
      adi   kvstl          add to former limit
      sti   kvstl          store as new stlimit
      ldi   intvt          get 10
      sti   kvstc          set as new count
      jsr   stgcc          recompute countdown counters
      erb   244,statement count exceeds value of stlimit keyword

```

```

*
*      stmgo -- start execution of new statement
*
*      (xr)                pointer to cdblk for new statement
*      brn  stmgo          jump to execute new statement
*
*      stmgo continues by executing the next statement
*
stmgo  rtn  244,statement countunt
      mov  xr,r$cod          set new code block pointer
      dcvt stmct            see if time to check something
      bze  stmct,stmgo2      jump if so
      mov  kvstn,kvlst       set lastno
      mov  cdstm(xr),kvstn   set stno
if .csln
      mov  kvlin,kvlln       set lastline
      mov  cdsln(xr),kvlin   set line
fi
      add  *cdcod,xr         point to first code word
      lcp  xr                set code pointer
*
*      here to execute first code word of statement
*
stgo1  lcw  xr              load next code word
      zer  xl              clear garbage xl
      bri  (xr)            execute it
*
*      check profiling, polling, stlimit, statement tracing
*
stgo2  bze  kvpfl,stmgo3    skip if no profiling
      jsr  prflu           else profile the statement in kvstn
*
*      here when finished with profiling
*
stgo3  mov  kvstn,kvlst     set lastno
      mov  cdstm(xr),kvstn  set stno
if .csln
      mov  kvlin,kvlln       set lastline
      mov  cdsln(xr),kvlin   set line
fi
      add  *cdcod,xr         point to first code word
      lcp  xr                set code pointer
if .cpol
*
*      here to check for polling
*
      mov  stmcs,-(xs)       save present count start on stack
      dcvt polct            poll interval within stmct
      bnz  polct,stmgo4      jump if not poll time yet
      zer  wa                =0 for poll

```

	mov kvstn,wb	statement number
	mov xr,xl	make collectable
	jsr syspl	allow interactive access
	err syspl	allow interactive access
	ppm	single step
	ppm	expression evaluation
	mov xl,xr	restore code block pointer
	mov wa,polcs	poll interval start value
	jsr stgcc	recompute counter values
<i>fi</i>		
	*	
	* check statement limit	
	*	
stgo4	ldi kvstc	get stmt count
	ilt stgo5	omit counting if negative
	mti (xs)+	reload start value of counter
	ngi	negate
	adi kvstc	stmt count minus counter
	sti kvstc	replace it
	ile stcov	fail if stlimit reached
	bze r\$stc,stgo5	jump if no statement trace
	zer xr	clear garbage value in xr
	mov r\$stc,xl	load pointer to stcount trblk
	jsr ktrex	execute keyword trace
	*	
	* reset stmgo counter	
	*	
stgo5	mov stmcs,stmct	reset counter
	brn stgo1	fetch next code word

```

*
*      stopr -- terminate run
*
*      (xr)                points to ending message
*      brn stopr           jump to terminate run
*
*      terminate run and print statistics.  on entry xr points
*      to ending message or is zero if message  printed already.
*
stopr  rtn   stgo1
if .csax
    bze  xr,stpra           skip if sysax already called
    jsr  sysax             call after execution proc
    stpra add  rsmem,dname  use the reserve memory
else
    add  rsmem,dname       use the reserve memory
fi

    bne  xr,=endms,stpr0   skip if not normal end message
    bnz  exsts,stpr3       skip if exec stats suppressed
    zer  erich             clear errors to int.ch. flag

*
*      look to see if an ending message is supplied
*
stpr0  jsr  prtpg           eject printer
    bze  xr,stpr1         skip if no message
    jsr  prtst            print message

*
*      merge here if no message to print
*
stpr1  jsr  prtis          print blank line
if .csfn
    bnz  gbcfl,stpr5       if in garbage collection, skip
    mov  =stpm7,xr         point to message /in file xxx/
    jsr  prtst            print it
    mov  =prtmf,profs      set column offset
    mov  kvstn,wc          get statement number
    jsr  filnm            get file name
    mov  xl,xr            prepare to print
    jsr  prtst            print file name
    jsr  prtis            print to interactive channel
fi

if .csln
    if .csfn
    else
        bnz  gbcfl,stpr5   if in garbage collection, skip
    fi

    mov  r$cod,xr          get code pointer
    mti  cdsln(xr)        get source line number
    mov  =stpm6,xr        point to message /in line xxx/
    jsr  prtmx            print it

```


fi

```
stpr5  mti  kvstn
        mov  =stpm1,xr
        jsr  prtmx
        jsr  systm
        sbi  timsx
        sti  stpti
        mov  =stpm3,xr
        jsr  prtmx
        ldi  kvstl
        ilt  stpr2
        sbi  kvstc
        sti  stpsi
        mov  stmcs,wa
        sub  stmct,wa
        mti  wa
        adi  stpsi
        sti  stpsi
        mov  =stpm2,xr
        jsr  prtmx
```

if .ctmd

else

```
        ldi  stpti
        mli  intth
        iov  stpr2
        dvi  stpsi
        iov  stpr2
        mov  =stpm4,xr
        jsr  prtmx
```

fi

get statement number
point to message /in statement xxx/
print it
get current time
minus start time = elapsed exec tim
save for later
point to msg /execution time msec /
print it
get statement limit
skip if negative
minus counter = course count
save
refine with counter start value
minus current counter
convert to integer
add in course count
save
point to message /stmts executed/
print it

reload elapsed time
*1000 (microsecs)
jump if we cannot compute
divide by statement count
jump if overflow
point to msg (mcsec per statement /
print it

```

*
*      stopr (continued)
*
*      merge to skip message (overflow or negative stlimit)
*
stpr2  mti   gbcnt                load count of collections
      mov   =stpm5,xr            point to message /regenerations /
      jsr   prtmx                print it
      jsr   prtmm               print memory usage
      jsr   prtis               one more blank for luck

*
*      check if dump requested
*
if .cnpf
stpr3  mov   kvdmp,xr            load dump keyword
else
stpr3  jsr   prflr              print profile if wanted
*
      mov   kvdmp,xr            load dump keyword
fi

      jsr   dumpr                execute dump if requested
      mov   r$fcbl,xl            get fcbl chain head
      mov   kvabe,wa             load abend value
      mov   kvcod,wb             load code value
      jsr   sysej                exit to system
if .cera
*
*      here after sysea call and suppressing error msg print
*
stpr4  rtn   sysej
      add   rsmem,dname          use the reserve memory
      bze   exsts,stpr1          if execution stats requested
      brn   stpr3                check if dump or profile needed
fi

```

```

*
*      succp -- signal successful match of a pattern node
*
*      see pattern match routines for details
*
*      (xr)                current node
*      (wb)                current cursor
*      (x1)                may be non-collectable
*      brn  succp          signal successful pattern match
*
*      succp continues by matching the successor node
*
succp  rtn  stpr3
      mov  pthen(xr),xr          load successor node
      mov  (xr),x1              load node code entry address
      bri  x1                   jump to match successor node

```

```

*
*      sysab -- print /abnormal end/ and terminate
*
sysab  rtn   xl
      mov   =endab,xr           point to message
      mov   =num01,kvabe       set abend flag
      jsr   prtnl              skip to new line
      brn   stopr              jump to pack up

```

```

*
*      systu -- print /time up/ and terminate
*
systu  rtn  stopr
        mov  =endtu,xr          point to message
        mov  strtu,wa          get chars /tu/
        mov  wa,kvcod          put in kvcod
        mov  timup,wa          check state of timeup switch
        mnz  timup             set switch
        bnz  wa,stopr          stop run if already set
        erb  245,translation/execution  time expired

```

spitbol – utility procedures

```
*
*
* the following section contains procedures which are
* used for various purposes throughout the system.
*
* each procedure is preceded by a description of the
* calling sequence. usually the arguments are in registers
* but arguments can also occur on the stack and as
* parameters assembled after the jsr instruction.
*
* the following considerations apply to these descriptions.
*
* 1) the stack pointer (xs) is not changed unless the
* change is explicitly documented in the call.
*
* 2) registers whose entry values are not mentioned
* may contain any value except that xl,xr may only
* contain proper (collectable) pointer values.
* this condition means that the called routine
* may if it chooses preserve xl,xr by stacking.
*
* 3) registers not mentioned on exit contain the same
* values as they did on entry except that values in
* xr,xl may have been relocated by the collector.
*
* 4) registers which are destroyed on exit may contain
* any value except that values in xl,xr are proper
* (collectable) pointers.
*
* 5) the code pointer register points to the current
* code location on entry and is unchanged on exit.
*
* in the above description, a collectable pointer is one
* which either points outside the dynamic region or
* points to the start of a block in the dynamic region.
*
* in those cases where the calling sequence contains
* parameters which are used as alternate return points,
* these parameters may be replaced by error codes
* assembled with the err instruction. this will result
* in the posting of the error if the return is taken.
*
* the procedures all have names consisting of five letters
* and are in alphabetical order by their names.
```

```

*
*      access - access variable value with trace/input checks
*
*      access loads the value of a variable. trace and input
*      associations are tested for and executed as required.
*      access also handles the special cases of pseudo-variables.
*
*      (xl)          variable name base
*      (wa)          variable name offset
*      jsr  access    call to access value
*      ppm  loc       transfer loc if access failure
*      (xr)          variable value
*      (wa,wb,wc)     destroyed
*      (xl,ra)        destroyed
*
*      failure can occur if an input association causes an end
*      of file condition or if the evaluation of an expression
*      associated with an expression variable fails.
*
access  prc  r,1          entry point (recursive)
        mov  xl,xr        copy name base
        add  wa,xr        point to variable location
        mov  (xr),xr      load variable value
*
*      loop here to check for successive trblks
*
acs02   bne  (xr),=b$trt,acs18      jump if not trapped
*
*      here if trapped
*
        beq  xr,=trbkv,acs12      jump if keyword variable
        bne  xr,=trbev,acs05      jump if not expression variable
*
*      here for expression variable, evaluate variable
*
        mov  evexp(xl),xr      load expression pointer
        zer  wb                evaluate by value
        jsr  evalx            evaluate expression
        ppm  acs04            jump if evaluation failure
        brn  acs02            check value for more trblks

```

```

*
*      access (continued)
*
*      here on reading end of file
*
acs03  add  *num03,xs          pop trblk ptr, name base and offset
      mov  xr,dnamp          pop unused scblk
*
*      merge here when evaluation of expression fails
*
acs04  exi   1                take alternate (failure) return
*
*      here if not keyword or expression variable
*
acs05  mov  trtyp(xr),wb      load trap type code
      bnz  wb,acs10          jump if not input association
      bze  kvinp,acs09       ignore input assoc if input is off
*
*      here for input association
*
      mov  xl,-(xs)          stack name base
      mov  wa,-(xs)          stack name offset
      mov  xr,-(xs)          stack trblk pointer
      mov  kvtrm,actrm       temp to hold trim keyword
      mov  trfpt(xr),xl      get file ctrl blk ptr or zero
      bnz  xl,acs06          jump if not standard input file
      beq  trter(xr),=v$ter,acs21  jump if terminal
*
*      here to read from standard input file
*
      mov  cswin,wa          length for read buffer
      jsr  alocs             build string of appropriate length
      jsr  sysrd             read next standard input image
      ppm  acs03             jump to fail exit if end of file
      brn  acs07             else merge with other file case
*
*      here for input from other than standard input file
*
acs06  mov  xl,wa            fcbk ptr
      jsr  sysil             get input record max length (to wa)
      bnz  wc,acs6a          jump if not binary file
      mov  wc,actrm          disable trim for binary file
acs6a  jsr  alocs             allocate string of correct size
      mov  xl,wa            fcbk ptr
      jsr  sysin             call system input routine
      ppm  acs03             jump to fail exit if end of file
      ppm  acs22             error
      ppm  acs23             error

```



```

*
*      access (continued)
*
*      merge here after obtaining input record
*
acs07  mov  actrm,wb          load trim indicator
      jsr  trimr            trim record as required
      mov  xr,wb            copy result pointer
      mov  (xs),xr          reload pointer to trblk
*
*      loop to chase to end of trblk chain and store value
*
acs08  mov  xr,xl            save pointer to this trblk
      mov  trnxt(xr),xr      load forward pointer
      beq  (xr),=b$trt,acs08 loop if this is another trblk
      mov  wb,trnxt(xl)      else store result at end of chain
      mov  (xs)+,xr          restore initial trblk pointer
      mov  (xs)+,wa          restore name offset
      mov  (xs)+,xl          restore name base pointer
*
*      come here to move to next trblk
*
acs09  mov  trnxt(xr),xr      load forward ptr to next value
      brn  acs02            back to check if trapped
*
*      here to check for access trace trblk
*
acs10  bne  wb,=trtac,acs09   loop back if not access trace
      bze  kvtra,acs09        ignore access trace if trace off
      dcv  kvtra              else decrement trace count
      bze  trfnc(xr),acs11    jump if print trace

```

```

*
*      access (continued)
*
*      here for full function trace
*
      jsr  trxeq          call routine to execute trace
      brn  acs09          jump for next trblk
*
*      here for case of print trace
*
acs11  jsr  prtzn          print statement number
      jsr  prtnv          print name = value
      brn  acs09          jump back for next trblk
*
*      here for keyword variable
*
acs12  mov  kvnum(xl),xr   load keyword number
      bge  xr,=k$v$$,acs14 jump if not one word value
      mti  kvabe(xr)      else load value as integer
*
*      common exit with keyword value as integer in (ia)
*
acs13  jsr  icbld          build icblk
      brn  acs18          jump to exit
*
*      here if not one word keyword value
*
acs14  bge  xr,=k$s$$,acs15 jump if special case
      sub  =k$v$$,xr      else get offset
      wtb  xr              convert to byte offset
      add  =ndabo,xr       point to pattern value
      brn  acs18          jump to exit
*
*      here if special keyword case
*
acs15  mov  kvrtn,xl       load rtntype in case
      ldi  kvstl          load stlimit in case
      sub  =k$s$$,xr       get case number
      bsw  xr,k$$n$        switch on keyword number
if .csfn
      iff  k$$fl,acs26     file
      iff  k$$lf,acs27     lastfile
fi
if .culk
      iff  k$$lc,acs24     lcase
      iff  k$$uc,acs25     ucase
fi
      iff  k$$al,acs16     jump if alphabet
      iff  k$$rt,acs17     rtntype

```

iff k\$\$\$sc,acs19
iff k\$\$\$sl,acs13
iff k\$\$\$et,acs20
esw

stcount
stlimit
errtext
end switch on keyword number

```

*
*      access (continued)
*
if .culk
*      lcase
*
acs24  mov  =lcase,xr      load pointer to lcase string
      brn  acs18          common return
*
*      ucase
*
acs25  mov  =ucase,xr      load pointer to ucase string
      brn  acs18          common return
*
fi
if .csfn
*      file
*
acs26  mov  kvstn,wc      load current stmt number
      brn  acs28          merge to obtain file name
*
*      lastfile
*
acs27  mov  kvlst,wc      load last stmt number
*
*      merge here to map statement number in wc to file name
*
acs28  jsr  film          obtain file name for this stmt
      brn  acs17          merge to return string in xl
fi
*      alphabet
*
acs16  mov  kvalp,xl      load pointer to alphabet string
*
*      rtnctype merges here
*
acs17  mov  xl,xr          copy string ptr to proper reg
*
*      common return point
*
acs18  exi                return to access caller
*
*      here for stcount (ia has stlimit)
*
acs19  ilt  acs29          if counting suppressed
      mov  stmcs,wa        refine with counter start value
      sub  stmct,wa        minus current counter
      mti  wa              convert to integer

```

	adi kvstl	add stlimit
acs29	sbi kvstc	stcount = limit - left
	brn acs13	merge back with integer result
	*	
	*	
	errtext	
	*	
acs20	mov r\$etx,xr	get errtext string
	brn acs18	merge with result
	*	
	*	
	here to read a record from terminal	
	*	
acs21	mov =rilen,wa	buffer length
	jsr alocs	allocate buffer
	jsr sysri	read record
	ppm acs03	endfile
	brn acs07	merge with record read
	*	
	*	
	error returns	
	*	
acs22	mov xr,dnamp	pop unused scblk
	erb 202,input from file	caused non-recoverable error
	*	
acs23	mov xr,dnamp	pop unused scblk
	erb 203,input file record	has incorrect format
	enp	end procedure acess

```

*
*      acomp -- compare two arithmetic values
*
*      1(xs)          first argument
*      0(xs)          second argument
*      jsr  acomp      call to compare values
*      ppm  loc        transfer loc if arg1 is non-numeric
*      ppm  loc        transfer loc if arg2 is non-numeric
*      ppm  loc        transfer loc for arg1 lt arg2
*      ppm  loc        transfer loc for arg1 eq arg2
*      ppm  loc        transfer loc for arg1 gt arg2
*      (normal return is never given)
*      (wa,wb,wc,ia,ra)  destroyed
*      (x1,xr)          destroyed
*
acomp  prc  n,5          entry point
      jsr  arith         load arithmetic operands
      ppm  acmp7         jump if first arg non-numeric
      ppm  acmp8         jump if second arg non-numeric
if .cnra
else
      ppm  acmp4         jump if real arguments
fi

*
*      here for integer arguments
*
      sbi  icval(x1)      subtract to compare
      iov  acmp3          jump if overflow
      ilt  acmp5          else jump if arg1 lt arg2
      ieq  acmp2          jump if arg1 eq arg2
*
*      here if arg1 gt arg2
*
acmp1  exi  5            take gt exit
*
*      here if arg1 eq arg2
*
acmp2  exi  4            take eq exit

```

```

*
*      acomp (continued)
*
*      here for integer overflow on subtract
*
acmp3  ldi   icval(x1)           load second argument
      ilt   acmp1               gt if negative
      brn   acmp5               else lt
if .cnra
else
*
*      here for real operands
*
acmp4  sbr   rcval(x1)           subtract to compare
      rov   acmp6               jump if overflow
      rgt   acmp1               else jump if arg1 gt
      req   acmp2               jump if arg1 eq arg2
fi

*
*      here if arg1 lt arg2
*
acmp5  exi   3                   take lt exit
if .cnra
else
*
*      here if overflow on real subtraction
*
acmp6  ldr   rcval(x1)           reload arg2
      rlt   acmp1               gt if negative
      brn   acmp5               else lt
fi

*
*      here if arg1 non-numeric
*
acmp7  exi   1                   take error exit
*
*      here if arg2 non-numeric
*
acmp8  exi   2                   take error exit
      enp                       end procedure acomp

```

```

*
*      alloc          allocate block of dynamic storage
*
*      (wa)           length required in bytes
*      jsr  alloc      call to allocate block
*      (xr)           pointer to allocated block
*
*      a possible alternative to aov ... and following stmt is -
*      mov  dname,xr . sub  wa,xr . blo xr,dnamp,aloc2 .
*      mov  dnamp,xr . add  wa,xr
*
alloc  prc  e,0                      entry point
*
*      common exit point
*
aloc1  mov  dnamp,xr                point to next available loc
      aov  wa,xr,aloc2             point past allocated block
      bgt  xr,dname,aloc2          jump if not enough room
      mov  xr,dnamp                store new pointer
      sub  wa,xr                   point back to start of allocated bk
      exi                          return to caller
*
*      here if insufficient room, try a garbage collection
*
aloc2  mov  wb,allsv                save wb
alc2a  zer  wb                      set no upward move for gbcol
      jsr  gbcol                   garbage collect
if .csed
      mov  xr,wb                   remember new sediment size
fi
*
*      see if room after gbcol or sysmm call
*
aloc3  mov  dnamp,xr                point to first available loc
      aov  wa,xr,alc3a             point past new block
      blo  xr,dname,aloc4          jump if there is room now
*
*      failed again, see if we can get more core
*
alc3a  jsr  sysmm                   try to get more memory
      wtb  xr                      convert to bauss (sgd05)
      add  xr,dname                bump ptr by amount obtained
      bnz  xr,alc3                 jump if got more core
if .csed
      bze  dnams,alc3b             jump if there was no sediment
      zer  dnams                   try collecting the sediment
      brn  dnams                   try collecting the sediment
*
*      sysmm failed and there was no sediment to collect
*

```


<code>alc3b</code>	<code>add</code>	<code>rsmem,dname</code>	get the reserve memory
<code>else</code>			
	<code>add</code>	<code>rsmem,dname</code>	get the reserve memory
<code>fi</code>			
	<code>zer</code>	<code>rsmem</code>	only permissible once
	<code>icv</code>	<code>errft</code>	fatal error
	<code>erb</code>	<code>errft</code>	fatal error

```

*
*      here after successful garbage collection
*
alloc4  sti   allia                                save ia
if .csed
      mov  wb,dnams                                record new sediment size
fi

      mov  dname,wb                                get dynamic end adrs
      sub  dnamp,wb                                compute free store
      btw  wb                                       convert bytes to words
      mti  wb                                       put free store in ia
      mli  alfsf                                    multiply by free store factor
      iov  aloc5                                    jump if overflowed
      mov  dname,wb                                dynamic end adrs
      sub  dnamb,wb                                compute total amount of dynamic
      btw  wb                                       convert to words
      mov  wb,aldyn                                store it
      sbi  aldyn                                    subtract from scaled up free store
      igt  aloc5                                    jump if sufficient free store
      jsr  sysmm                                    try to get more store
      wtb  xr                                       convert to baus (sgd05)
      add  xr,dname                                adjust dynamic end adrs

*
*      merge to restore ia and wb
*
alloc5  ldi   allia                                recover ia
      mov  allsv,wb                                restore wb
      brn  aloc1                                    jump back to exit
      enp                                          end procedure alloc

```

if .cnbf

else

```

*
*      alobf -- allocate buffer
*
*      this routines allocates a new buffer.  as the bfbk
*      and bcbk come in pairs, both are allocated here,
*      and xr points to the bcbk on return.  the bfbk
*      and bcbk are set to the null buffer, and the idval
*      is zero on return.
*
*      (wa)                buffer size in characters
*      jsr  alobf           call to create buffer
*      (xr)                bcbk ptr
*      (wa,wb)             destroyed
*
alobf  prc   e,0            entry point
      bgt   wa,kvmxl,alb01  check for maxlngth exceeded
      mov   wa,wb          hang onto allocation size
      ctb   wa,bfsi$       get total block size
      add   *bcsi$,wa      add in allocation for bcbk
      jsr   alloc         allocate frame
      mov   =b$bct,(xr)    set type
      zer   idval(xr)      no id yet
      zer   bclen(xr)      no defined length
      mov   xl,wa          save xl
      mov   xr,xl          copy bcbk ptr
      add   *bcsi$,xl      bias past partially built bcbk
      mov   =b$bft,(xl)    set bfbk type word
      mov   wb,bfalc(xl)   set allocated size
      mov   xl,bcbuf(xr)   set pointer in bcbk
      zer   bfchr(xl)      clear first word (null pad)
      mov   wa,xl          restore entry xl
      exi                  return to caller
*
*      here for mxlen exceeded
*
alb01  erb   273,buffer size exceeds  value of maxlngth keyword
      enp                               end procedure alobf

```

fi

```

*
*      alocs -- allocate string block
*
*      alocs is used to build a frame for a string block into
*      which the actual characters are placed by the caller.
*      all strings are created with a call to alocs (the
*      exceptions occur in trimr and s$rpl procedures).
*
*      (wa)                length of string to be allocated
*      jsr  alocs           call to allocate scblk
*      (xr)                pointer to resulting scblk
*      (wa)                destroyed
*      (wc)                character count (entry value of wa)
*
*      the resulting scblk has the type word and the length
*      filled in and the last word is cleared to zero characters
*      to ensure correct right padding of the final word.
*
alocs  prc   e,0                entry point
       bgt   wa,kvmxl,alcs2     jump if length exceeds maxlength
       mov   wa,wc              else copy length
       ctb   wa,scsi$           compute length of scblk in bytes
       mov   dnamp,xr           point to next available location
       aov   wa,xr,alcs0        point past block
       blo   xr,dname,alcs1     jump if there is room
*
*      insufficient memory
*
alcs0  zer   xr                else clear garbage xr value
       jsr   alloc             and use standard allocator
       add   wa,xr              point past end of block to merge
*
*      merge here with xr pointing beyond new block
*
alcs1  mov   xr,dnamp           set updated storage pointer
       zer   -(xr)              store zero chars in last word
       dca   wa                 decrement length
       sub   wa,xr              point back to start of block
       mov   =b$sc1,(xr)        set type word
       mov   wc,sclen(xr)        store length in chars
       exi                     return to alocs caller
*
*      come here if string is too long
*
alcs2  erb   205,string length  exceeds value of maxlngth keyword
       enp                     end procedure alocs

```

```

*
*      alost -- allocate space in static region
*
*      (wa)                length required in bytes
*      jsr  alost           call to allocate space
*      (xr)                pointer to allocated block
*      (wb)                destroyed
*
*      note that the coding ensures that the resulting value
*      of state is always less than dnamb. this fact is used
*      in testing a variable name for being in the static region
*
alost  prc  e,0                entry point
*
*      merge back here after allocating new chunk
*
alst1  mov  state,xr           point to current end of area
      aov  wa,xr,alst2        point beyond proposed block
      bge  xr,dnamb,alst2     jump if overlap with dynamic area
      mov  xr,state           else store new pointer
      sub  wa,xr              point back to start of block
      exi                    return to alost caller
*
*      here if no room, prepare to move dynamic storage up
*
alst2  mov  wa,alsta           save wa
      bge  wa,*e$sts,alst3    skip if requested chunk is large
      mov  *e$sts,wa          else set to get large enough chunk
*
*      here with amount to move up in wa
*
alst3  jsr  alloc             allocate block to ensure room
      mov  xr,dnamp           and delete it
      mov  wa,wb              copy move up amount
      jsr  gbcol              call gbcol to move dynamic area up
if .csed
      mov  xr,dnams           remember new sediment size
fi
*
      mov  alsta,wa           restore wa
      brn  alst1              loop back to try again
      enp                    end procedure alost

```

if .cnbf

else

```
*
*      apndb -- append string to buffer
*
*      this routine is used by buffer handling routines to
*      append data to an existing bfbk.
*
*      (xr)          existing bcbk to be appended
*      (xl)          convertible to string
*      jsr  apndb      call to append to buffer
*      ppm  loc        thread if (xl) cant be converted
*      ppm  loc        if not enough room
*      (wa,wb)        destroyed
*
*      if more characters are specified than can be inserted,
*      then no action is taken and the second return is taken.
*
apndb  prc   e,2          entry point
       mov  bclen(xr),wa  load offset to insert
       zer  wb            replace section is null
       jsr  insbf         call to insert at end
       ppm  apn01         convert error
       ppm  apn02         no room
       exi                return to caller
*
*      here to take convert failure exit
*
apn01  exi   1            return to caller alternate
*
*      here for no fit exit
*
apn02  exi   2            alternate exit to caller
       enp                end procedure apndb
```

fi

```
*
*
*      arith -- fetch arithmetic operands
*
*      arith is used by functions and operators which expect
*      two numeric arguments (operands) which must both be
*      integer or both be real. arith fetches two arguments from
*      the stack and performs any necessary conversions.
*
*      1(xs)                first argument (left operand)
*      0(xs)                second argument (right operand)
*      jsr  arith            call to fetch numeric arguments
*      ppm  loc              transfer loc for opnd 1 non-numeric
*      ppm  loc              transfer loc for opnd 2 non-numeric
```

if .cnra

else

```
*      ppm  loc              transfer loc for real operands
```

fi

```
*
*
*      for integer args, control returns past the parameters
*
*      (ia)                left operand value
*      (xr)                ptr to icblk for left operand
*      (xl)                ptr to icblk for right operand
*      (xs)                popped twice
*      (wa,wb,ra)          destroyed
```

if .cnra

else

```
*
*
*      for real arguments, control returns to the location
*      specified by the third parameter.
*
*      (ra)                left operand value
*      (xr)                ptr to rcblk for left operand
*      (xl)                ptr to rcblk for right operand
*      (wa,wb,wc)          destroyed
*      (xs)                popped twice
```

fi

```

*
*      arith (continued)
*
*      entry point
*
if .cnra
arith   prc   n,2                      entry point
else
arith   prc   n,3                      entry point
fi

      mov   (xs)+,xl                  load right operand
      mov   (xs)+,xr                  load left operand
      mov   (xl),wa                   get right operand type word
      beq   wa,=b$ic1,arth1           jump if integer

if .cnra
else
      beq   wa,=b$rc1,arth4           jump if real
fi

      mov   xr,-(xs)                  else replace left arg on stack
      mov   xl,xr                    copy left arg pointer
      jsr   gtnum                     convert to numeric
      ppm   arth6                     jump if unconvertible
      mov   xr,xl                    else copy converted result
      mov   (xl),wa                   get right operand type word
      mov   (xs)+,xr                 reload left argument

if .cnra
else
      beq   wa,=b$rc1,arth4           jump if right arg is real
fi

*
*      here if right arg is an integer
*
arth1   bne   (xr),=b$ic1,arth3        jump if left arg not integer
*
*      exit for integer case
*
arth2   ldi   icval(xr)                load left operand value
      exi                                return to arith caller

*
*      here for right operand integer, left operand not
*
arth3   jsr   gtnum                    convert left arg to numeric
      ppm   arth7                     jump if not convertible
      beq   wa,=b$ic1,arth2           jump back if integer-integer

if .cnra
else
*
*      here we must convert real-integer to real-real
*

```



```
mov  xr,-(xs)
ldi  icval(xl)
itr
jsr  rcblb
mov  xr,xl
mov  (xs)+,xr
brn  arth5
```

```
put left arg back on stack
load right argument value
convert to real
get real block for right arg, merge
copy right arg ptr
load left argument
merge for real-real case
```

```

*
*      arith (continued)
*
*      here if right argument is real
*
arth4  beq  (xr),=b$rcl,arth5      jump if left arg real
      jsr  gtrea                  else convert to real
      ppm  arth7                  error if unconvertible
*
*      here for real-real
*
arth5  ldr  rcval(xr)              load left operand value
      exi  3                      take real-real exit
fi
*
*      here for error converting right argument
*
arth6  ica  xs                    pop unwanted left arg
      exi  2                      take appropriate error exit
*
*      here for error converting left operand
*
arth7  exi  1                      take appropriate error return
      enp                        end procedure arith

```

```

*
*      assign -- perform assignment
*
*      assign performs the assignment of a value to a variable
*      with appropriate checks for output associations and
*      value trace associations which are executed as required.
*      assign also handles the special cases of assignment to
*      pattern and expression variables.
*
*      (wb)                value to be assigned
*      (xl)                base pointer for variable
*      (wa)                offset for variable
*      jsr  assign         call to assign value to variable
*      ppm  loc            transfer loc for failure
*      (xr,xl,wa,wb,wc)    destroyed
*      (ra)                destroyed
*
*      failure occurs if the evaluation of an expression
*      associated with an expression variable fails.
*
assign  prc   r,1                entry point (recursive)
*
*      merge back here to assign result to expression variable.
*
asg01  add   wa,xl                point to variable value
      mov   (xl),xr              load variable value
      beq   (xr),=b$trt,asg02    jump if trapped
      mov   wb,(xl)              else perform assignment
      zer   xl                  clear garbage value in xl
      exi                                and return to assign caller
*
*      here if value is trapped
*
asg02  sub   wa,xl                restore name base
      beq   xr,=trbkv,asg14       jump if keyword variable
      bne   xr,=trbev,asg04       jump if not expression variable
*
*      here for assignment to expression variable
*
      mov   evexp(xl),xr          point to expression
      mov   wb,-(xs)              store value to assign on stack
      mov   =num01,wb            set for evaluation by name
      jsr   evalx                 evaluate expression by name
      ppm   asg03                 jump if evaluation fails
      mov   (xs)+,wb              else reload value to assign
      brn   asg01                 loop back to perform assignment

```

```

*
*      assign (continued)
*
*      here for failure during expression evaluation
*
asg03  ica   xs                      remove stacked value entry
      exi    1                      take failure exit
*
*      here if not keyword or expression variable
*
asg04  mov   xr,-(xs)                save ptr to first trblk
*
*      loop to chase down trblk chain and assign value at end
*
asg05  mov   xr,wc                  save ptr to this trblk
      mov   trnxt(xr),xr            point to next trblk
      beq   (xr),=b$trt,asg05       loop back if another trblk
      mov   wc,xr                  else point back to last trblk
      mov   wb,trval(xr)            store value at end of chain
      mov   (xs)+,xr               restore ptr to first trblk
*
*      loop to process trblk entries on chain
*
asg06  mov   trtyp(xr),wb           load type code of trblk
      beq   wb,=trtv1,asg08         jump if value trace
      beq   wb,=trtou,asg10         jump if output association
*
*      here to move to next trblk on chain
*
asg07  mov   trnxt(xr),xr           point to next trblk on chain
      beq   (xr),=b$trt,asg06       loop back if another trblk
      exi                                else end of chain, return to caller
*
*      here to process value trace
*
asg08  bze   kvtra,asg07            ignore value trace if trace off
      dcv   kvtra                  else decrement trace count
      bze   trfnc(xr),asg09        jump if print trace
      jsr   trxeq                  else execute function trace
      brn   asg07                  and loop back

```

```

*
*      assign (continued)
*
*      here for print trace
*
asg09  jsr  prtsn          print statement number
      jsr  prtnv          print name = value
      brn  asg07          loop back for next trblk
*
*      here for output association
*
asg10  bze  kvoup,asg07    ignore output assoc if output off
asg1b  mov  xr,xl          copy trblk pointer
      mov  trnxt(xr),xr    point to next trblk
      beq  (xr),=b$trt,asg1b loop back if another trblk
      mov  xl,xr          else point back to last trblk
if .cnbf
      mov  trval(xr),-(xs) stack value to output
else
      mov  trval(xr),xr    get value to output
      beq  (xr),=b$bct,asg11 branch if buffer
      mov  xr,-(xs)       stack value to output
fi

      jsr  gtstg          convert to string
      ppm  asg12          get datatype name if unconvertible
*
*      merge with string or buffer to output in xr
*
asg11  mov  trfpt(xl),wa   fcbk ptr
      bze  wa,asg13       jump if standard output file
*
*      here for output to file
*
asg1a  jsr  sysou          call system output routine
      err  206,output caused file overflow
      err  207,output caused non-recoverable error
      exi                    else all done, return to caller
*
*      if not printable, get datatype name instead
*
asg12  jsr  dtype          call datatype routine
      brn  asg11          merge
*
*      here to print a string to standard output or terminal
*
if .csou
asg13  beq  trter(xl),=v$ter,asg1a jump if terminal output
      icv  wa            signal standard output
      brn  asg1a          use sysou to perform output
else

```

<i>if</i> .cnbf	
asg13 jsr prtst	print string value
<i>else</i>	
asg13 bne (xr),=b\$bct,asg1c	branch if not buffer
mov xr,-(xs)	stack buffer
jsr gtstg	convert to string
ppm	always succeeds
asg1c jsr prtst	print string value
<i>fi</i>	
beq trter(xl),=v\$ter,asg20	jump if terminal output
jsr prtnl	end of line
exi	return to caller
<i>fi</i>	

```

*
*      assign (continued)
*
*      here for keyword assignment
*
asg14  mov  kvnum(xl),xl          load keyword number
      beq  xl,=k$etx,asg19       jump if errtext
      mov  wb,xr                copy value to be assigned
      jsr  gtint                convert to integer
      err  208,keyword value     assigned is not integer
      ldi  icval(xr)            else load value
      beq  xl,=k$stl,asg16       jump if special case of stlimit
      mfi  wa,asg18              else get addr integer, test overflow
      bgt  wa,mxlen,asg18        fail if too large
      beq  xl,=k$ert,asg17       jump if special case of errtype
if .cnpf
else
      beq  xl,=k$pf1,asg21       jump if special case of profile
fi

      beq  xl,=k$mx1,asg24       jump if special case of maxlen
      beq  xl,=k$fls,asg26       jump if special case of fullscan
      blt  xl,=k$p$$,asg15       jump unless protected
      erb  209,keyword in assignment is protected

*
*      here to do assignment if not protected
*
asg15  mov  wa,kvabe(xl)         store new value
      exi                          return to assign caller

*
*      here for special case of stlimit
*
*      since stcount is maintained as (stlimit-stcount)
*      it is also necessary to modify stcount appropriately.
*
asg16  sbi  kvstl                subtract old limit
      adi  kvstc                add old counter
      sti  kvstc                store course counter value
      ldi  kvstl                check if counting suppressed
      ilt  asg25                do not refine if so
      mov  stmcs,wa             refine with counter breakout
      sub  stmct,wa             values
      mti  wa                  convert to integer
      ngi                          current-start value
      adi  kvstc                add in course counter value
      sti  kvstc                save refined value
asg25  ldi  icval(xr)            reload new limit value
      sti  kvstl                store new limit value
      jsr  stgcc                recompute countdown counters
      exi                          return to assign caller

*
*      here for special case of errtype

```

```

*
asg17  ble  wa,=nini9,error          ok to signal if in range
*
*      here if value assigned is out of range
*
asg18  erb  210,keyword value        assigned is negative or too large
*
*      here for special case of errtext
*
asg19  mov  wb,-(xs)                 stack value
      jsr   gtstg                    convert to string
      err   211,value assigned       to keyword errtext not a string
      mov   xr,r$etx                 make assignment
      exi                               return to caller
if .csou
else
*
*      print string to terminal
*
asg20  jsr   prttr                    print
      exi                               return
fi

*
if .cnpf
else
*      here for keyword profile
*
asg21  bgt   wa,=num02,asg18          moan if not 0,1, or 2
      bze   wa,asg15                 just assign if zero
      bze   pfdmp,asg22              branch if first assignment
      beq   wa,pfdmp,asg23           also if same value as before
      erb   268,inconsistent         value assigned to keyword profile
*
asg22  mov   wa,pfdmp                note value on first assignment
asg23  mov   wa,kvpfl                store new value
      jsr   stgcc                    recompute countdown counts
      jsr   systm                    get the time
      sti   pfstm                    fudge some kind of start time
      exi                               return to assign caller
fi

*
*      here for keyword maxlengh
*
asg24  bge   wa,=mnlcn,asg15         if acceptable value
      erb   287,value assigned       to keyword maxlengh is too small
*
*      here for keyword fullscan
*

```



```
asg26  bnz  wa,asg15
       erb  274,value assigned
       *
       enp
```

```
if acceptable value
to keyword fullscan is zero

end procedure asign
```

```
*
*      asinp -- assign during pattern match
*
*      asinp is like asign and has a similar calling sequence
*      and effect. the difference is that the global pattern
*      variables are saved and restored if required.
*
*      (xl)                base pointer for variable
*      (wa)                offset for variable
*      (wb)                value to be assigned
*      jsr   asinp         call to assign value to variable
*      ppm   loc           transfer loc if failure
*      (xr,xl)             destroyed
*      (wa,wb,wc,ra)       destroyed
*
asinp  prc    r,1          entry point, recursive
      add    wa,xl        point to variable
      mov    (xl),xr      load current contents
      beq    (xr),=b$trt,asnp1 jump if trapped
      mov    wb,(xl)      else perform assignment
      zer    xl           clear garbage value in xl
      exi                    return to asinp caller
*
*      here if variable is trapped
*
asnp1  sub    wa,xl        restore base pointer
      mov    pmssl,-(xs)   stack subject string length
      mov    pmhbs,-(xs)   stack history stack base ptr
      mov    r$pms,-(xs)   stack subject string pointer
      mov    pmdfl,-(xs)   stack dot flag
      jsr    asign        call full-blown assignment routine
      ppm    asnp2        jump if failure
      mov    (xs)+,pmdfl   restore dot flag
      mov    (xs)+,r$pms   restore subject string pointer
      mov    (xs)+,pmhbs   restore history stack base pointer
      mov    (xs)+,pmssl   restore subject string length
      exi                    return to asinp caller
*
*      here if failure in asign call
*
asnp2  mov    (xs)+,pmdfl   restore dot flag
      mov    (xs)+,r$pms   restore subject string pointer
      mov    (xs)+,pmhbs   restore history stack base pointer
      mov    (xs)+,pmssl   restore subject string length
      exi    1            take failure exit
      enp                    end procedure asinp
```

```

*
*      blkln -- determine length of block
*
*      blkln determines the length of a block in dynamic store.
*
*      (wa)                first word of block
*      (xr)                pointer to block
*      jsr  blkln           call to get block length
*      (wa)                length of block in bytes
*      (xl)                destroyed
*
*      blkln is used by the garbage collector and is not
*      permitted to call gbccl directly or indirectly.
*
*      the first word stored in the block (i.e. at xr) may
*      be anything, but the contents of wa must be correct.
*
blkln  prc  e,0              entry point
      mov  wa,xl            copy first word
      lei  xl               get entry id (bl$xx)
      bsw  xl,bl$$$$,bln00  switch on block type
      iff  bl$ar,bln01      arblk
if .cnbf
else
      iff  bl$bc,bln04      bcbblk
      iff  bl$bf,bln11      bfblk
fi
if .csln
      iff  bl$cd,bln12      cdblk
else
      iff  bl$cd,bln01      cdblk
fi
      iff  bl$df,bln01      dfblk
      iff  bl$ef,bln01      efblk
if .csln
      iff  bl$ex,bln12      exblk
else
      iff  bl$ex,bln01      exblk
fi
      iff  bl$pf,bln01      pfblk
      iff  bl$tb,bln01      tbblk
      iff  bl$vc,bln01      vcblk
      iff  bl$ev,bln03      evblk
      iff  bl$kv,bln03      kvblk
      iff  bl$p0,bln02      p0blk
      iff  bl$se,bln02      seblk
      iff  bl$nm,bln03      nmblk
      iff  bl$p1,bln03      p1blk
      iff  bl$p2,bln04      p2blk
      iff  bl$te,bln04      teblk
      iff  bl$ff,bln05      ffblk

```

	iff	b1\$tr,bln05	trblk
	iff	b1\$ct,bln06	ctblk
	iff	b1\$ic,bln07	icblk
	iff	b1\$pd,bln08	pdblk
<i>if</i>	.cnra		
<i>else</i>			
	iff	b1\$rc,bln09	rcblk
<i>fi</i>			
	iff	b1\$sc,bln10	scblk
	esw		end of jump table on block type

```

*
*      blkln (continued)
*
*      here for blocks with length in second word
*
bln00  mov  num01(xr),wa          load length
      exi                      return to blkln caller
*
*      here for length in third word (ar,cd,df,ef,ex,pf,tb,vc)
*
bln01  mov  num02(xr),wa          load length from third word
      exi                      return to blkln caller
*
*      here for two word blocks (p0,se)
*
bln02  mov  *num02,wa             load length (two words)
      exi                      return to blkln caller
*
*      here for three word blocks (nm,p1,ev,kv)
*
bln03  mov  *num03,wa             load length (three words)
      exi                      return to blkln caller
*
*      here for four word blocks (p2,te,bc)
*
bln04  mov  *num04,wa             load length (four words)
      exi                      return to blkln caller
*
*      here for five word blocks (ff,tr)
*
bln05  mov  *num05,wa             load length
      exi                      return to blkln caller

```

```

*
*      blkln (continued)
*
*      here for ctblk
*
bln06  mov  *ctsi$,wa      set size of ctblk
      exi                return to blkln caller
*
*      here for icblk
*
bln07  mov  *icsi$,wa      set size of icblk
      exi                return to blkln caller
*
*      here for pdblk
*
bln08  mov  pddfp(xr),xl    point to dfblk
      mov  dfpdl(xl),wa    load pdblk length from dfblk
      exi                return to blkln caller
if .cnra
else
*
*      here for rcblk
*
bln09  mov  *rcsi$,wa      set size of rcblk
      exi                return to blkln caller
fi
*
*      here for scblk
*
bln10  mov  sclen(xr),wa    load length in characters
      ctb  wa,scsi$        calculate length in bytes
      exi                return to blkln caller
if .cnbf
else
*
*      here for bfblk
*
bln11  mov  bfalc(xr),wa    get allocation in bytes
      ctb  wa,bfsi$        calculate length in bytes
      exi                return to blkln caller
fi
if .csln
*
*      here for length in fourth word (cd,ex)
*
bln12  mov  num03(xr),wa    load length from cdlen/exlen
      exi                return to blkln caller
fi

```

enp

end procedure blkln

```

*
*      copyb -- copy a block
*
*      (xs)                block to be copied
*      jsr  copyb           call to copy block
*      ppm  loc             return if block has no idval field
*                          normal return if idval field
*      (xr)                copy of block
*      (xs)                popped
*      (xl,wa,wb,wc)        destroyed
*
copyb  prc  n,1              entry point
      mov  (xs),xr          load argument
      beq  xr,=nulls,cop10  return argument if it is null
      mov  (xr),wa          else load type word
      mov  wa,wb            copy type word
      jsr  blkln            get length of argument block
      mov  xr,xl            copy pointer
      jsr  alloc            allocate block of same size
      mov  xr,(xs)          store pointer to copy
      mvw                     copy contents of old block to new
      zer  xl               clear garbage xl
      mov  (xs),xr          reload pointer to start of copy
      beq  wb,=b$tblt,cop05 jump if table
      beq  wb,=b$vct,cop01  jump if vector
      beq  wb,=b$pdtd,cop01 jump if program defined
if .cnbf
else
      beq  wb,=b$bct,cop11  jump if buffer
fi
      bne  wb,=b$art,cop10  return copy if not array
*
*      here for array (arblk)
*
      add  arofs(xr),xr     point to prototype field
      brn  cop02            jump to merge
*
*      here for vector, program defined
*
cop01  add  *pdfld,xr        point to pdfld = vcvs
*
*      merge here for arblk, vcbk, pdbk to delete trap
*      blocks from all value fields (the copy is untrapped)
*
cop02  mov  (xr),xl          load next pointer
*
*      loop to get value at end of trblk chain
*
cop03  bne  (xl),=b$trt,cop04 jump if not trapped
      mov  trval(xl),xl     else point to next value

```


brn cop03

and loop back

```

*
*      copyb (continued)
*
*      here with untrapped value in x1
*
cop04  mov  x1,(xr)+          store real value, bump pointer
      bne  xr,dnamp,cop02     loop back if more to go
      brn  cop09              else jump to exit

*
*      here to copy a table
*
cop05  zer  idval(xr)         zero id to stop dump blowing up
      mov  *tesi$,wa          set size of teblk
      mov  *tbbuk,wc          set initial offset

*
*      loop through buckets in table
*
cop06  mov  (xs),xr           load table pointer
      beq  wc,tblen(xr),cop09 jump to exit if all done
      mov  wc,wb              else copy offset
      sub  *tenxt,wb          subtract link offset to merge
      add  wb,xr              next bucket header less link offset
      ica  wc                 bump offset

*
*      loop through teblks on one chain
*
cop07  mov  tenxt(xr),x1      load pointer to next teblk
      mov  (xs),tenxt(xr)     set end of chain pointer in case
      beq  (x1),=b$tbtt,cop06 back for next bucket if chain end
      sub  wb,xr              point to head of previous block
      mov  xr,-(xs)           stack ptr to previous block
      mov  *tesi$,wa          set size of teblk
      jsr  alloc              allocate new teblk
      mov  xr,-(xs)           stack ptr to new teblk
      mvw  copy old teblk to new teblk
      mov  (xs)+,xr           restore pointer to new teblk
      mov  (xs)+,x1           restore pointer to previous block
      add  wb,x1              add offset back in
      mov  xr,tenxt(x1)       link new block to previous
      mov  xr,x1              copy pointer to new block

*
*      loop to set real value after removing trap chain
*
cop08  mov  teval(x1),x1      load value
      beq  (x1),=b$trtt,cop08 loop back if trapped
      mov  x1,teval(xr)       store untrapped value in teblk
      zer  wb                 zero offset within teblk
      brn  cop07              back for next teblk

*
*      common exit point
*

```

cop09	mov (xs)+,xr	load pointer to block
	exi	return
	*	
	* alternative return	
	*	
cop10	exi 1	return

```

if .cnbf
else
    *
    *      here to copy buffer
    *
cop11  mov  bcbuf(xr),xl      get bfbk ptr
      mov  bfalc(xl),wa      get allocation
      ctb  wa,bfsi$          set total size
      mov  xr,xl             save bcbk ptr
      jsr  alloc            allocate bfbk
      mov  bcbuf(xl),wb      get old bfbk
      mov  xr,bcbuf(xl)      set pointer to new bfbk
      mov  wb,xl             point to old bfbk
      mvw                      copy bfbk too
      zer  xl               clear rubbish ptr
      brn  cop09            branch to exit

fi

      enp                  end procedure copyb

    *
    *      cdgcg -- generate code for complex goto
    *
    *      used by cmpil to process complex goto tree
    *
    *      (wb)              must be collectable
    *      (xr)              expression pointer
    *      jsr  cdgcg         call to generate complex goto
    *      (xl,xr,wa)         destroyed
    *
cdgcg  prc  e,0              entry point
      mov  cmopn(xr),xl      get unary goto operator
      mov  cmrop(xr),xr      point to goto operand
      beq  xl,=opdvd,cdgc2   jump if direct goto
      jsr  cdgnm             generate opnd by name if not direct

    *
    *      return point
    *
cdgc1  mov  xl,wa            goto operator
      jsr  cdwrd            generate it
      exi                  return to caller

    *
    *      direct goto
    *
cdgc2  jsr  cdgvl            generate operand by value
      brn  cdgc1            merge to return
      enp                  end procedure cdgcg

```

```

*
*      cdgex -- build expression block
*
*      cdgex is passed a pointer to an expression tree (see
*      expan) and returns an expression (seblk or exblk).
*
if .cevb
*      (wa)                  0 if by value, 1 if by name
fi

*      (wc)                  some collectable value
*      (wb)                  integer in range 0 le x le mxlen
*      (xl)                  ptr to expression tree
*      jsr  cdgex             call to build expression
*      (xr)                  ptr to seblk or exblk
*      (xl,wa,wb)            destroyed
*
cdgex  prc   r,0              entry point, recursive
      blo   (xl),=b$vr$,cdgx1  jump if not variable
*
*      here for natural variable, build seblk
*
      mov   *sesi$,wa        set size of seblk
      jsr   alloc            allocate space for seblk
      mov   =b$sel,(xr)      set type word
      mov   xl,sevar(xr)     store vrbk pointer
      exi                    return to cdgex caller
*
*      here if not variable, build exblk
*
cdgx1  mov   xl,xr           copy tree pointer
      mov   wc,-(xs)         save wc
      mov   cwcof,xl         save current offset
if .cevb
      bze   wa,cdgx2         jump if by value
fi

      mov   (xr),wa          get type word
      bne   wa,=b$cmt,cdgx2  call by value if not cmbk
      bge   cmtyp(xr),=c$$nm,cdgx2  jump if cmbk only by value

```

```

*
*      cdgex (continued)
*
*      here if expression can be evaluated by name
*
      jsr   cdgnm                generate code by name
      mov   =ornm$,wa           load return by name word
      brn   cdgx3               merge with value case
*
*      here if expression can only be evaluated by value
*
cdgx2  jsr   cdgvl                generate code by value
      mov   =orvl$,wa           load return by value word
*
*      merge here to construct exblk
*
cdgx3  jsr   cdwrd                generate return word
      jsr   exbld                build exblk
      mov   (xs)+,wc             restore wc
      exi                        return to cdgex caller
      enp                        end procedure cdgex

```

```

*
*      cdgnm -- generate code by name
*
*      cdgnm is called during the compilation process to
*      generate code by name for an expression. see cdblk
*      description for details of code generated. the input
*      to cdgnm is an expression tree as generated by expan.
*
*      cdgnm is a recursive procedure which proceeds by making
*      recursive calls to generate code for operands.
*
*      (wb)                integer in range 0 le n le dnamb
*      (xr)                ptr to tree generated by expan
*      (wc)                constant flag (see below)
*      jsr  cdgnm          call to generate code by name
*      (xr,wa)            destroyed
*      (wc)                set non-zero if non-constant
*
*      wc is set to a non-zero (collectable) value if the
*      expression for which code is generated cannot be
*      evaluated at compile time, otherwise wc is unchanged.
*
*      the code is generated in the current ccbk (see cdwrd).
*
cdgnm  prc  r,0                entry point, recursive
      mov  xl,-(xs)            save entry xl
      mov  wb,-(xs)            save entry wb
      chk                                check for stack overflow
      mov  (xr),wa            load type word
      beq  wa,=b$cmt,cgn04     jump if cmlbk
      bhi  wa,=b$vr$,cgn02     jump if simple variable
*
*      merge here for operand yielding value (e.g. constant)
*
cgn01  erb  212,syntax error:    value used where name is required
*
*      here for natural variable reference
*
cgn02  mov  =olvn$,wa          load variable load call
      jsr  cdwrd                generate it
      mov  xr,wa                copy vrbk pointer
      jsr  cdwrd                generate vrbk pointer

```

```

*
*      cdgnm (continued)
*
*      here to exit with wc set correctly
*
cgn03  mov  (xs)+,wb          restore entry wb
       mov  (xs)+,xl          restore entry xl
       exi                    return to cdgnm caller
*
*      here for cmlbk
*
cgn04  mov  xr,xl             copy cmlbk pointer
       mov  cmtyp(xr),xr      load cmlbk type
       bge  xr,=c$$nm,cgn01   error if not name operand
       bsw  xr,c$$nm          else switch on type
       iff  c$arr,cgn05       array reference
       iff  c$fnc,cgn08       function call
       iff  c$def,cgn09       deferred expression
       iff  c$ind,cgn10       indirect reference
       iff  c$key,cgn11       keyword reference
       iff  c$ubo,cgn08       undefined binary op
       iff  c$uuo,cgn08       undefined unary op
       esw                    end switch on cmlbk type
*
*      here to generate code for array reference
*
cgn05  mov  *cmopn,wb         point to array operand
*
*      loop to generate code for array operand and subscripts
*
cgn06  jsr  cmgen             generate code for next operand
       mov  cmlen(xl),wc      load length of cmlbk
       blt  wb,wc,cgn06       loop till all generated
*
*      generate appropriate array call
*
       mov  =oaon$,wa         load one-subscript case call
       beq  wc,*cmar1,cgn07   jump to exit if one subscript case
       mov  =oamn$,wa         else load multi-subscript case call
       jsr  cdwrd             generate call
       mov  wc,wa             copy cmlbk length
       btw  wa                convert to words
       sub  =cmvls,wa         calculate number of subscripts

```



```

*
*      cdgnm (continued)
*
*      here to exit generating word (non-constant)
*
cgn07  mnz  wc                      set result non-constant
      jsr  cdwrđ                    generate word
      brn  cgn03                    back to exit
*
*      here to generate code for functions and undefined oprs
*
cgn08  mov  xl,xr                    copy cmlbk pointer
      jsr  cdgvl                    gen code by value for call
      mov  =ofne$,wa                get extra call for by name
      brn  cgn07                    back to generate and exit
*
*      here to generate code for deferred expression
*
cgn09  mov  cmrop(xl),xr              check if variable
      bhi   (xr),=b$vr$,cgn02        treat *variable as simple var
      mov  xr,xl                     copy ptr to expression tree
if .cevb
      mov  =num01,wa                 return name
fi
      jsr  cdgex                     else build exblk
      mov  =olex$,wa                 set call to load expr by name
      jsr  cdwrđ                    generate it
      mov  xr,wa                     copy exblk pointer
      jsr  cdwrđ                    generate exblk pointer
      brn  cgn03                    back to exit
*
*      here to generate code for indirect reference
*
cgn10  mov  cmrop(xl),xr              get operand
      jsr  cdgvl                    generate code by value for it
      mov  =oinn$,wa                load call for indirect by name
      brn  cgn12                    merge
*
*      here to generate code for keyword reference
*
cgn11  mov  cmrop(xl),xr              get operand
      jsr  cdgnm                    generate code by name for it
      mov  =okwn$,wa                load call for keyword by name
*
*      keyword, indirect merge here
*
cgn12  jsr  cdwrđ                    generate code for operator
      brn  cgn03                    exit
      enp                          end procedure cdgnm

```

```

*
*      cdgvl -- generate code by value
*
*      cdgvl is called during the compilation process to
*      generate code by value for an expression. see cdblk
*      description for details of the code generated. the input
*      to cdgvl is an expression tree as generated by expan.
*
*      cdgvl is a recursive procedure which proceeds by making
*      recursive calls to generate code for operands.
*
*      (wb)                integer in range 0 le n le dnamb
*      (xr)                ptr to tree generated by expan
*      (wc)                constant flag (see below)
*      jsr  cdgvl          call to generate code by value
*      (xr,wa)            destroyed
*      (wc)                set non-zero if non-constant
*
*      wc is set to a non-zero (collectable) value if the
*      expression for which code is generated cannot be
*      evaluated at compile time, otherwise wc is unchanged.
*
*      if wc is non-zero on entry, then preevaluation is not
*      allowed regardless of the nature of the operand.
*
*      the code is generated in the current ccbk (see cdwrd).
*
cdgvl  prc  r,0                entry point, recursive
      mov  (xr),wa            load type word
      beq  wa,=b$cmt,cgv01    jump if cmbk
      blt  wa,=b$ vra,cgv00   jump if icbk,rcbk,sckb
      bnz  vrlen(xr),cgv10    jump if not system variable
      mov  xr,-(xs)           stack xr
      mov  vrsvp(xr),xr       point to svbk
      mov  svbit(xr),wa       get svbk property bits
      mov  (xs)+,xr           recover xr
      anb  btkwv,wa           check if constant keyword value
      beq  wa,btkwv,cgv00     jump if constant keyword value
*
*      here for variable value reference
*
cgv10  mnz  wc                indicate non-constant value
*
*      merge here for simple constant (icbk,rcbk,sckb)
*      and for variables corresponding to constant keywords.
*
cgv00  mov  xr,wa            copy ptr to var or constant
      jsr  cdwrd            generate as code word
      exi                  return to caller

```

```

*
*      cdgvl (continued)
*
*      here for tree node (cmlbk)
*
cgv01  mov  wb,-(xs)          save entry wb
      mov  xl,-(xs)          save entry xl
      mov  wc,-(xs)          save entry constant flag
      mov  cwcof,-(xs)       save initial code offset
      chk                      check for stack overflow

*
*      prepare to generate code for cmlbk. wc is set to the
*      value of cswno (zero if -optimise, 1 if -noopt) to
*      start with and is reset non-zero for any non-constant
*      code generated. if it is still zero after generating all
*      the cmlbk code, then its value is computed as the result.
*
      mov  xr,xl              copy cmlbk pointer
      mov  cmtyp(xr),xr       load cmlbk type
      mov  cswno,wc           reset constant flag
      ble  xr,=c$pr$,cgv02    jump if not predicate value
      mnz  wc                 else force non-constant case

*
*      here with wc set appropriately
*
cgv02  bsw  xr,c$$nv          switch to appropriate generator
      iff  c$arr,cgv03        array reference
      iff  c$fnc,cgv05        function call
      iff  c$def,cgv14        deferred expression
      iff  c$sel,cgv15        selection
      iff  c$ind,cgv31        indirect reference
      iff  c$key,cgv27        keyword reference
      iff  c$ubo,cgv29        undefined binop
      iff  c$uuo,cgv30        undefined unop
      iff  c$bvl,cgv18        binops with val opds
      iff  c$alt,cgv18        alternation
      iff  c$uvl,cgv19        unops with valu opnd
      iff  c$ass,cgv21        assignment
      iff  c$cnc,cgv24        concatenation
      iff  c$cnp,cgv24        concatenation (not pattern match)
      iff  c$unm,cgv27        unops with name opnd
      iff  c$bvn,cgv26        binary $ and .
      iff  c$int,cgv31        interrogation
      iff  c$neg,cgv28        negation
      iff  c$pmt,cgv18        pattern match
      esw                      end switch on cmlbk type

```

```

*
*      cdgvl (continued)
*
*      here to generate code for array reference
*
cgv03  mov  *cmopn,wb          set offset to array operand
*
*      loop to generate code for array operand and subscripts
*
cgv04  jsr   cmgen             gen value code for next operand
      mov  cmlen(xl),wc        load cmlen length
      blt  wb,wc,cgv04         loop back if more to go
*
*      generate call to appropriate array reference routine
*
      mov  =oaov$,wa           set one subscript call in case
      beq  wc,*cmar1,cgv32      jump to exit if 1-sub case
      mov  =oamv$,wa           else set call for multi-subscripts
      jsr  cdwrd               generate call
      mov  wc,wa               copy length of cmlen
      sub  *cmvls,wa           subtract standard length
      btw  wa                  get number of words
      brn  cgv32               jump to generate subscript count
*
*      here to generate code for function call
*
cgv05  mov  *cmvls,wb          set offset to first argument
*
*      loop to generate code for arguments
*
cgv06  beq  wb,cmlen(xl),cgv07  jump if all generated
      jsr  cmgen               else gen value code for next arg
      brn  cgv06               back to generate next argument
*
*      here to generate actual function call
*
cgv07  sub  *cmvls,wb          get number of arg ptrs (bytes)
      btw  wb                  convert bytes to words
      mov  cmopn(xl),xr        load function vrbk pointer
      bnz  vrlen(xr),cgv12     jump if not system function
      mov  vrsvp(xr),xl        load svblk ptr if system var
      mov  svbit(xl),wa        load bit mask
      anb  btffc,wa            test for fast function call allowed
      zrb  wa,cgv12            jump if not

```

```

*
*      cdgvl (continued)
*
*      here if fast function call is allowed
*
      mov  svbit(xl),wa      reload bit indicators
      anb  btpre,wa         test for preevaluation ok
      nzb  wa,cgv08         jump if preevaluation permitted
      mnz  wc              else set result non-constant
*
*      test for correct number of args for fast call
*
cgv08  mov  vrfnc(xr),xl    load ptr to svfnc field
      mov  fargs(xl),wa    load svnar field value
      beq  wa,wb,cgv11     jump if argument count is correct
      bhi  wa,wb,cgv09     jump if too few arguments given
*
*      here if too many arguments, prepare to generate o$pop$
*
      sub  wa,wb           get number of extra args
      lct  wb,wb           set as count to control loop
      mov  =opop$,wa      set pop call
      brn  cgv10          jump to common loop
*
*      here if too few arguments, prepare to generate nulls
*
cgv09  sub  wb,wa          get number of missing arguments
      lct  wb,wa          load as count to control loop
      mov  =nulls,wa      load ptr to null constant
*
*      loop to generate calls to fix argument count
*
cgv10  jsr  cdwrd          generate one call
      bct  wb,cgv10       loop till all generated
*
*      here after adjusting arg count as required
*
cgv11  mov  xl,wa         copy pointer to svfnc field
      brn  cgv36         jump to generate call

```

```

*
*      cdgvl (continued)
*
*      come here if fast call is not permitted
*
cgv12  mov  =ofns$,wa           set one arg call in case
      beq  wb,=num01,cgv13      jump if one arg case
      mov  =ofnc$,wa           else load call for more than 1 arg
      jsr  cdwrd               generate it
      mov  wb,wa               copy argument count

*
*      one arg case merges here
*
cgv13  jsr  cdwrd               generate =o$fns or arg count
      mov  xr,wa               copy vrbk pointer
      brn  cgv32               jump to generate vrbk ptr

*
*      here for deferred expression
*
cgv14  mov  cmrop(xl),xl        point to expression tree
if.cevb
      zer  wa                  return value
fi

      jsr  cdgex               build exblk or seblk
      mov  xr,wa               copy block ptr
      jsr  cdwrd               generate ptr to exblk or seblk
      brn  cgv34               jump to exit, constant test

*
*      here to generate code for selection
*
cgv15  zer  -(xs)               zero ptr to chain of forward jumps
      zer  -(xs)               zero ptr to prev o$slc forward ptr
      mov  *cmvls,wb           point to first alternative
      mov  =osla$,wa           set initial code word

*
*      0(xs)                   is the offset to the previous word
*                               which requires filling in with an
*                               offset to the following o$slc,o$sld
*
*      1(xs)                   is the head of a chain of offset
*                               pointers indicating those locations
*                               to be filled with offsets past
*                               the end of all the alternatives
*
cgv16  jsr  cdwrd               generate o$slc (o$sla first time)
      mov  cwcof,(xs)          set current loc as ptr to fill in
      jsr  cdwrd               generate garbage word there for now
      jsr  cmgen               gen value code for alternative
      mov  =oslb$,wa           load o$slb pointer
      jsr  cdwrd               generate o$slb call

```

```
mov num01(xs),wa  
mov cwcof,num01(xs)  
jsr  cdwrd
```

```
load old chain ptr  
set current loc as new chain head  
generate forward chain link
```

```

*
*      cdgvl (continued)
*
*      now to fill in the skip offset to o$slc,o$sld
*
      mov  (xs),xr          load offset to word to plug
      add  r$ccb,xr         point to actual location to plug
      mov  cwcof,(xr)       plug proper offset in
      mov  =oslc$,wa        load o$slc ptr for next alternative
      mov  wb,xr            copy offset (destroy garbage xr)
      ica  xr               bump extra time for test
      blt  xr,cmlen(xl),cgv16 loop back if not last alternative
*
*      here to generate code for last alternative
*
      mov  =osld$,wa        get header call
      jsr  cdwrđ           generate o$sld call
      jsr  cmgen           generate code for last alternative
      ica  xs              pop offset ptr
      mov  (xs)+,xr         load chain ptr
*
*      loop to plug offsets past structure
*
cgv17  add  r$ccb,xr        make next ptr absolute
      mov  (xr),wa         load forward ptr
      mov  cwcof,(xr)      plug required offset
      mov  wa,xr           copy forward ptr
      bnz  wa,cgv17        loop back if more to go
      brn  cgv33           else jump to exit (not constant)
*
*      here for binary ops with value operands
*
cgv18  mov  cmlop(xl),xr   load left operand pointer
      jsr  cdgvl          gen value code for left operand
*
*      here for unary ops with value operand (binops merge)
*
cgv19  mov  cmrop(xl),xr   load right (only) operand ptr
      jsr  cdgvl          gen code by value

```



```

*
*      cdgvl (continued)
*
*      merge here to generate operator call from cmopn field
*
cgv20  mov  cmopn(xl),wa      load operator call pointer
      brn  cgv36            jump to generate it with cons test
*
*      here for assignment
*
cgv21  mov  cmlop(xl),xr      load left operand pointer
      blo  (xr),=b$vr$,cgv22  jump if not variable
*
*      here for assignment to simple variable
*
      mov  cmrop(xl),xr      load right operand ptr
      jsr  cdgvl            generate code by value
      mov  cmlop(xl),wa      reload left operand vrbk ptr
      add  *vrsto,wa         point to vrsto field
      brn  cgv32            jump to generate store ptr
*
*      here if not simple variable assignment
*
cgv22  jsr  expap            test for pattern match on left side
      ppm  cgv23            jump if not pattern match
*
*      here for pattern replacement
*
      mov  cmrop(xr),cmlop(xl)  save pattern ptr in safe place
      mov  cmlop(xr),xr        load subject ptr
      jsr  cdgnm              gen code by name for subject
      mov  cmlop(xl),xr        load pattern ptr
      jsr  cdgvl              gen code by value for pattern
      mov  =opmn$,wa          load match by name call
      jsr  cdwrd              generate it
      mov  cmrop(xl),xr        load replacement value ptr
      jsr  cdgvl              gen code by value
      mov  =orpl$,wa          load replace call
      brn  cgv32              jump to gen and exit (not constant)
*
*      here for assignment to complex variable
*
cgv23  mnz  wc                inhibit pre-evaluation
      jsr  cdgnm              gen code by name for left side
      brn  cgv31              merge with unop circuit

```

```

*
*      cdgvl (continued)
*
*      here for concatenation
*
cgv24  mov  cmlop(xl),xr          load left operand ptr
      bne  (xr),=b$cmt,cgv18     ordinary binop if not cmblk
      mov  cmtyp(xr),wb          load cmblk type code
      beq  wb,=c$int,cgv25       special case if interrogation
      beq  wb,=c$neg,cgv25       or negation
      bne  wb,=c$fnc,cgv18       else ordinary binop if not function
      mov  cmopn(xr),xr          else load function vrbk ptr
      bnz  vrlen(xr),cgv18       ordinary binop if not system var
      mov  vrsvp(xr),xr          else point to svblk
      mov  svbit(xr),wa          load bit indicators
      anb  btprd,wa              test for predicate function
      zrb  wa,cgv18              ordinary binop if not
*
*      here if left arg of concatenation is predicate function
*
cgv25  mov  cmlop(xl),xr          reload left arg
      jsr  cdgvl                 gen code by value
      mov  =opop$,wa             load pop call
      jsr  cdwrd                 generate it
      mov  cmrop(xl),xr          load right operand
      jsr  cdgvl                 gen code by value as result code
      brn  cg33                  exit (not constant)
*
*      here to generate code for pattern, immediate assignment
*
cgv26  mov  cmlop(xl),xr          load left operand
      jsr  cdgvl                 gen code by value, merge
*
*      here for unops with arg by name (binary $ . merge)
*
cgv27  mov  cmrop(xl),xr          load right operand ptr
      jsr  cdgnm                 gen code by name for right arg
      mov  cmopn(xl),xr          get operator code word
      bne  (xr),=o$kwv,cgv20     gen call unless keyword value

```

```

*
*      cdgvl (continued)
*
*      here for keyword by value. this is constant only if
*      the operand is one of the special system variables with
*      the svckw bit set to indicate a constant keyword value.
*      note that the only constant operand by name is a variable
*
      bnz  wc,cgv20          gen call if non-constant (not var)
      mnz  wc                else set non-constant in case
      mov  cmrop(xl),xr      load ptr to operand vrbk
      bnz  vrlen(xr),cgv20  gen (non-constant) if not sys var
      mov  vrsvp(xr),xr      else load ptr to svblk
      mov  svbit(xr),wa      load bit mask
      anb  btckw,wa          test for constant keyword
      zrb  wa,cgv20          go gen if not constant
      zer  wc                else set result constant
      brn  cg20              and jump back to generate call
*
*      here to generate code for negation
*
cgv28  mov  =onta$,wa        get initial word
      jsr  cdwrd              generate it
      mov  cwcof,wb          save next offset
      jsr  cdwrd              generate gunk word for now
      mov  cmrop(xl),xr      load right operand ptr
      jsr  cdgvl              gen code by value
      mov  =ontb$,wa         load end of evaluation call
      jsr  cdwrd              generate it
      mov  wb,xr              copy offset to word to plug
      add  r$ccb,xr           point to actual word to plug
      mov  cwcof,(xr)         plug word with current offset
      mov  =ontc$,wa         load final call
      brn  cg32              jump to generate it (not constant)
*
*      here to generate code for undefined binary operator
*
cgv29  mov  cmlop(xl),xr      load left operand ptr
      jsr  cdgvl              generate code by value

```

```

*
*      cdgvl (continued)
*
*      here to generate code for undefined unary operator
*
cgv30  mov  =c$uo$,wb          set unop code + 1
      sub  cmtyp(xl),wb       set number of args (1 or 2)
*
*      merge here for undefined operators
*
      mov  cmrop(xl),xr       load right (only) operand pointer
      jsr  cdgvl              gen value code for right operand
      mov  cmopn(xl),xr       load pointer to operator dv
      mov  dvopn(xr),xr       load pointer offset
      wtb  xr                 convert word offset to bytes
      add  =r$uba,xr          point to proper function ptr
      sub  *vrfunc,xr         set standard function offset
      brn  cgv12              merge with function call circuit
*
*      here to generate code for interrogation, indirection
*
cgv31  mnz  wc                set non constant
      brn  cgv19              merge
*
*      here to exit generating a word, result not constant
*
cgv32  jsr  cdwrđ             generate word, merge
*
*      here to exit with no word generated, not constant
*
cgv33  mnz  wc                indicate result is not constant
*
*      common exit point
*
cgv34  ica  xs                pop initial code offset
      mov  (xs)+,wa           restore old constant flag
      mov  (xs)+,xl           restore entry xl
      mov  (xs)+,wb           restore entry wb
      bnz  wc,cgv35           jump if not constant
      mov  wa,wc              else restore entry constant flag
*
*      here to return after dealing with wc setting
*
cgv35  exi                    return to cdgvl caller
*
*      exit here to generate word and test for constant
*
cgv36  jsr  cdwrđ             generate word
      bnz  wc,cgv34           jump to exit if not constant

```

```

*
*      cdgvl (continued)
*
*      here to preevaluate constant sub-expression
*
      mov  =orvl$,wa          load call to return value
      jsr  cdwrld             generate it
      mov  (xs),xl            load initial code offset
      jsr  exbld              build exblk for expression
      zer  wb                 set to evaluate by value
      jsr  evalx              evaluate expression
      ppm                      should not fail
      mov  (xr),wa            load type word of result
      blo  wa,=$aaaa,cgv37    jump if not pattern
      mov  =olpt$,wa          else load special pattern load call
      jsr  cdwrld             generate it
*
*      merge here to generate pointer to resulting constant
*
cgv37  mov  xr,wa              copy constant pointer
      jsr  cdwrld             generate ptr
      zer  wc                 set result constant
      brn  cgv34              jump back to exit
      enp                     end procedure cdgvl

```

```

*
*      cdwrđ -- generate one word of code
*
*      cdwrđ writes one word into the current code block under
*      construction. a new, larger, block is allocated if there
*      is insufficient room in the current block. cdwrđ ensures
if.csln
*      that there are at least four words left in the block
else
*      that there are at least three words left in the block
fi

*      after entering the new word. this guarantees that any
*      extra space at the end can be split off as a ccbk.
*
*      (wa)                word to be generated
*      jsr  cdwrđ          call to generate word
*
cdwrđ  prc  e,0            entry point
      mov  xr,-(xs)        save entry xr
      mov  wa,-(xs)        save code word to be generated
*
*      merge back here after allocating larger block
*
cdwd1  mov  r$ccb,xr       load ptr to ccbk being built
      bnz  xr,cdwd2        jump if block allocated
*
*      here we allocate an entirely fresh block
*
      mov  *e$cbs,wa       load initial length
      jsr  alloc           allocate ccbk
      mov  =b$cct,(xr)     store type word
      mov  *cccđ,cwcof     set initial offset
      mov  wa,cclen(xr)    store block length
if.csln
      zer  ccsln(xr)       zero line number
fi

      mov  xr,r$ccb        store ptr to new block
*
*      here we have a block we can use
*
cdwd2  mov  cwcof,wa       load current offset
if.csln
      add  *num05,wa       adjust for test (five words)
else
      add  *num04,wa       adjust for test (four words)
fi

      blo  wa,cclen(xr),cdwd4  jump if room in this block
*
*      here if no room in current block

```

*

```
bge  wa,mxlen,cdwd5
add  *e$cb$cs,wa
mov  x1,-(xs)
mov  xr,x1
blt  wa,mxlen,cdwd3
mov  mxlen,wa
```

```
jump if already at max size
else get new size
save entry x1
copy pointer
jump if not too large
else reset to max allowed size
```

```

*
*      cdwrđ (continued)
*
*      here with new block size in wa
*
cdwd3  jsr   alloc                allocate new block
      mov  xr,r$ccb              store pointer to new block
      mov  =b$cct,(xr)+          store type word in new block
      mov  wa,(xr)+              store block length
if .csln
      mov  ccsln(xl),(xr)+        copy source line number word
fi

      add  *ccuse,xl              point to ccuse,cccđd fields in old
      mov  (xl),wa                load ccuse value
      mvw                      copy useful words from old block
      mov  (xs)+,xl              restore xl
      brn  cdwd1                  merge back to try again

*
*      here with room in current block
*
cdwd4  mov  cwcof,wa              load current offset
      ica  wa                      get new offset
      mov  wa,cwcof                store new offset
      mov  wa,ccuse(xr)            store in ccbk for gbcol
      dca  wa                      restore ptr to this word
      add  wa,xr                    point to current entry
      mov  (xs)+,wa                reload word to generate
      mov  wa,(xr)                  store word in block
      mov  (xs)+,xr                restore entry xr
      exi                          return to caller

*
*      here if compiled code is too long for cdblk
*
cdwd5  erb  213,syntax error:      statement is too complicated.
      enp                          end procedure cdwrđ

```



```

*
*      cmgen -- generate code for cmblk ptr
*
*      cmgen is a subsidiary procedure used to generate value
*      code for a cmblk ptr from the main code generators.
*
*      (xl)          cmblk pointer
*      (wb)          offset to pointer in cmblk
*      jsr  cmgen     call to generate code
*      (xr,wa)        destroyed
*      (wb)          bumped by one word
*
cmgen  prc   r,0          entry point, recursive
      mov  xl,xr         copy cmblk pointer
      add  wb,xr         point to cmblk pointer
      mov  (xr),xr       load cmblk pointer
      jsr  cdgvl         generate code by value
      ica  wb            bump offset
      exi                    return to caller
      enp                    end procedure cmgen

```

```

*
*      cmpil (compile source code)
*
*      cmpil is used to convert snobol4 source code to internal
*      form (see cdblk format). it is used both for the initial
*      compile and at run time by the code and convert functions
*      this procedure has control for the entire duration of
*      initial compilation. an error in any procedure called
*      during compilation will lead first to the error section
*      and ultimately back here for resumed compilation. the
*      re-entry points after an error are specially labelled -
*
*      cmpce          resume after control card error
*      cmpse          resume after label error
*      cmpse          resume after statement error
*
*      jsr  cmpil      call to compile code
*      (xr)            ptr to cdblk for entry statement
*      (xl,wa,wb,wc,ra) destroyed
*
*      the following global variables are referenced
*
*      cmpln          line number of first line of
*                     statement to be compiled
*
*      cmpsn          number of next statement
*                     to be compiled.
*
*      cswxx          control card switch values are
*                     changed when relevant control
*                     cards are met.
*
*      cwcof          offset to next word in code block
*                     being built (see cdwrd).
*
*      lstsn          number of statement most recently
*                     compiled (initially set to zero).
*
*      r$cim          current (initial) compiler image
*                     (zero for initial compile call)
*
*      r$cni          used to point to following image.
*                     (see readr procedure).
*
*      scnngo         goto switch for scan procedure
*
*      scnll          length of current image excluding
*                     characters removed by -input.
*
*      scnpt          current scan offset, see scan.
*
*      scnrs          rescan switch for scan procedure.
*

```

```
*      scnse      offset (in r$cm) of most recently
*      scanned element. set zero if not
*      currently scanning items
```

```

*
*      cmpil (continued)
*
*      stage          stgic  initial compile in progress
*                     stgxc  code/convert compile
*                     stgev  building exblk for eval
*                     stgxt  execute time (outside compile)
*                     stgce  initial compile after end line
*                     stgxe  execute compile after end line
*
*      cmpil also uses a fixed number of locations on the
*      main stack as follows. (the definitions of the actual
*      offsets are in the definitions section).
*
*      cmstm(xs)       pointer to expan tree for body of
*                     statement (see expan procedure).
*
*      cmsgo(xs)       pointer to tree representation of
*                     success goto (see procedure scngo)
*                     zero if no success goto is given
*
*      cmfgo(xs)       like cmsgo for failure goto.
*
*      cmcgo(xs)       set non-zero only if there is a
*                     conditional goto. used for -fail,
*                     -nofail code generation.
*
*      cmpcd(xs)       pointer to cdblk for previous
*                     statement. zero for 1st statement.
*
*      cmffp(xs)       set non-zero if cdfal in previous
*                     cdblk needs filling with forward
*                     pointer, else set to zero.
*
*      cmffc(xs)       same as cmffp for current cdblk
*
*      cmsop(xs)       offset to word in previous cdblk
*                     to be filled in with forward ptr
*                     to next cdblk for success goto.
*                     zero if no fill in is required.
*
*      cmsoc(xs)       same as cmsop for current cdblk.
*
*      cmlbl(xs)       pointer to vrbk for label of
*                     current statement. zero if no label
*
*      cmtra(xs)       pointer to cdblk for entry stmt.

```

```

*
*      cmpil (continued)
*
*      entry point
*
cmpil  prc    e,0                      entry point
      lct    wb,=cmnen                set number of stack work locations
*
*      loop to initialize stack working locations
*
cmp00  zer    -(xs)                   store a zero, make one entry
      bct    wb,cmp00                 loop back until all set
      mov    xs,cmpxs                 save stack pointer for error sec
      sss    cmpss                    save s-r stack pointer if any
*
*      loop through statements
*
cmp01  mov    scnpt,wb                 set scan pointer offset
      mov    wb,scnse                 set start of element location
      mov    =ocer$,wa                point to compile error call
      jsr    cdwr                     generate as temporary cdfal
      blt    wb,scnil,cmp04           jump if chars left on this image
*
*      loop here after comment or control card
*      also special entry after control card error
*
cmpce  zer    xr                      clear possible garbage xr value
if .cinc
      bnz    cnind,cmpc2              if within include file
fi
      bne    stage,=stgic,cmp02       skip unless initial compile
cmpc2  jsr    readr                   read next input image
      bze    xr,cmp09                 jump if no input available
      jsr    nexts                    acquire next source image
      mov    cmpsn,lstsn              store stmt no for use by listr
      mov    rdcln,cmpln              store line number at start of stmt
      zer    scnpt                    reset scan pointer
      brn    cmp04                    go process image
*
*      for execute time compile, permit embedded control cards
*      and comments (by skipping to next semi-colon)
*
cmp02  mov    r$cim,xr                 get current image
      mov    scnpt,wb                 get current offset
      plc    xr,wb                     prepare to get chars
*
*      skip to semi-colon
*
cmp03  bge    scnpt,scnil,cmp09        end loop if end of image
      lch    wc,(xr)+                 get char

```

icv **scnpt**
bne **wc,=ch\$sm,cmp03**

advance offset
loop if not semi-colon

```

*
*      cmpil (continued)
*
*      here with image available to scan. note that if the input
*      string is null, then everything is ok since null is
*      actually assembled as a word of blanks.
*
cmp04  mov  r$cim,xr          point to current image
      mov  scnpt,wb         load current offset
      mov  wb,wa            copy for label scan
      plc  xr,wb            point to first character
      lch  wc,(xr)+         load first character
      beq  wc,=ch$sm,cmp12  no label if semicolon
      beq  wc,=ch$as,cmpce  loop back if comment card
      beq  wc,=ch$mn,cmp32  jump if control card
      mov  r$cim,r$cmp      about to destroy r$cim
      mov  =cmlab,xl        point to label work string
      mov  xl,r$cim         scane is to scan work string
      psc  xl               point to first character position
      sch  wc,(xl)+         store char just loaded
      mov  =ch$sm,wc        get a semicolon
      sch  wc,(xl)          store after first char
      csc  xl               finished character storing
      zer  xl               clear pointer
      zer  scnpt            start at first character
      mov  scnil,-(xs)       preserve image length
      mov  =num02,scnil     read 2 chars at most
      jsr  scane            scan first char for type
      mov  (xs)+,scnil       restore image length
      mov  xl,wc            note return code
      mov  r$cmp,xl         get old r$cim
      mov  xl,r$cim         put it back
      mov  wb,scnpt         reinstate offset
      bnz  scnbl,cmp12      blank seen - cant be label
      mov  xl,xr            point to current image
      plc  xr,wb            point to first char again
      beq  wc,=t$var,cmp06  ok if letter
      beq  wc,=t$con,cmp06  ok if digit

*
*      drop in or jump from error section if scane failed
*
cmple  mov  r$cmp,r$cim     point to bad line
      erb  214,bad label or misplaced continuation line

*
*      loop to scan label
*
cmp05  beq  wc,=ch$sm,cmp07  skip if semicolon
      icv  wa               bump offset
      beq  wa,scnil,cmp07   jump if end of image (label end)

```

```

*
*      cmpil (continued)
*
*      enter loop at this point
*
cmp06  lch   wc,(xr)+           else load next character
if.caht beq   wc,=ch$ht,cmp07    jump if horizontal tab
fi
if.cavt beq   wc,=ch$vt,cmp07    jump if vertical tab
fi
      bne   wc,=ch$b1,cmp05      loop back if non-blank
*
*      here after scanning out label
*
cmp07  mov   wa,scnpt           save updated scan offset
      sub   wb,wa               get length of label
      bze   wa,cmp12            skip if label length zero
      zer   xr                  clear garbage xr value
      jsr   sbstr               build scblk for label name
      jsr   gtnvr               locate/construct vrbk
      ppm                      dummy (impossible) error return
      mov   xr,cmlbl(xs)         store label pointer
      bnz   vrlen(xr),cmp11      jump if not system label
      bne   vrsvp(xr),=v$end,cmp11 jump if not end label
*
*      here for end label scanned out
*
      add   =stgnd,stage         adjust stage appropriately
      jsr   scane               scan out next element
      beq   x1,=t$smc,cmp10      jump if end of image
      bne   x1,=t$var,cmp08      else error if not variable
*
*      here check for valid initial transfer
*
      beq   vrlbl(xr),=stndl,cmp08 jump if not defined (error)
      mov   vrlbl(xr),cmtra(xs)  else set initial entry pointer
      jsr   scane               scan next element
      beq   x1,=t$smc,cmp10      jump if ok (end of image)
*
*      here for bad transfer label
*
cmp08  erb   215,syntax error:   undefined or erroneous entry label
*
*      here for end of input (no end label detected)
*
cmp09  zer   xr                  clear garbage xr value
      add   =stgnd,stage         adjust stage appropriately

```


	beq	stage,=stgxe,cmp10	jump if code call (ok)
	erb	216,syntax error:	missing end line
	*		
	*	here after processing end line (merge here on end error)	
	*		
cmp10	mov	=ostp\$,wa	set stop call pointer
	jsr	cdwrd	generate as statement call
	brn	cmpse	jump to generate as failure

```

*
*      cmpil (continued)
*
*      here after processing label other than end
*
cmp11  bne  stage,=stgic,cmp12          jump if code call - redef. ok
      beq  vrlbl(xr),=stndl,cmp12      else check for redefinition
      zer  cmlbl(xs)                   leave first label decln undisturbed
      erb  217,syntax error:           duplicate label
*
*      here after dealing with label
*      null statements and statements just containing a
*      constant subject are optimized out by resetting the
*      current ccblk to empty.
*
cmp12  zer  wb                         set flag for statement body
      jsr  expan                       get tree for statement body
      mov  xr,cmstm(xs)                store for later use
      zer  cmsgo(xs)                   clear success goto pointer
      zer  cmfgo(xs)                   clear failure goto pointer
      zer  cmcgo(xs)                   clear conditional goto flag
      jsr  scane                       scan next element
      beq  xl,=t$col,cmp13             jump if colon (goto)
      bnz  cswno,cmp18                 jump if not optimizing
      bnz  cmlbl(xs),cmp18             jump if label present
      mov  cmstm(xs),xr                load tree ptr for statement body
      mov  (xr),wa                     load type word
      beq  wa,=b$cmt,cmp18             jump if cmlbl
      bge  wa,=b$ vra,cmp18            jump if not icblk, scblk, or rcblk
      mov  r$ccb,xl                   load ptr to ccblk
      mov  *cccod,ccuse(xl)            reset use offset in ccblk
      mov  *cccod,cwcof                and in global
      icv  cmpsn                      bump statement number
      brn  cmp01                      generate no code for statement
*
*      loop to process goto fields
*
cmp13  mnz  scngo                      set goto flag
      jsr  scane                       scan next element
      beq  xl,=t$smc,cmp31             jump if no fields left
      beq  xl,=t$sgo,cmp14            jump if s for success goto
      beq  xl,=t$fgo,cmp16            jump if f for failure goto
*
*      here for unconditional goto (i.e. not f or s)
*
      mnz  scnrs                      set to rescan element not f,s
      jsr  scngf                      scan out goto field
      bnz  cmfgo(xs),cmp17            error if fgoto already
      mov  xr,cmfgo(xs)                else set as fgoto
      brn  cmp15                      merge with sgoto circuit
*

```

<pre> * here for success goto * cmp14 jsr scngf mov =num01,cmcgo(xs) * * uncntional goto merges here * cmp15 bnz cmsgo(xs),cmp17 mov xr,cmsgo(xs) brn cmp13 * * here for failure goto * cmp16 jsr scngf mov =num01,cmcgo(xs) bnz cmfgo(xs),cmp17 mov xr,cmfgo(xs) brn cmp13 </pre>	<pre> scan success goto field set conditional goto flag error if sgoto already given else set sgoto loop back for next goto field scan goto field set conditonal goto flag error if fgoto already given else store fgoto pointer loop back for next field </pre>
---	--

```

*
*      cmpil (continued)
*
*      here for duplicated goto field
*
cmp17  erb   218,syntax error:          duplicated goto field
*
*      here to generate code
*
cmp18  zer   scnse                      stop positional error flags
      mov   cmstm(xs),xr                load tree ptr for statement body
      zer   wb                          collectable value for wb for cdgvl
      zer   wc                          reset constant flag for cdgvl
      jsr   expap                       test for pattern match
      ppm   cmp19                       jump if not pattern match
      mov   =opms$,cmopn(xr)            else set pattern match pointer
      mov   =opms$,cmopn(xr)            else set pattern match pointer
*
*      here after dealing with special pattern match case
*
cmp19  jsr   cdgvl                      generate code for body of statement
      mov   cmsgo(xs),xr                load sgoto pointer
      mov   xr,wa                       copy it
      bze   xr,cmp21                    jump if no success goto
      zer   cmsoc(xs)                   clear success offset fillin ptr
      bhi   xr,state,cmp20              jump if complex goto
*
*      here for simple success goto (label)
*
      add   *vrtra,wa                   point to vrtra field as required
      jsr   cdwrd                       generate success goto
      brn   cmp22                       jump to deal with fgoto
*
*      here for complex success goto
*
cmp20  beq   xr,cmfgo(xs),cmp22         no code if same as fgoto
      zer   wb                          else set ok value for cdgvl in wb
      jsr   cdgcg                       generate code for success goto
      brn   cmp22                       jump to deal with fgoto
*
*      here for no success goto
*
cmp21  mov   cwcof,cmsoc(xs)            set success fill in offset
      mov   =ocer$,wa                  point to compile error call
      jsr   cdwrd                       generate as temporary value

```

```

*
*      cmpil (continued)
*
*      here to deal with failure goto
*
cmp22  mov  cmfgo(xs),xr      load failure goto pointer
      mov  xr,wa            copy it
      zer  cmffc(xs)        set no fill in required yet
      bze  xr,cmp23         jump if no failure goto given
      add  *vrtra,wa        point to vrtra field in case
      blo  xr,state,cmpse   jump to gen if simple fgoto

*
*      here for complex failure goto
*
      mov  cwcof,wb         save offset to o$gof call
      mov  =ogof$,wa        point to failure goto call
      jsr  cdwrd            generate
      mov  =ofif$,wa        point to fail in fail word
      jsr  cdwrd            generate
      jsr  cdgcg            generate code for failure goto
      mov  wb,wa            copy offset to o$gof for cdfal
      mov  =b$cdc,wb        set complex case cdtyp
      brn  cmp25            jump to build cdblk

*
*      here if no failure goto given
*
cmp23  mov  =ounf$,wa        load unexpected failure call in cas
      mov  cswfl,wc         get -nofail flag
      orb  cmcgo(xs),wc     check if conditional goto
      zrb  wc,cmpse         jump if -nofail and no cond. goto
      mnz  cmffc(xs)        else set fill in flag
      mov  =ocer$,wa        and set compile error for temporary

*
*      merge here with cdfal value in wa, simple cdblk
*      also special entry after statement error
*
cmpse  mov  =b$cds,wb        set cdtyp for simple case

```

```

*
*      cmpil (continued)
*
*      merge here to build cdblk
*
*      (wa)                  cdfal value to be generated
*      (wb)                  cdtyp value to be generated
*
*      at this stage, we chop off an appropriate chunk of the
*      current ccblk and convert it into a cdblk. the remainder
*      of the ccblk is reformatted to be the new ccblk.
*
cmp25  mov  r$ccb,xr          point to cblk
      mov  cmlbl(xs),xl      get possible label pointer
      bze  xl,cmp26          skip if no label
      zer  cmlbl(xs)         clear flag for next statement
      mov  xr,vrlbl(xl)      put cdblk ptr in vrbk label field
*
*      merge after doing label
*
cmp26  mov  wb,(xr)          set type word for new cdblk
      mov  wa,cdfal(xr)      set failure word
      mov  xr,xl             copy pointer to ccbk
      mov  ccuse(xr),wb       load length gen (= new cdlen)
      mov  ccclen(xr),wc      load total ccbk length
      add  wb,xl             point past cdblk
      sub  wb,wc             get length left for chop off
      mov  =b$cct,(xl)        set type code for new ccbk at end
      mov  *cccod,ccuse(xl)    set initial code offset
      mov  *cccod,cwcof        initialise cwcof
      mov  wc,ccclen(xl)      set new length
      mov  xl,r$ccb          set new ccbk pointer
if.csln
      zer  ccsln(xl)          initialize new line number
      mov  cmpln,cdsln(xr)    set line number in old block
fi
      mov  cmpsn,cdstm(xr)    set statement number
      icv  cmpsn             bump statement number
*
*      set pointers in previous code block as required
*
      mov  cmpcd(xs),xl       load ptr to previous cdblk
      bze  cmffp(xs),cmp27    jump if no failure fill in required
      mov  xr,cdfal(xl)       else set failure ptr in previous
*
*      here to deal with success forward pointer
*
cmp27  mov  cmsop(xs),wa      load success offset
      bze  wa,cmp28          jump if no fill in required
      add  wa,xl             else point to fill in location
      mov  xr,(xl)           store forward pointer

```

zer xl

clear garbage xl value

```

*
*      cmpil (continued)
*
*      now set fill in pointers for this statement
*
cmp28  mov  cmffc(xs),cmffp(xs)      copy failure fill in flag
      mov  cmsoc(xs),cmsop(xs)      copy success fill in offset
      mov  xr,cmpcd(xs)             save ptr to this cdblk
      bnz  cmtra(xs),cmp29          jump if initial entry already set
      mov  xr,cmtra(xs)             else set ptr here as default

*
*      here after compiling one statement
*
cmp29  blt  stage,=stgce,cmp01      jump if not end line just done
      bze  cswls,cmp30             skip if -nolist
      jsr  listr                   list last line

*
*      return
*
cmp30  mov  cmtra(xs),xr            load initial entry cdblk pointer
      add  *cmnen,xs               pop work locations off stack
      exi                          and return to cmpil caller

*
*      here at end of goto field
*
cmp31  mov  cmfgo(xs),wb            get fail goto
      orb  msggo(xs),wb            or in success goto
      bnz  wb,cmp18                ok if non-null field
      erb  219,syntax error:       empty goto field

*
*      control card found
*
cmp32  icv  wb                    point past ch$mn
      jsr  cnrd                   process control card
      zer  scnse                   clear start of element loc.
      brn  cmpce                   loop for next statement
      enp                          end procedure cmpil

```



```

*
*      cncrd -- control card processor
*
*      called to deal with control cards
*
*      r$cim          points to current image
*      (wb)           offset to 1st char of control card
*      jsr  cncrd      call to process control cards
*      (xl,xr,wa,wb,wc,ia) destroyed
*
cncrd  prc  e,0          entry point
       mov  wb,scnpt     offset for control card scan
       mov  =ccnoc,wa     number of chars for comparison
       ctw  wa,0         convert to word count
       mov  wa,cnswc     save word count

*
*      loop here if more than one control card
*
cnc01  bge  scnpt,scnil,cnc09      return if end of image
       mov  r$cim,xr              point to image
       plc  xr,scnpt              char ptr for first char
       lch  wa,(xr)+              get first char
if .culc
       flc  wa                    fold to upper case
fi

       beq  wa,=ch$li,cnc07        special case of -inxxx
cnc0a  mnz  scncc                 set flag for scane
       jsr  scane                  scan card name
       zer  scncc                 clear scane flag
       bnz  xl,cnc06               fail unless control card name
       mov  =ccnoc,wa             no. of chars to be compared
if .cicc
       blt  sclen(xr),wa,cnc08     fail if too few chars
else
       blt  sclen(xr),wa,cnc06     fail if too few chars
fi

       mov  xr,xl                  point to control card name
       zer  wb                     zero offset for substring
       jsr  sbstr                  extract substring for comparison
if .culc
       mov  sclen(xr),wa           reload length
       jsr  flstg                  fold to upper case
fi

       mov  xr,cnsc               keep control card substring ptr
       mov  =ccnms,xr             point to list of standard names
       zer  wb                     initialise name offset
       lct  wc,=cc$nc             number of standard names

*
*      try to match name
*

```

cnc02	mov cnscc,xl	point to name
	lct wa,cnswc	counter for inner loop
	brn cnc04	jump into loop
	*	
	*	inner loop to match card name chars
	*	
cnc03	ica xr	bump standard names ptr
	ica xl	bump name pointer
	*	
	*	here to initiate the loop
	*	
cnc04	cne schar(xl),(xr),cnc05	comp. up to cfp\$c chars at once
	bct wa,cnc03	loop if more words to compare

```

*
*      cncrd (continued)
*
*      matched - branch on card offset
*
      mov  wb,x1                      get name offset
if .cicc
      bsw  x1,cc$nc,cnc08             switch
else
      bsw  x1,cc$nc,cnc06             switch
fi
if .culc
      iff  cc$ca,cnc37                -case
fi
if .ccmc
      iff  cc$co,cnc39                -compare
fi
      iff  cc$do,cnc10                -double
      iff  cc$du,cnc11                -dump
if .cinc
      iff  cc$cp,cnc41                -copy
fi
      iff  cc$ej,cnc12                -eject
      iff  cc$er,cnc13                -errors
      iff  cc$ex,cnc14                -execute
      iff  cc$fa,cnc15                -fail
if .cinc
      iff  cc$in,cnc41                -include
fi
if .csln
      iff  cc$ln,cnc44                -line
fi
      iff  cc$li,cnc16                -list
      iff  cc$nr,cnc17                -noerrors
      iff  cc$nx,cnc18                -noexecute
      iff  cc$nf,cnc19                -nofail
      iff  cc$nl,cnc20                -nolist
      iff  cc$no,cnc21                -noopt
      iff  cc$np,cnc22                -noprint
      iff  cc$op,cnc24                -optimise
      iff  cc$pr,cnc25                -print
      iff  cc$si,cnc27                -single
      iff  cc$sp,cnc28                -space
      iff  cc$st,cnc31                -style
      iff  cc$ti,cnc32                -title
      iff  cc$tr,cnc36                -trace
      esw                             end switch
*
*      not matched yet. align std names ptr and try again

```

<pre> * cnc05 ica xr bct wa,cnc05 icv wb bct wc,cnc02 if .cicc brn cnc08 fi </pre>	<pre> bump standard names ptr loop bump names offset continue if more names ignore unrecognized control card </pre>
<pre> * * invalid control card name * cnc06 erb 247,invalid control </pre>	<pre> statement </pre>
<pre> * * special processing for -inxxx * cnc07 lch wa,(xr)+ if .culc flc wa fi </pre>	<pre> get next char fold to upper case </pre>
<pre> bne wa,=ch\$1n,cnc0a lch wa,(xr) blt wa,=ch\$d0,cnc0a bgt wa,=ch\$d9,cnc0a add =num02,scnpt jsr scane mov xr,-(xs) jsr gtsmi ppm cnc06 ppm cnc06 mov xr,cswin </pre>	<pre> if not letter n get third char if not digit if not digit bump offset past -in scan integer after -in stack scanned item check if integer fail if not integer fail if negative or large keep integer </pre>

```

*
*      cncrd (continued)
*
*      check for more control cards before returning
*
cnc08  mov  scnpt,wa           preserve in case xeq time compile
      jsr   scane             look for comma
      beq   x1,=$cma,cnc01    loop if comma found
      mov   wa,scnpt          restore scnpt in case xeq time
*
*      return point
*
cnc09  exi                   return
*
*      -double
*
cnc10  mnz   cswdb            set switch
      brn   cnc08             merge
*
*      -dump
*      this is used for system debugging . it has the effect of
*      producing a core dump at compilation time
*
cnc11  jsr   sysdm            call dumper
      brn   cnc09             finished
*
*      -eject
*
cnc12  bze   cswls,cnc09      return if -nolist
      jsr   prtps             eject
      jsr   listt             list title
      brn   cnc09             finished
*
*      -errors
*
cnc13  zer   cswex            clear switch
      brn   cnc08             merge
*
*      -execute
*
cnc14  zer   cswex            clear switch
      brn   cnc08             merge
*
*      -fail
*
cnc15  mnz   cswfl            set switch
      brn   cnc08             merge
*
*      -list

```

```

*
cnc16  mnz  cswls                set switch
      beq  stage,=stgic,cnc08    done if compile time
*
*      list code line if execute time compile
*
      zer  lstpf                permit listing
      jsr  listr                list line
      brn  cnc08                merge

```

```

*
*      cncrd (continued)
*
*      -noerrors
*
cnc17  mnz  cswcr
      brn  cnc08
                                     set switch
                                     merge
*
*      -noexecute
*
cnc18  mnz  cswex
      brn  cnc08
                                     set switch
                                     merge
*
*      -nofail
*
cnc19  zer  cswfl
      brn  cnc08
                                     clear switch
                                     merge
*
*      -nolist
*
cnc20  zer  cswls
      brn  cnc08
                                     clear switch
                                     merge
*
*      -nooptimise
*
cnc21  mnz  cswno
      brn  cnc08
                                     set switch
                                     merge
*
*      -noprint
*
cnc22  zer  cswpr
      brn  cnc08
                                     clear switch
                                     merge
*
*      -optimise
*
cnc24  zer  cswno
      brn  cnc08
                                     clear switch
                                     merge
*
*      -print
*
cnc25  mnz  cswpr
      brn  cnc08
                                     set switch
                                     merge

```

```

*
*      cncrd (continued)
*
*      -single
*
cnc27  zer   cswdb           clear switch
      brn   cnc08           merge
*
*      -space
*
cnc28  bze   cswls,cnc09     return if -nolist
      jsr   scane           scan integer after -space
      mov   =num01,wc       1 space in case
      beq   xr,=t$smc,cnc29  jump if no integer
      mov   xr,-(xs)        stack it
      jsr   gtsmi           check integer
      ppm   cnc06           fail if not integer
      ppm   cnc06           fail if negative or large
      bnz   wc,cnc29        jump if non zero
      mov   =num01,wc       else 1 space
*
*      merge with count of lines to skip
*
cnc29  add   wc,lstlc        bump line count
      lct   wc,wc           convert to loop counter
      blt   lstlc,lstnp,cnc30  jump if fits on page
      jsr   prtps          eject
      jsr   listt          list title
      brn   cnc09          merge
*
*      skip lines
*
cnc30  jsr   prtnl          print a blank
      bct   wc,cnc30        loop
      brn   cnc09          merge

```



```

*
*      cncrd (continued)
*
*      -stttl
*
cnc31  mov  =r$stl,cnr$t          ptr to r$stl
      brn  cnc33                  merge
*
*      -title
*
cnc32  mov  =nulls,r$stl          clear subtitle
      mov  =r$ttl,cnr$t          ptr to r$ttl
*
*      common processing for -title, -stttl
*
cnc33  mov  =nulls,xr             null in case needed
      mnz  cnttl                  set flag for next listr call
      mov  =ccofs,wb              offset to title/subtitle
      mov  scnil,wa               input image length
      blo  wa,wb,cnc34            jump if no chars left
      sub  wb,wa                  no of chars to extract
      mov  r$cim,xl               point to image
      jsr  sbstr                  get title/subtitle
*
*      store title/subtitle
*
cnc34  mov  cnr$t,xl              point to storage location
      mov  xr,(xl)                store title/subtitle
      beq  xl,=r$stl,cnc09        return if sttl
      bnz  precl,cnc09            return if extended listing
      bze  prich,cnc09            return if regular printer
      mov  sclen(xr),xl           get length of title
      mov  xl,wa                  copy it
      bze  xl,cnc35               jump if null
      add  =num10,xl              increment
      bhi  xl,prlen,cnc09         use default lstp0 val if too long
      add  =num04,wa              point just past title
*
*      store offset to page nn message for short title
*
cnc35  mov  wa,lstp0              store offset
      brn  cnc09                  return
*
*      -trace
*      provided for system debugging.  toggles the system label
*      trace switch at compile time
*
cnc36  jsr  systt                 toggle switch
      brn  cnc08                  merge
if .culc

```

```

*
*      -case
*      sets value of kvcas so that names are folded or not
*      during compilation.
*
cnc37  jsr   scanec           scan integer after -case
      zer   wc               get 0 in case none there
      beq   xl,=t$smc,cnc38  skip if no integer
      mov   xr,-(xs)         stack it
      jsr   gtsmi           check integer
      ppm   cnc06           fail if not integer
      ppm   cnc06           fail if negative or too large
cnc38  mov   wc,kvcas        store new case value
      brn   cnc09           merge
fi
if .ccmc
*
*      -compare
*
*      sets value of kvcom so that string comparisons may
*      follow collation sequence determined by the interface.
*
cnc39  jsr   scanec           scan integer after -compare
      zer   wc               get 0 in case none there
      beq   xl,=t$smc,cnc40  skip if no integer
      mov   xr,-(xs)         stack it
      jsr   gtsmi           check integer
      ppm   cnc06           fail if not integer
      ppm   cnc06           fail if negative or too large
cnc40  mov   wc,kvcom        store new compare value
      brn   cnc09           merge
fi
if .cinc
*
*      -include
*
cnc41  mnz   scncc           set flag for scanec
      jsr   scanec           scan quoted file name
      zer   scncc           clear scanec flag
      bne   xl,=t$con,cnc06  if not constant
      bne   (xr),=b$sc1,cnc06 if not string constant
      mov   xr,r$ifn         save file name
      mov   r$inc,xl         examine include file name table
      zer   wb               lookup by value
      jsr   tfind           do lookup
      ppm   cnc06           never fails
      beq   xr,=inton,cnc09  ignore if already in table
      mnz   wb               set for trim
      mov   r$ifn,xr         file name
      jsr   trimr           remove trailing blanks
      mov   r$inc,xl         include file name table

```

mnz wb	lookup by name this time
jsr tfind	do lookup
ppm	never fails
mov =inton,teval(xl)	make table value integer 1
icv cnind	increase nesting level
mov cnind,wa	load new nest level
bgt wa,=ccinm,cnc42	fail if excessive nesting
<i>if</i> .csfn	
*	
* record the name and line number of the current input file	
*	
mov r\$ifa,xl	array of nested file names
add =vcv1b,wa	compute offset in words
wtb wa	convert to bytes
add wa,xl	point to element
mov r\$sfc,(xl)	record current file name
mov wa,xl	preserve nesting byte offset
mti rdnl	fetch source line number as integer
jsr icbld	convert to icblk
add r\$ifl,xl	entry in nested line number array
mov xr,(xl)	record in array
<i>fi</i>	
*	
* here to switch to include file named in r\$ifn	
*	
mov cswin,wa	max read length
mov r\$ifn,xl	include file name
jsr alocs	get buffer for complete file name
jsr sysif	open include file
ppm cnc43	could not open
<i>if</i> .csfn	
*	
* make note of the complete file name for error messages	
*	
zer wb	do not trim trailing blanks
jsr trimr	adjust scblk for actual length
mov xr,r\$sfc	save ptr to file name
mti cmpsn	current statement as integer
jsr icbld	build icblk for stmt number
mov r\$sfn,xl	file name table
mnz wb	lookup statement number by name
jsr tfind	allocate new teblk
ppm	always possible to allocate block
mov r\$sfc,teval(xl)	record file name as entry value
<i>else</i>	
mov xr,dnamp	release allocated scblk
<i>fi</i>	
zer rdnl	restart line counter for new file
beq stage,=stgic,cnc09	if initial compile
bne cnind,=num01,cnc09	if not first execute-time nesting

```

*
*      here for -include during execute-time compile
*
      mov r$cim,r$ici      remember code argument string
      mov scnpt,cnspt      save position in string
      mov scnsl,cnsl       and length of string
      brn  cnc09           all done, merge
*
*      here for excessive include file nesting
*
cnc42  erb  284,excessively nested      include files
*
*      here if include file could not be opened
*
cnc43  mov  xr,dnamp          release allocated scblk
      erb  285,include file      cannot be opened
*
fi
if .csln
*
*      -line n filename
*
cnc44  jsr  scane            scan integer after -line
      bne  xl,=t$con,cnc06   jump if no line number
      bne  (xr),=b$icl,cnc06 jump if not integer
      ldi  icval(xr)         fetch integer line number
      ile  cnc06            error if negative or zero
      beq  stage,=stgic,cnc45 skip if initial compile
      mfi  cmpln            set directly for other compiles
      brn  cnc46            no need to set rdln
cnc45  sbi  intv1           adjust number by one
      mfi  rdln            save line number
if .csfn
cnc46  mnz  scncc           set flag for scane
      jsr  scane            scan quoted file name
      zer  scncc           clear scane flag
      beq  xl,=t$smc,cnc47  done if no file name
      bne  xl,=t$con,cnc06  error if not constant
      bne  (xr),=b$scl,cnc06 if not string constant
      jsr  newfn           record new file name
      brn  cnc09           merge
*
*      here if file name not present
*
cnc47  dcw  scnpt          set to rescan the terminator
      brn  cnc09           merge
else
cnc46  brn  cnc09           merge
fi
fi

```

enp

end procedure cncrd

```

if .ceng
    *
    *      enevs -- evaluate string expression for engine
    *
    *      enevs is used by the external interface to evaluate a
    *      string expression, typically for an engine wishing to
    *      obtain the value of a variable or expression.
    *
if .cevb
    *      (wb)                  0 if by value, 1 if by name
fi
    *      (xr)                  scblk for string to evaluate
    *      jsr  enevs             call to convert and evaluate
    *      (xr)                  pointer to result
    *                          = 0 if expression evaluation failed
    *                          = 1 if conversion to expression failed
    *
enevs  prc  r,0                  entry point (recursive)
if .cevb
    mov  wb,-(xs)                save value/name flag
fi
    jsr  gtexp                   convert to expression
    ppm  enev2                   conversion fails
if .cevb
    mov  (xs)+,wb                recover value/name flag
fi
    jsr  evalx                   evaluate expression by value
    ppm  enev1                   evaluation fails
    exi  enev1                   evaluation fails
    *
    *      here if expression evaluation failed
    *
enev1  zer  xr                  return zero result
    exi  xr                      return zero result
    *
    *      here if conversion to expression failed
    *
if .cevb
enev2  ica  xs                  discard value/name flag
    mov  =num01,xr              return integer one result
else
enev2  mov  =num01,xr            return integer one result
fi
    exi  =num01,xr              return integer one result
    enp  =num01,xr              return integer one result

```

```

*
*      engts -- get string for engine
*
*      engts is passed an object and returns a string with
*      any necessary conversions performed.
*
*      (xr)                input argument
*      jsr  engts           call to convert to string
*      (xr)                pointer to resulting string
*                        =0 if conversion not possible
*
engts  prc  e,0              entry point
      mov  xr,-(xs)         stack argument to convert
      jsr  gtstg            convert to string
      ppm  engt1            convert impossible
      exi  engt1            convert impossible
*
*      here if unable to convert to string
*
engt1  zer  xr              return zero
      exi  xr              return zero
      enp  xr              return zero

```

fi

```

*
*      dffnc -- define function
*
*      dffnc is called whenever a new function is assigned to
*      a variable. it deals with external function use counts.
*
*      (xr)                pointer to vrbk
*      (xl)                pointer to new function block
*      jsr  dffnc           call to define function
*      (wa,wb)             destroyed
*
dffnc  prc   e,0                entry point
if .cnld
else
    bne  (xl),=b$efc,dffn1      skip if new function not external
    icv  efuse(xl)              else increment its use count
*
*      here after dealing with new function use count
*
dffn1  mov  xr,wa                save vrbk pointer
    mov  vrfnc(xr),xr           load old function pointer
    bne  (xr),=b$efc,dffn2      jump if old function not external
    mov  efuse(xr),wb           else get use count
    dcw  wb                     decrement
    mov  wb,efuse(xr)           store decremented value
    bnz  wb,dffn2               jump if use count still non-zero
    jsr  sysul                  else call system unload function
*
*      here after dealing with old function use count
*
dffn2  mov  wa,xr                restore vrbk pointer
fi
    mov  xl,wa                  copy function block ptr
    blt  xr,=r$yyy,dffn3        skip checks if opsyn op definition
    bnz  vrlen(xr),dffn3        jump if not system variable
*
*      for system variable, check for illegal redefinition
*
    mov  vrsvp(xr),xl           point to svblk
    mov  svbit(xl),wb           load bit indicators
    anb  btfnc,wb               is it a system function
    zrb  wb,dffn3               redef ok if not
    erb  248,attempted redefinition of system function
*
*      here if redefinition is permitted
*
dffn3  mov  wa,vrfnc(xr)        store new function pointer
    mov  wa,xl                  restore function block pointer
    exi                          return to dffnc caller

```


enp

end procedure dfnc

```

*
*      dtach -- detach i/o associated names
*
*      detaches trblks from i/o associated variables, removes
*      entry from iochn chain attached to filearg1 vrbk and may
*      remove vrbk access and store traps.
*      input, output, terminal are handled specially.
*
*      (xl)                i/o assoc. vbl name base ptr
*      (wa)                offset to name
*      jsr  dtach          call for detach operation
*      (xl,xr,wa,wb,wc)    destroyed
*
dtach  prc  e,0                entry point
       mov  xl,dtcnb          store name base (gbcnl not called)
       add  wa,xl             point to name location
       mov  xl,dtcnm          store it
*
*      loop to search for i/o trblk
*
dtch1  mov  xl,xr                copy name pointer
*
*      continue after block deletion
*
dtch2  mov  (xl),xl            point to next value
       bne  (xl),=b$trt,dtch6  jump at chain end
       mov  trtyp(xl),wa       get trap block type
       beq  wa,=trtin,dtch3    jump if input
       beq  wa,=trtou,dtch3    jump if output
       add  *trnxt,xl          point to next link
       brn  dtch1              loop
*
*      delete an old association
*
dtch3  mov  trval(xl),(xr)      delete trblk
       mov  xl,wa              dump xl ...
       mov  xr,wb              ... and xr
       mov  trtrf(xl),xl       point to trtrf trap block
       bze  xl,dtch5           jump if no iochn
       bne  (xl),=b$trt,dtch5  jump if input, output, terminal
*
*      loop to search iochn chain for name ptr
*
dtch4  mov  xl,xr                remember link ptr
       mov  trtrf(xl),xl       point to next link
       bze  xl,dtch5           jump if end of chain
       mov  ionmb(xl),wc       get name base
       add  ionmo(xl),wc       add offset
       bne  wc,dtcnm,dtch4     loop if no match
       mov  trtrf(xl),trtrf(xr) remove name from chain

```

```

*
*      dtach (continued)
*
*      prepare to resume i/o trblk scan
*
dtch5  mov  wa,xl          recover xl ...
      mov  wb,xr          ... and xr
      add  *trval,xl      point to value field
      brn  dtch2          continue

*
*      exit point
*
dtch6  mov  dtcnb,xr      possible vrbk ptr
      jsr  setvr          reset vrbk if necessary
      exi                return
      enp                end procedure dtach

```

```

*
*      dtype -- get datatype name
*
*      (xr)                object whose datatype is required
*      jsr  dtype           call to get datatype
*      (xr)                result datatype
*
dtype  prc   e,0                entry point
      beq   (xr),=b$pdtdtyp1    jump if prog.defined
      mov   (xr),xr            load type word
      lei   xr                  get entry point id (block code)
      wtb   xr                  convert to byte offset
      mov   scnmt(xr),xr        load table entry
      exi                                exit to dtype caller

*
*      here if program defined
*
dtyp1  mov   pddfp(xr),xr        point to dfblk
      mov   dfnam(xr),xr        get datatype name from dfblk
      exi                        return to dtype caller
      enp                        end procedure dtype

```

```

*
*      dumpr -- print dump of storage
*
*      (xr)                dump argument (see below)
*      jsr  dumpr           call to print dump
*      (xr,xl)             destroyed
*      (wa,wb,wc,ra)       destroyed
*
*      the dump argument has the following significance
*
*      dmarg = 0            no dump printed
*      dmarg = 1            partial dump (nat vars, keywords)
*      dmarg = 2            full dump (arrays, tables, etc.)
*      dmarg = 3            full dump + null variables
*      dmarg ge 4           core dump
*
*      since dumpr scrambles store, it is not permissible to
*      collect in mid-dump. hence a collect is done initially
*      and then if store runs out an error message is produced.
*
dumpr  prc   e,0            entry point
      bze   xr,dmp28        skip dump if argument is zero
      bgt   xr,=num03,dmp29 jump if core dump required
      zer   xl              clear xl
      zer   wb              zero move offset
      mov   xr,dmarg        save dump argument
if .csed
      zer   dnams           collect sediment too
fi

      jsr   gbcol           collect garbage
      jsr   prtpg           eject printer
      mov   =dmhdv,xr       point to heading for variables
      jsr   prtst           print it
      jsr   prtln           terminate print line
      jsr   prtln           and print a blank line
*
*      first all natural variable blocks (vrblk) whose values
*      are non-null are linked in lexical order using dmvch as
*      the chain head and chaining through the vrget fields.
*      note that this scrambles store if the process is
*      interrupted before completion e.g. by exceeding time or
*      print limits. since the subsequent core dumps and
*      failures if execution is resumed are very confusing, the
*      execution time error routine checks for this event and
*      attempts an unscramble. similar precautions should be
*      observed if translate time dumping is implemented.
*
      zer   dmvch            set null chain to start
      mov   hshtb,wa         point to hash table
*
*      loop through headers in hash table
*

```

dmp00	mov wa,xr	copy hash bucket pointer
	ica wa	bump pointer
	sub *vrnxt,xr	set offset to merge
	*	
	*	
	loop through vrblks on one chain	
	*	
dmp01	mov vrnxt(xr),xr	point to next vrblk on chain
	bze xr,dmp09	jump if end of this hash chain
	mov xr,xl	else copy vrblk pointer

```

*
*      dump (continued)
*
*      loop to find value and skip if null
*
dmp02  mov  vrval(xl),xl          load value
      beq  dmarg,=num03,dmp2a    skip null value check if dump(3)
      beq  xl,=nulls,dmp01       loop for next vrbk if null value
dmp2a  beq  (xl),=b$trt,dmp02    loop back if value is trapped
*
*      non-null value, prepare to search chain
*
      mov  xr,wc                save vrbk pointer
      add  *vrsof,xr            adjust ptr to be like scblk ptr
      bnz  sclen(xr),dmp03       jump if non-system variable
      mov  vrsvo(xr),xr         else load ptr to name in svblk
*
*      here with name pointer for new block in xr
*
dmp03  mov  xr,wb                save pointer to chars
      mov  wa,dmpsv             save hash bucket pointer
      mov  =dmvch,wa            point to chain head
*
*      loop to search chain for correct insertion point
*
dmp04  mov  wa,dmpch            save chain pointer
      mov  wa,xl                copy it
      mov  (xl),xr              load pointer to next entry
      bze  xr,dmp08              jump if end of chain to insert
      add  *vrsof,xr            else get name ptr for chained vrbk
      bnz  sclen(xr),dmp05       jump if not system variable
      mov  vrsvo(xr),xr         else point to name in svblk
*
*      here prepare to compare the names
*
      (wa)                      scratch
      (wb)                      pointer to string of entering vrbk
      (wc)                      pointer to entering vrbk
      (xr)                      pointer to string of current block
      (xl)                      scratch
*
dmp05  mov  wb,xl                point to entering vrbk string
      mov  sclen(xl),wa          load its length
      plc  xl                    point to chars of entering string
if .ccmc
      mov  wb,dmpsb             save wb
      mov  sclen(xr),wb          length of old string
      plc  xr                    point to chars of old string
      jsr  syscm                 generalized lexical compare
      ppm  dmp06                 string too long, treat like eq
      ppm  dmp06                 entering string lt old string

```

	ppm	dmp07	entering string gt old string
*			
*		here when entering string le old string	
*			
dmp06	mov	dmpsb,wb	restore wb
	brn	dmp08	found insertion point


```

*
*      dump (continued)
*
*      here we move out on the chain
*
dmp07  mov  dmps,wb           restore wb
      mov  dmpch,xl         copy chain pointer
else
      bhi  wa,sclen(xr),dmp06  jump if entering length high
      plc  xr                else point to chars of old string
      cmc  dmp08,dmp07        compare, insert if new is llt old
      brn  dmp08              or if leq (we had shorter length)
*
*      here when new length is longer than old length
*
dmp06  mov  sclen(xr),wa      load shorter length
      plc  xr                point to chars of old string
      cmc  dmp08,dmp07        compare, insert if new one low

```

```

*
*      dumpr (continued)
*
*      here we move out on the chain
*
dmp07  mov  dmpch,xl          copy chain pointer
fi
      mov  (xl),wa          move to next entry on chain
      brn  dmp04            loop back
*
*      here after locating the proper insertion point
*
dmp08  mov  dmpch,xl          copy chain pointer
      mov  dmpsv,wa          restore hash bucket pointer
      mov  wc,xr             restore vrbk pointer
      mov  (xl),vrget(xr)    link vrbk to rest of chain
      mov  xr,(xl)           link vrbk into current chain loc
      brn  dmp01            loop back for next vrbk
*
*      here after processing all vrbks on one chain
*
dmp09  bne  wa,hshte,dmp00    loop back if more buckets to go
*
*      loop to generate dump of natural variable values
*
dmp10  mov  dmvch,xr          load pointer to next entry on chain
      bze  xr,dmp11          jump if end of chain
      mov  (xr),dmvch        else update chain ptr to next entry
      jsr  setvr             restore vrget field
      mov  xr,xl             copy vrbk pointer (name base)
      mov  *vrval,wa         set offset for vrbk name
      jsr  prtntv            print name = value
      brn  dmp10            loop back till all printed
*
*      prepare to print keywords
*
dmp11  jsr  prtntl           print blank line
      jsr  prtntl           and another
      mov  =dmhdk,xr        point to keyword heading
      jsr  prtst            print heading
      jsr  prtntl           end line
      jsr  prtntl           print one blank line
      mov  =vdmkw,xl        point to list of keyword svblk ptrs

```

```

*
*      dumpr (continued)
*
*      loop to dump keyword values
*
dmp12  mov  (x1)+,xr          load next svblk ptr from table
      bze  xr,dmp13          jump if end of list
if .ccmk
      beq  xr,=num01,dmp12    &compare ignored if not implemented
fi

      mov  =ch$am,wa          load ampersand
      jsr  prtch              print ampersand
      jsr  prtst              print keyword name
      mov  svlen(xr),wa        load name length from svblk
      ctb  wa,svchs           get length of name
      add  wa,xr              point to svknm field
      mov  (xr),dmpkn          store in dummy kvblk
      mov  =tmbeb,xr           point to blank-equal-blank
      jsr  prtst              print it
      mov  x1,dmpsv           save table pointer
      mov  =dmpkb,x1          point to dummy kvblk
      mov  =b$kv, (x1)         build type word
      mov  =trbkv,kvvar(x1)    build ptr to dummy trace block
      mov  *kvvar,wa           set zero offset
      jsr  access             get keyword value
      ppm                     failure is impossible
      jsr  prtvl              print keyword value
      jsr  prtnl              terminate print line
      mov  dmpsv,x1           restore table pointer
      brn  dmp12              loop back till all printed

*
*      here after completing partial dump
*
dmp13  beq  dmarg,=num01,dmp27  exit if partial dump complete
      mov  dnamb,xr            else point to first dynamic block

*
*      loop through blocks in dynamic storage
*
dmp14  beq  xr,dnamp,dmp27      jump if end of used region
      mov  (xr),wa             else load first word of block
      beq  wa,=b$vect,dmp16     jump if vector
      beq  wa,=b$art,dmp17      jump if array
      beq  wa,=b$pd, dmp18      jump if program defined
      beq  wa,=b$tbl,dmp19      jump if table
if .cnbf
else
      beq  wa,=b$bct,dmp30      jump if buffer
fi

*
*      merge here to move to next block

```

	*		
dmp15	jsr	blkln	get length of block
	add	wa,xr	point past this block
	brn	dmp14	loop back for next block

```

*
*      dumpr (continued)
*
*      here for vector
*
dmp16  mov  *vcvls,wb          set offset to first value
      brn  dmp19              jump to merge
*
*      here for array
*
dmp17  mov  arofs(xr),wb      set offset to arpro field
      ica  wb                  bump to get offset to values
      brn  dmp19              jump to merge
*
*      here for program defined
*
dmp18  mov  *pdfld,wb         point to values, merge
*
*      here for table (others merge)
*
dmp19  bze  idval(xr),dmp15    ignore block if zero id value
      jsr  blkln              else get block length
      mov  xr,xl              copy block pointer
      mov  wa,dmpsv           save length
      mov  wb,wa              copy offset to first value
      jsr  prtnl              print blank line
      mov  wa,dmpsa           preserve offset
      jsr  prtv1              print block value (for title)
      mov  dmpsa,wa           recover offset
      jsr  prtnl              end print line
      beq  (xr),=b$tbtt,dmp22 jump if table
      dca  wa                 point before first word
*
*      loop to print contents of array, vector, or program def
*
dmp20  mov  xl,xr              copy block pointer
      ica  wa                  bump offset
      add  wa,xr              point to next value
      beq  wa,dmpsv,dmp14     exit if end (xr past block)
      sub  *vrval,xr          subtract offset to merge into loop
*
*      loop to find value and ignore nulls
*
dmp21  mov  vrval(xr),xr       load next value
      beq  dmarg,=num03,dmp2b  skip null value check if dump(3)
      beq  xr,=nulls,dmp20     loop back if null value
dmp2b  beq  (xr),=b$trtt,dmp21 loop back if trapped
      jsr  prtnv              else print name = value
      brn  dmp20              loop back for next field

```

```

*
*      dumpr (continued)
*
*      here to dump a table
*
dmp22  mov  *tbbuk,wc          set offset to first bucket
      mov  *teval,wa          set name offset for all teblks
*
*      loop through table buckets
*
dmp23  mov  x1,-(xs)          save tbbk pointer
      add  wc,x1              point to next bucket header
      ica  wc                  bump bucket offset
      sub  *tenxt,x1          subtract offset to merge into loop
*
*      loop to process teblks on one chain
*
dmp24  mov  tenxt(x1),x1       point to next teblk
      beq  x1,(xs),dmp26      jump if end of chain
      mov  x1,xr              else copy teblk pointer
*
*      loop to find value and ignore if null
*
dmp25  mov  teval(xr),xr       load next value
      beq  xr,=nulls,dmp24     ignore if null value
      beq  (xr),=b$trt,dmp25   loop back if trapped
      mov  wc,dmpsv           else save offset pointer
      jsr  prtntv             print name = value
      mov  dmpsv,wc           reload offset
      brn  dmp24              loop back for next teblk
*
*      here to move to next hash chain
*
dmp26  mov  (xs)+,x1           restore tbbk pointer
      bne  wc,tblen(x1),dmp23  loop back if more buckets to go
      mov  x1,xr              else copy table pointer
      add  wc,xr              point to following block
      brn  dmp14              loop back to process next block
*
*      here after completing dump
*
dmp27  jsr  prtptg            eject printer
*
*      merge here if no dump given (dmarg=0)
*
dmp28  exi                    return to dump caller
*
*      call system core dump routine
*
dmp29  jsr  sysdm             call it

```

```
        brn    dmp28                return
if .cnbf
else
```

```

*
*      dumpr (continued)
*
*      here to dump buffer block
*
dmp30  jsr  prtnl          print blank line
        jsr  prtvl        print value id for title
        jsr  prtnl        force new line
        mov  =ch$dq,wa     load double quote
        jsr  prtch        print it
        mov  bclen(xr),wc  load defined length
        bze  wc,dmp32      skip characters if none
        lct  wc,wc        load count for loop
        mov  xr,wb        save bcbk ptr
        mov  bcbuf(xr),xr  point to bfbk
        plc  xr           get set to load characters

*
*      loop here stuffing characters in output stream
*
dmp31  lch  wa,(xr)+      get next character
        jsr  prtch        stuff it
        bct  wc,dmp31     branch for next one
        mov  wb,xr        restore bcbk pointer

*
*      merge to stuff closing quote mark
*
dmp32  mov  =ch$dq,wa     stuff quote
        jsr  prtch        print it
        jsr  prtnl        print new line
        mov  (xr),wa      get first wd for blkln
        brn  dmp15        merge to get next block

fi

        enp              end procedure dumpr

```


*		
*	errmsg -- print error code and error message	
*		
*	kvert	error code
*	jsr errmsg	call to print message
*	(xr,xl,wa,wb,wc,ia)	destroyed
*		
errmsg	prc e,0	entry point
	mov kvert,wa	load error code
	mov =ermms,xr	point to error message /error/
	jsr prtst	print it
	jsr ertex	get error message text
	add =thsnd,wa	bump error code for print
	mti wa	fail code in int acc
	mov profs,wb	save current buffer position
	jsr prtln	print code (now have error1xxx)
	mov prbuf,xl	point to print buffer
	psc xl,wb	point to the 1
	mov =ch\$bl,wa	load a blank
	sch wa,(xl)	store blank over 1 (error xxx)
	csc xl	complete store characters
	zer xl	clear garbage pointer in xl
	mov xr,wa	keep error text
	mov =ermns,xr	point to / - /
	jsr prtst	print it
	mov wa,xr	get error text again
	jsr prtst	print error message text
	jsr prtis	print line
	jsr prtis	print blank line
	exi	return to errmsg caller
	enp	end procedure errmsg

```

*
*      ertex -- get error message text
*
*      (wa)                error code
*      jsr ertex           call to get error text
*      (xr)                ptr to error text in dynamic
*      (r$etx)             copy of ptr to error text
*      (xl,wc,ia)          destroyed
*
ertex  prc  e,0              entry point
      mov wa,ertwa          save wa
      mov wb,ertwb          save wb
      jsr sysmem            get failure message text
      mov xr,xl             copy pointer to it
      mov sclen(xr),wa      get length of string
      bze wa,ert02          jump if null
      zer wb                offset of zero
      jsr sbstr             copy into dynamic store
      mov xr,r$etx          store for relocation
*
*      return
*
ert01  mov ertwb,wb          restore wb
      mov ertwa,wa          restore wa
      exi                   return to caller
*
*      return errtext contents instead of null
*
ert02  mov r$etx,xr          get errtext
      brn ert01             return
      enp ert01             return

```

```

*
*      evali -- evaluate integer argument
*
*      evali is used by pattern primitives len,tab,rtab,pos,rpos
*      when their argument is an expression value.
*
*      (xr)                node pointer
*      (wb)                cursor
*      jsr  evali          call to evaluate integer
*      ppm  loc            transfer loc for non-integer arg
*      ppm  loc            transfer loc for out of range arg
*      ppm  loc            transfer loc for evaluation failure
*      ppm  loc            transfer loc for successful eval
*      (the normal return is never taken)
*      (xr)                ptr to node with integer argument
*      (wc,xl,ra)          destroyed
*
*      on return, the node pointed to has the integer argument
*      in parm1 and the proper successor pointer in pthen.
*      this allows merging with the normal (integer arg) case.
*
evali  prc  r,4            entry point (recursive)
      jsr  evalp          evaluate expression
      ppm  evli1          jump on failure
      mov  xl,-(xs)        stack result for gtsmi
      mov  pthen(xr),xl    load successor pointer
      mov  xr,evlio        save original node pointer
      mov  wc,evlif        zero if simple argument
      jsr  gtsmi          convert arg to small integer
      ppm  evli2          jump if not integer
      ppm  evli3          jump if out of range
      mov  xr,evliv        store result in special dummy node
      mov  =evlin,xr       point to dummy node with result
      mov  =p$len,(xr)     dummy pattern block pcode
      mov  xl,ptthen(xr)   store successor pointer
      exi  4              take successful exit
*
*      here if evaluation fails
*
evli1  exi  3              take failure return
*
*      here if argument is not integer
*
evli2  exi  1              take non-integer error exit
*
*      here if argument is out of range
*
evli3  exi  2              take out-of-range error exit
      enp                  end procedure evali

```

```

*
*      evalp -- evaluate expression during pattern match
*
*      evalp is used to evaluate an expression (by value) during
*      a pattern match. the effect is like evalx, but pattern
*      variables are stacked and restored if necessary.
*
*      evalp also differs from evalx in that if the result is
*      an expression it is reevaluated. this occurs repeatedly.
*
*      to support optimization of pos and rpos, evalp uses wc
*      to signal the caller for the case of a simple vrbk
*      that is not an expression and is not trapped. because
*      this case cannot have any side effects, optimization is
*      possible.
*
*      (xr)          node pointer
*      (wb)          pattern match cursor
*      jsr  evalp     call to evaluate expression
*      ppm  loc       transfer loc if evaluation fails
*      (xl)          result
*      (wa)          first word of result block
*      (wc)          zero if simple vrbk, else non-zero
*      (xr,wb)       destroyed (failure case only)
*      (ra)          destroyed
*
*      the expression pointer is stored in parm1 of the node
*
*      control returns to failp on failure of evaluation
*
evalp  prc  r,1                entry point (recursive)
      mov  parm1(xr),xl        load expression pointer
      beq  (xl),=b$exl,evlp1   jump if exblk case
*
*      here for case of seblk
*
*      we can give a fast return if the value of the vrbk is
*      not an expression and is not trapped.
*
      mov  sevar(xl),xl        load vrbk pointer
      mov  vrval(xl),xl        load value of vrbk
      mov  (xl),wa             load first word of value
      bhi  wa,=b$t$$,evlp3     jump if not seblk, trblk or exblk
*
*      here for exblk or seblk with expr value or trapped value
*
evlp1  chk                    check for stack space
      mov  xr,-(xs)            stack node pointer
      mov  wb,-(xs)            stack cursor
      mov  r$pms,-(xs)         stack subject string pointer
      mov  pmssl,-(xs)         stack subject string length
      mov  pmdfl,-(xs)         stack dot flag

```

```
mov pmhbs,-(xs)
mov parm1(xr),xr
```

```
stack history stack base pointer
load expression pointer
```

```

*
*      evalp (continued)
*
*      loop back here to reevaluate expression result
*
evlp2  zer   wb                      set flag for by value
      jsr   evalx                  evaluate expression
      ppm   evlp4                  jump on failure
      mov   (xr),wa                else load first word of value
      blo   wa,=b$e$$,evlp2       loop back to reevaluate expression

*
*      here to restore pattern values after successful eval
*
      mov   xr,xl                  copy result pointer
      mov   (xs)+,pmhbs            restore history stack base pointer
      mov   (xs)+,pmdfl            restore dot flag
      mov   (xs)+,pmssl            restore subject string length
      mov   (xs)+,r$pms            restore subject string pointer
      mov   (xs)+,wb               restore cursor
      mov   (xs)+,xr               restore node pointer
      mov   xr,wc                  non-zero for simple vrbk
      exi                          return to evalp caller

*
*      here to return after simple vrbk case
*
evlp3  zer   wc                      simple vrbk, no side effects
      exi                          return to evalp caller

*
*      here for failure during evaluation
*
evlp4  mov   (xs)+,pmhbs            restore history stack base pointer
      mov   (xs)+,pmdfl            restore dot flag
      mov   (xs)+,pmssl            restore subject string length
      mov   (xs)+,r$pms            restore subject string pointer
      add   *num02,xs              remove node ptr, cursor
      exi   1                      take failure exit
      enp                          end procedure evalp

```

```

*
*      evals -- evaluate string argument
*
*      evals is used by span, any, notany, break, breakx when
*      they are passed an expression argument.
*
*      (xr)                node pointer
*      (wb)                cursor
*      jsr  evals           call to evaluate string
*      ppm  loc             transfer loc for non-string arg
*      ppm  loc             transfer loc for evaluation failure
*      ppm  loc             transfer loc for successful eval
*      (the normal return is never taken)
*      (xr)                ptr to node with parms set
*      (xl,wc,ra)          destroyed
*
*      on return, the node pointed to has a character table
*      pointer in parm1 and a bit mask in parm2. the proper
*      successor is stored in pthen of this node. thus it is
*      ok for merging with the normal (multi-char string) case.
*
evals  prc  r,3              entry point (recursive)
      jsr  evalp            evaluate expression
      ppm  evls1           jump if evaluation fails
      mov  pthen(xr),-(xs)  save successor pointer
      mov  wb,-(xs)        save cursor
      mov  xl,-(xs)        stack result ptr for patst
      zer  wb              dummy pcode for one char string
      zer  wc              dummy pcode for expression arg
      mov  =p$brk,xl       appropriate pcode for our use
      jsr  patst           call routine to build node
      ppm  evls2           jump if not string
      mov  (xs)+,wb        restore cursor
      mov  (xs)+,pthen(xr) store successor pointer
      exi  3              take success return
*
*      here if evaluation fails
*
evls1  exi  2              take failure return
*
*      here if argument is not string
*
evls2  add  *num02,xs      pop successor and cursor
      exi  1              take non-string error exit
      enp                end procedure evals

```

```

*
*      evalx -- evaluate expression
*
*      evalx is called to evaluate an expression
*
*      (xr)                pointer to exblk or seblk
*      (wb)                0 if by value, 1 if by name
*      jsr  evalx          call to evaluate expression
*      ppm  loc            transfer loc if evaluation fails
*      (xr)                result if called by value
*      (xl,wa)             result name base,offset if by name
*      (xr)                destroyed (name case only)
*      (xl,wa)             destroyed (value case only)
*      (wb,wc,ra)          destroyed
*
evalx  prc   r,1            entry point, recursive
      beq   (xr),=b$exl,evlx2  jump if exblk case
*
*      here for seblk
*
      mov  sevar(xr),xl      load vrbk pointer (name base)
      mov  *vrval,wa        set name offset
      bnz  wb,evlx1         jump if called by name
      jsr  acess            call routine to access value
      ppm  evlx9            jump if failure on access
*
*      merge here to exit for seblk case
*
evlx1  exi                return to evalx caller

```



```

*
*      evalx (continued)
*
*      here for full expression (exblk) case
*
*      if an error occurs in the expression code at execution
*      time, control is passed via error section to exfal
*      without returning to this routine.
*      the following entries are made on the stack before
*      giving control to the expression code
*
*
*              evalx return point
*              saved value of r$cod
*              code pointer (-r$cod)
*              saved value of flptr
*              0 if by value, 1 if by name
*      flptr ----- *exflc, fail offset in exblk
*
evlx2  scp   wc              get code pointer
      mov   r$cod,wa         load code block pointer
      sub   wa,wc            get code pointer as offset
      mov   wa,-(xs)         stack old code block pointer
      mov   wc,-(xs)         stack relative code offset
      mov   flptr,-(xs)      stack old failure pointer
      mov   wb,-(xs)         stack name/value indicator
      mov   *exflc,-(xs)     stack new fail offset
      mov   flptr,gtcef      keep in case of error
      mov   r$cod,r$gtc      keep code block pointer similarly
      mov   xs,flptr         set new failure pointer
      mov   xr,r$cod         set new code block pointer
      mov   kvstn,exstm(xr)  remember stmt number
      add   *excod,xr        point to first code word
      lcp   xr              set code pointer
      bne   stage,=stgxt,evlx0  jump if not execution time
      mov   =stgee,stage     evaluating expression
*
*      here to execute first code word of expression
*
evlx0  zer   xl              clear garbage xl
      lcw   xr              load first code word
      bri   (xr)            execute it

```

```

*
*      evalx (continued)
*
*      come here if successful return by value (see o$rvl)
*
evlx3  mov  (xs)+,xr          load value
       bze  num01(xs),evlx5   jump if called by value
       erb  249,expression evaluated by name returned value
*
*      here for expression returning by name (see o$rnrm)
*
evlx4  mov  (xs)+,wa          load name offset
       mov  (xs)+,xl          load name base
       bnz  num01(xs),evlx5   jump if called by name
       jsr  acess            else access value first
       ppm  evlx6             jump if failure during access
*
*      here after loading correct result into xr or xl,wa
*
evlx5  zer  wb                note successful
       brn  evlx7             merge
*
*      here for failure in expression evaluation (see o$fex)
*
evlx6  mnz  wb                note unsuccessful
*
*      restore environment
*
evlx7  bne  stage,=stgee,evlx8 skip if was not previously xt
       mov  =stgxt,stage      execute time
*
*      merge with stage set up
*
evlx8  add  *num02,xs          pop name/value indicator, *exfal
       mov  (xs)+,flptr       restore old failure pointer
       mov  (xs)+,wc          load code offset
       add  (xs),wc           make code pointer absolute
       mov  (xs)+,r$cod        restore old code block pointer
       lcp  wc                restore old code pointer
       bze  wb,evlx1          jump for successful return
*
*      merge here for failure in seblk case
*
evlx9  exi  1                 take failure exit
       enp                    end of procedure evalx

```

```

*
*      exbld -- build exblk
*
*      exbld is used to build an expression block from the
*      code compiled most recently in the current ccblk.
*
*      (xl)                offset in ccblk to start of code
*      (wb)                integer in range 0 le n le mxlen
*      jsr  exbld           call to build exblk
*      (xr)                ptr to constructed exblk
*      (wa,wb,xl)          destroyed
*
exbld  prc   e,0            entry point
       mov  xl,wa          copy offset to start of code
       sub  *excod,wa      calc reduction in offset in exblk
       mov  wa,-(xs)       stack for later
       mov  cwcof,wa       load final offset
       sub  xl,wa          compute length of code
       add  *exsi$,wa      add space for standard fields
       jsr  alloc          allocate space for exblk
       mov  xr,-(xs)       save pointer to exblk
       mov  =b$exl,extyp(xr) store type word
       zer  exstm(xr)      zeroise stmt number field

if .csln
       mov  cmpln,exsln(xr) set line number field
fi

       mov  wa,exlen(xr)   store length
       mov  =ofex$,exflc(xr) store failure word
       add  *exsi$,xr      set xr for mvw
       mov  xl,cwcof       reset offset to start of code
       add  r$ccb,xl       point to start of code
       sub  *exsi$,wa      length of code to move
       mov  wa,-(xs)       stack length of code
       mvw  (xs)+,wa       move code to exblk
       btr  wa             get length of code
       ltr  wa             convert byte count to word count
       lct  wa,wa          prepare counter for loop
       mov  (xs),xl        copy exblk ptr, dont unstack
       add  *excod,xl       point to code itself
       mov  num01(xs),wb   get reduction in offset

*
*      this loop searches for negation and selection code so
*      that the offsets computed whilst code was in code block
*      can be transformed to reduced values applicable in an
*      exblk.
*
exbl1  mov  (xl)+,xr       get next code word
       beq  xr,=osla$,exbl3 jump if selection found
       beq  xr,=onta$,exbl3 jump if negation found
       bct  wa,exbl1       loop to end of code
*

```

```

*      no selection found or merge to exit on termination
*
exbl2  mov  (xs)+,xr      pop exblk ptr into xr
      mov  (xs)+,xl      pop reduction constant
      exi                return to caller

```

```

*
*      exbld (continued)
*
*      selection or negation found
*      reduce the offsets as needed. offsets occur in words
*      following code words -
*          =onta$, =osla$, =oslb$, =oslc$
*
exbl3  sub   wb,(x1)+          adjust offset
       bct   wa,exbl4          decrement count
*
exbl4  bct   wa,exbl5          decrement count
*
*      continue search for more offsets
*
exbl5  mov   (x1)+,xr          get next code word
       beq   xr,=osla$,exbl3    jump if offset found
       beq   xr,=oslb$,exbl3    jump if offset found
       beq   xr,=oslc$,exbl3    jump if offset found
       beq   xr,=onta$,exbl3    jump if offset found
       bct   wa,exbl5           loop
       brn   exbl2              merge to return
       enp                     end procedure exbld

```

```

*
*   expand -- analyze expression
*
*   the expression analyzer (expand) procedure is used to scan
*   an expression and convert it into a tree representation.
*   see the description of cmlblk in the structures section
*   for detailed format of tree blocks.
*
*   the analyzer uses a simple precedence scheme in which
*   operands and operators are placed on a single stack
*   and condensations are made when low precedence operators
*   are stacked after a higher precedence operator. a global
*   variable (in wb) keeps track of the level as follows.
*
*   0   scanning outer level of statement or expression
*   1   scanning outer level of normal goto
*   2   scanning outer level of direct goto
*   3   scanning inside array brackets
*   4   scanning inside grouping parentheses
*   5   scanning inside function parentheses
*
*   this variable is saved on the stack on encountering a
*   grouping and restored at the end of the grouping.
*
*   another global variable (in wc) counts the number of
*   items at one grouping level and is incremented for each
*   comma encountered. it is stacked with the level indicator
*
*   the scan is controlled by a three state finite machine.
*   a global variable stored in wa is the current state.
*
*   wa=0           nothing scanned at this level
*   wa=1           operand expected
*   wa=2           operator expected
*
*   (wb)           call type (see below)
*   jsr expand      call to analyze expression
*   (xr)           pointer to resulting tree
*   (xl,wa,wb,wc,ra) destroyed
*
*   the entry value of wb indicates the call type as follows.
*
*   0   scanning either the main body of a statement or the
*       text of an expression (from eval call). valid
*       terminators are colon, semicolon. the rescan flag is
*       set to return the terminator on the next scan call.
*
*   1   scanning a normal goto. the only valid
*       terminator is a right paren.
*
*   2   scanning a direct goto. the only valid
*       terminator is a right bracket.

```

*			
*	expan	(continued)	
*			
*		entry point	
*			
expan	prc	e,0	entry point
	zer	-(xs)	set top of stack indicator
	zer	wa	set initial state to zero
	zer	wc	zero counter value
*			
*		loop here for successive entries	
*			
exp01	jsr	scane	scan next element
	add	wa,xl	add state to syntax code
	bsw	xl,t\$nes	switch on element type/state
	iff	t\$va0,exp03	variable, s=0
	iff	t\$va1,exp03	variable, state one
	iff	t\$va2,exp04	variable, s=2
	iff	t\$co0,exp03	constant, s=0
	iff	t\$co1,exp03	constant, s=1
	iff	t\$co2,exp04	constant, s=2
	iff	t\$lp0,exp06	left paren, s=0
	iff	t\$lp1,exp06	left paren, s=1
	iff	t\$lp2,exp04	left paren, s=2
	iff	t\$fn0,exp10	function, s=0
	iff	t\$fn1,exp10	function, s=1
	iff	t\$fn2,exp04	function, s=2
	iff	t\$rp0,exp02	right paren, s=0
	iff	t\$rp1,exp05	right paren, s=1
	iff	t\$rp2,exp12	right paren, s=2
	iff	t\$lb0,exp08	left brkt, s=0
	iff	t\$lb1,exp08	left brkt, s=1
	iff	t\$lb2,exp09	left brkt, s=2
	iff	t\$rb0,exp02	right brkt, s=0
	iff	t\$rb1,exp05	right brkt, s=1
	iff	t\$rb2,exp18	right brkt, s=2
	iff	t\$uo0,exp27	unop, s=0
	iff	t\$uo1,exp27	unop, s=1
	iff	t\$uo2,exp04	unop, s=2
	iff	t\$bo0,exp05	binop, s=0
	iff	t\$bo1,exp05	binop, s=1
	iff	t\$bo2,exp26	binop, s=2
	iff	t\$cm0,exp02	comma, s=0
	iff	t\$cm1,exp05	comma, s=1
	iff	t\$cm2,exp11	comma, s=2
	iff	t\$c10,exp02	colon, s=0
	iff	t\$c11,exp05	colon, s=1
	iff	t\$c12,exp19	colon, s=2
	iff	t\$sm0,exp02	semicolon, s=0
	iff	t\$sm1,exp05	semicolon, s=1
	iff	t\$sm2,exp19	semicolon, s=2
	esw		end switch on element type/state

```

*
*      expans (continued)
*
*      here for rbr,rpr,col,smc,cma in state 0
*
*      set to rescan the terminator encountered and create
*      a null constant (case of omitted null)
*
exp02  mnz  scnrs          set to rescan element
      mov  =nulls,xr      point to null, merge
*
*      here for var or con in states 0,1
*
*      stack the variable/constant and set state=2
*
exp03  mov  xr,-(xs)      stack pointer to operand
      mov  =num02,wa      set state 2
      brn  exp01          jump for next element
*
*      here for var,con,lpr,fnc,uop in state 2
*
*      we rescan the element and create a concatenation operator
*      this is the case of the blank concatenation operator.
*
exp04  mnz  scnrs          set to rescan element
      mov  =opdvc,xr      point to concat operator dv
      bze  wb,exp4a        ok if at top level
      mov  =opdvp,xr      else point to unmistakable concat.
*
*      merge here when xr set up with proper concatenation dvblk
*
exp4a  bnz  scnbl,exp26    merge bop if blanks, else error
*
*      dcv  scnse          adjust start of element location
      erb  220,syntax error:  missing operator
*
*      here for cma,rpr,rbr,col,smc,bop(s=1) bop(s=0)
*
*      this is an erroneous construction
*
*      dcv  scnse          adjust start of element location
exp05  erb  221,syntax error:  missing operand
*
*      here for lpr (s=0,1)
*
exp06  mov  =num04,xl      set new level indicator
      zer  xr              set zero value for cmopn

```



```

*
*      expan (continued)
*
*      merge here to store old level on stack and start new one
*
exp07  mov  xr,-(xs)          stack cmopn value
      mov  wc,-(xs)          stack old counter
      mov  wb,-(xs)          stack old level indicator
      chk                     check for stack overflow
      zer  wa                 set new state to zero
      mov  xl,wb              set new level indicator
      mov  =num01,wc          initialize new counter
      brn  exp01              jump to scan next element

*
*      here for lbr (s=0,1)
*
*      this is an illegal use of left bracket
*
exp08  erb  222,syntax error:      invalid use of left bracket

*
*      here for lbr (s=2)
*
*      set new level and start to scan subscripts
*
exp09  mov  (xs)+,xr          load array ptr for cmopn
      mov  =num03,xl          set new level indicator
      brn  exp07              jump to stack old and start new

*
*      here for fnc (s=0,1)
*
*      stack old level and start to scan arguments
*
exp10  mov  =num05,xl          set new lev indic (xr=vrbk=cmopn)
      brn  exp07              jump to stack old and start new

*
*      here for cma (s=2)
*
*      increment argument count and continue
*
exp11  icv  wc                increment counter
      jsr  expdm              dump operators at this level
      zer  -(xs)              set new level for parameter
      zer  wa                 set new state
      bgt  wb,=num02,exp01     loop back unless outer level
      erb  223,syntax error:   invalid use of comma

```

```

*
*      expans (continued)
*
*      here for rpr (s=2)
*
*      at outer level in a normal goto this is a terminator
*      otherwise it must terminate a function or grouping
*
exp12  beq  wb,=num01,exp20          end of normal goto
      beq  wb,=num05,exp13          end of function arguments
      beq  wb,=num04,exp14          end of grouping / selection
      erb  224,syntax error:        unbalanced right parenthesis
*
*      here at end of function arguments
*
exp13  mov  =c$func,xl              set cmtyp value for function
      brn  exp15                    jump to build cmlbk
*
*      here for end of grouping
*
exp14  beq  wc,=num01,exp17          jump if end of grouping
      mov  =c$sel,xl               else set cmtyp for selection
*
*      merge here to build cmlbk for level just scanned and
*      to pop up to the previous scan level before continuing.
*
exp15  jsr  expdm                   dump operators at this level
      mov  wc,wa                    copy count
      add  =cmvls,wa                add for standard fields at start
      wtb  wa                       convert length to bytes
      jsr  alloc                    allocate space for cmlbk
      mov  =b$cmt,(xr)              store type code for cmlbk
      mov  xl,cmtyp(xr)             store cmlbk node type indicator
      mov  wa,cmlen(xr)             store length
      add  wa,xr                    point past end of block
      lct  wc,wc                    set loop counter
*
*      loop to move remaining words to cmlbk
*
exp16  mov  (xs)+,-(xr)             move one operand ptr from stack
      mov  (xs)+,wb                 pop to old level indicator
      bct  wc,exp16                 loop till all moved

```

```

*
*      expans (continued)
*
*      complete cmlblk and stack pointer to it on stack
*
      sub  *cmvls,xr          point back to start of block
      mov  (xs)+,wc          restore old counter
      mov  (xs),cmopn(xr)    store operand ptr in cmlblk
      mov  xr,(xs)           stack cmlblk pointer
      mov  =num02,wa         set new state
      brn  exp01             back for next element

*
*      here at end of a parenthesized expression
*
exp17  jsr  expdm            dump operators at this level
      mov  (xs)+,xr          restore xr
      mov  (xs)+,wb          restore outer level
      mov  (xs)+,wc          restore outer count
      mov  xr,(xs)          store opnd over unused cmopn val
      mov  =num02,wa         set new state
      brn  exp01            back for next element

*
*      here for rbr (s=2)
*
*      at outer level in a direct goto, this is a terminator.
*      otherwise it must terminate a subscript list.
*
exp18  mov  =c$arr,xl        set cmtyp for array reference
      beq  wb,=num03,exp15   jump to build cmlblk if end arrayref
      beq  wb,=num02,exp20   jump if end of direct goto
      erb  225,syntax error: unbalanced right bracket

```

```

*
*      expans (continued)
*
*      here for col,smc (s=2)
*
*      error unless terminating statement body at outer level
*
exp19  mnz  scnrs          rescan terminator
      mov  wb,xl          copy level indicator
      bsw  x1,6          switch on level indicator
      iff  0,exp20        normal outer level
      iff  1,exp22        fail if normal goto
      iff  2,exp23        fail if direct goto
      iff  3,exp24        fail array brackets
      iff  4,exp21        fail if in grouping
      iff  5,exp21        fail function args
      esw                end switch on level

*
*      here at normal end of expression
*
exp20  jsr  expdm          dump remaining operators
      mov  (xs)+,xr        load tree pointer
      ica  xs              pop off bottom of stack marker
      exi                return to expans caller

*
*      missing right paren
*
exp21  erb  226,syntax error:      missing right paren

*
*      missing right paren in goto field
*
exp22  erb  227,syntax error:      right paren missing from goto

*
*      missing bracket in goto
*
exp23  erb  228,syntax error:      right bracket missing from goto

*
*      missing array bracket
*
exp24  erb  229,syntax error:      missing right array bracket

```

```

*
*      expans (continued)
*
*      loop here when an operator causes an operator dump
*
exp25  mov  229,syntax error::
      jsr  expop                      pop one operator
      mov  expsv,xr                  restore op dv pointer and merge
*
*      here for bop (s=2)
*
*      remove operators (condense) from stack until no more
*      left at this level or top one has lower precedence.
*      loop here till this condition is met.
*
exp26  mov  num01(xs),xl              load operator dvptr from stack
      ble  xl,=num05,exp27           jump if bottom of stack level
      blt  dvrpr(xr),dvlpr(xl),exp25 else pop if new prec is lo
*
*      here for uop (s=0,1)
*
*      binary operator merges after precedence check
*
*      the operator dv is stored on the stack and the scan
*      continues after setting the scan state to one.
*
exp27  mov  xr,-(xs)                 stack operator dvptr on stack
      chk                                check for stack overflow
      mov  =num01,wa                 set new state
      bne  xr,=opdvs,exp01           back for next element unless =
*
*      here for special case of binary =. the syntax allows a
*      null right argument for this operator to be left
*      out. accordingly we reset to state zero to get proper
*      action on a terminator (supply a null constant).
*
      zer  wa                        set state zero
      brn  exp01                     jump for next element
      enp                             end procedure expans

```

```

*
*      expap -- test for pattern match tree
*
*      expap is passed an expression tree to determine if it
*      is a pattern match. the following are recogized as
*      matches in the context of this call.
*
*      1)  an explicit use of binary question mark
*      2)  a concatenation
*      3)  an alternation whose left operand is a concatenation
*
*      (xr)                ptr to expan tree
*      jsr  expap           call to test for pattern match
*      ppm  loc             transfer loc if not a pattern match
*      (wa)                destroyed
*      (xr)                unchanged (if not match)
*      (xr)                ptr to binary operator blk if match
*
expap  prc  e,1             entry point
      mov  xl,-(xs)        save xl
      bne  (xr),=b$cmt,expp2  no match if not complex
      mov  cmtyp(xr),wa    else load type code
      beq  wa,=c$cnc,expp1  concatenation is a match
      beq  wa,=c$pmt,expp1  binary question mark is a match
      bne  wa,=c$alt,expp2  else not match unless alternation
*
*      here for alternation. change (a b) / c to a qm (b / c)
*
      mov  cmlop(xr),xl    load left operand pointer
      bne  (xl),=b$cmt,expp2  not match if left opnd not complex
      bne  cmtyp(xl),=c$cnc,expp2  not match if left op not conc
      mov  cmrop(xl),cmlop(xr)  xr points to (b / c)
      mov  xr,cmrop(xl)        set xl opnds to a, (b / c)
      mov  xl,xr              point to this altered node
*
*      exit here for pattern match
*
expp1  mov  (xs)+,xl        restore entry xl
      exi                      give pattern match return
*
*      exit here if not pattern match
*
expp2  mov  (xs)+,xl        restore entry xl
      exi  1                 give non-match return
      enp                    end procedure expap

```

```

*
*      expdm -- dump operators at current level (for expan)
*
*      expdm uses expop to condense all operators at this syntax
*      level. the stack bottom is recognized from the level
*      value which is saved on the top of the stack.
*
*      jsr  expdm          call to dump operators
*      (xs)                popped as required
*      (xr,wa)             destroyed
*
expdm  prc   n,0                entry point
      mov  xl,r$exs           save xl value
*
*      loop to dump operators
*
exdm1  ble  num01(xs),=num05,exdm2    jump if stack bottom (saved level
      jsr  expop                else pop one operator
      brn  exdm1                and loop back
*
*      here after popping all operators
*
exdm2  mov  r$exs,xl           restore xl
      zer  r$exs               release save location
      exi                          return to expdm caller
      enp                      end procedure expdm

```

```

*
*      expop-- pop operator (for expan)
*
*      expop is used by the expan routine to condense one
*      operator from the top of the syntax stack. an appropriate
*      cmbblk is built for the operator (unary or binary) and a
*      pointer to this cmbblk is stacked.
*
*      expop is also used by scngf (goto field scan) procedure
*
*      jsr  expop          call to pop operator
*      (xs)                popped appropriately
*      (xr,xl,wa)          destroyed
*
expop  prc   n,0                entry point
      mov   num01(xs),xr        load operator dv pointer
      beq   dvlpr(xr),=lluno,expo2  jump if unary
*
*      here for binary operator
*
      mov   *cmbs$,wa          set size of binary operator cmbblk
      jsr   alloc              allocate space for cmbblk
      mov   (xs)+,cmrop(xr)     pop and store right operand ptr
      mov   (xs)+,xl           pop and load operator dv ptr
      mov   (xs),cmlop(xr)      store left operand pointer
*
*      common exit point
*
expo1  mov   =b$cmt,(xr)        store type code for cmbblk
      mov   dvtyp(xl),cmtyp(xr) store cmbblk node type code
      mov   xl,cmopn(xr)        store dvptr (=ptr to dac o$xxx)
      mov   wa,cmlen(xr)        store cmbblk length
      mov   xr,(xs)             store resulting node ptr on stack
      exi                      return to expop caller
*
*      here for unary operator
*
expo2  mov   *cmus$,wa          set size of unary operator cmbblk
      jsr   alloc              allocate space for cmbblk
      mov   (xs)+,cmrop(xr)     pop and store operand pointer
      mov   (xs),xl            load operator dv pointer
      brn   expo1              merge back to exit
      enp                      end procedure expop

```


if.csfn

```

*
*      filnm -- obtain file name from statement number
*
*      filnm takes a statement number and examines the file name
*      table pointed to by r$sfn to find the name of the file
*      containing the given statement.  table entries are
*      arranged in order of ascending statement number (there
*      is only one hash bucket in this table).  elements are
*      added to the table each time there is a change in
*      file name, recording the then current statement number.
*
*      to find the file name, the linked list of teblks is
*      scanned for an element containing a subscript (statement
*      number) greater than the argument statement number, or
*      the end of chain.  when this condition is met, the
*      previous teblk contains the desired file name as its
*      value entry.
*
*      (wc)                statement number
*      jsr  filnm           call to obtain file name
*      (xl)                file name (scblk)
*      (ia)                destroyed
*
filnm  prc  e,0             entry point
       mov  wb,-(xs)        preserve wb
       bze  wc,filn3        return nulls if stno is zero
       mov  r$sfn,xl        file name table
       bze  xl,filn3        if no table
       mov  tbbuk(xl),wb    get bucket entry
       beq  wb,r$sfn,filn3  jump if no teblks on chain
       mov  xr,-(xs)        preserve xr
       mov  wb,xr           previous block pointer
       mov  wc,-(xs)        preserve stmt number
*
*      loop through teblks on hash chain
*
filn1  mov  xr,xl           next element to examine
       mov  tesub(xl),xr    load subscript value (an icblk)
       ldi  icval(xr)       load the statement number
       mfi  wc              convert to address constant
       blt  (xs),wc,filn2   compare arg with teblk stmt number
*
*      here if desired stmt number is ge teblk stmt number
*
       mov  xl,wb           save previous entry pointer
       mov  tenxt(xl),xr    point to next teblk on chain
       bne  xr,r$sfn,filn1  jump if there is one
*
*      here if chain exhausted or desired block found.
*

```

filn2	mov wb,xl	previous teblk
	mov teval(xl),xl	get ptr to file name scblk
	mov (xs)+,wc	restore stmt number
	mov (xs)+,xr	restore xr
	mov (xs)+,wb	restore wb
	exi (xs)+,wb	restore wb
	*	
	* no table or no table entries	
	*	
filn3	mov (xs)+,wb	restore wb
	mov =nulls,xl	return null string
	exi =nulls,xl	return null string
	enp =nulls,xl	return null string

fi

```

*
if .culc
*
*      flstg -- fold string to upper case
*
*      flstg folds a character string containing lower case
*      characcters to one containing upper case characters.
*      folding is only done if &case (kvcas) is not zero.
*
*      (xr)                string argument
*      (wa)                length of string
*      jsr  flstg          call to fold string
*      (xr)                result string (possibly original)
*      (wc)                destroyed
*
flstg  prc  e,0            entry point
      bze  kvcas,fst99    skip if &case is 0
      mov  xl,-(xs)       save xl across call
      mov  xr,-(xs)       save original scblk ptr
      jsr  alocs          allocate new string block
      mov  (xs),xl        point to original scblk
      mov  xr,-(xs)       save pointer to new scblk
      plc  xl             point to original chars
      psc  xr             point to new chars
      zer  -(xs)          init did fold flag
      lct  wc,wc          load loop counter
fst01  lch  wa,(xl)+       load character
      blt  wa,=ch$$a,fst02 skip if less than lc a
      bgt  wa,=ch$$$ ,fst02 skip if greater than lc z
      flc  wa             fold character to upper case
      mnz  (xs)           set did fold character flag
fst02  sch  wa,(xr)+       store (possibly folded) character
      bct  wc,fst01       loop thru entire string
      csc  xr             complete store characters
      mov  (xs)+,xr       see if any change
      bnz  xr,fst10       skip if folding done (no change)
      mov  (xs)+,dnamp     do not need new scblk
      mov  (xs)+,xr       return original scblk
      brn  fst20          merge below
fst10  mov  (xs)+,xr       return new scblk
      ica  xs             throw away original scblk pointer
fst20  mov  sclen(xr),wa   reload string length
      mov  (xs)+,xl       restore xl
fst99  exi                return
      enp                 return

```

fi

```
*
*
*      gbcoll -- perform garbage collection
*
*      gbcoll performs a garbage collection on the dynamic region
*      all blocks which are no longer in use are eliminated
*      by moving blocks which are in use down and resetting
*      dnamp, the pointer to the next available location.
*
*      (wb)                move offset (see below)
*      jsr  gbcoll          call to collect garbage
if .csed
*      (xr)                sediment size after collection
else
*      (xr)                destroyed
fi

*
*      the following conditions must be met at the time when
*      gbcoll is called.
*
*      1)  all pointers to blocks in the dynamic area must be
*          accessible to the garbage collector. this means
*          that they must occur in one of the following.
*
*          a)                main stack, with current top
*                           element being indicated by xs
*
*          b)                in relocatable fields of vrblls.
*
*          c)                in register xl at the time of call
*
*          e)                in the special region of working
*                           storage where names begin with r$.
*
*      2)  all pointers must point to the start of blocks with
*          the sole exception of the contents of the code
*          pointer register which points into the r$cod block.
*
*      3)  no location which appears to contain a pointer
*          into the dynamic region may occur unless it is in
*          fact a pointer to the start of the block. however
*          pointers outside this area may occur and will
*          not be changed by the garbage collector.
*          it is especially important to make sure that xl
*          does not contain a garbage value from some process
*          carried out before the call to the collector.
*
*      gbcoll has the capability of moving the final compacted
*      result up in memory (with addresses adjusted accordingly)
*      this is used to add space to the static region. the
*      entry value of wb is the number of bytes to move up.
*      the caller must guarantee that there is enough room.
```

* furthermore the value in wb if it is non-zero, must be at
* least 256 so that the mwb instruction conditions are met.

```

*
*
*   gbccl (continued)
*
*   the algorithm, which is a modification of the lisp-2
*   garbage collector devised by r.dewar and k.belcher
*   takes three passes as follows.
*
*   1)  all pointers in memory are scanned and blocks in use
*       determined from this scan. note that this procedure
*       is recursive and uses the main stack for linkage.
*       the marking process is thus similar to that used in
*       a standard lisp collector. however the method of
*       actually marking the blocks is different.
*
*       the first field of a block normally contains a
*       code entry point pointer. such an entry pointer
*       can be distinguished from the address of any pointer
*       to be processed by the collector. during garbage
*       collection, this word is used to build a back chain
*       of pointers through fields which point to the block.
*       the end of the chain is marked by the occurrence
*       of the word which used to be in the first word of
*       the block. this backchain serves both as a mark
*       indicating that the block is in use and as a list of
*       references for the relocation phase.
*
*   2)  storage is scanned sequentially to discover which
*       blocks are currently in use as indicated by the
*       presence of a backchain. two pointers are maintained
*       one scans through looking at each block. the other
*       is incremented only for blocks found to be in use.
*       in this way, the eventual location of each block can
*       be determined without actually moving any blocks.
*       as each block which is in use is processed, the back
*       chain is used to reset all pointers which point to
*       this block to contain its new address, i.e. the
*       address it will occupy after the blocks are moved.
*       the first word of the block, taken from the end of
*       the chain is restored at this point.
*
*       during pass 2, the collector builds blocks which
*       describe the regions of storage which are to be
*       moved in the third pass. there is one descriptor for
*       each contiguous set of good blocks. the descriptor
*       is built just behind the block to be moved and
*       contains a pointer to the next block and the number
*       of words to be moved.
*
*   3)  in the third and final pass, the move descriptor
*       blocks built in pass two are used to actually move
*       the blocks down to the bottom of the dynamic region.
*       the collection is then complete and the next
*       available location pointer is reset.

```

```

*
*      gbccl (continued)
*
if .csed
*      the garbage collector also recognizes the concept of
*      sediment.  sediment is defined as long-lived objects
*      which precipitate to the bottom of dynamic storage.
*      moving these objects during repeated collections is
*      inefficient.  it also contributes to thrashing on
*      systems with virtual memory.  in a typical worst-case
*      situation, there may be several megabytes of live objects
*      in the sediment, and only a few dead objects in need of
*      collection.  without recognising sediment, the standard
*      collector would move those megabytes of objects downward
*      to squeeze out the dead objects.  this type of move
*      would result in excessive thrashing for very little memory
*      gain.
*
*      scanning of blocks in the sediment cannot be avoided
*      entirely, because these blocks may contain pointers to
*      live objects above the sediment.  however, sediment
*      blocks need not be linked to a back chain as described
*      in pass one above.  since these blocks will not be moved,
*      pointers to them do not need to be adjusted.  eliminating
*      unnecessary back chain links increases locality of
*      reference, improving virtual memory performance.
*
*      because back chains are used to mark blocks whose con-
*      tents have been processed, a different marking system
if .cepp
*      is needed for blocks in the sediment.  since block type
*      words point to odd-parity entry addresses, merely incre-
*      menting the type word serves to mark the block as pro-
*      cessed.  during pass three, the type words are decre-
*      mented to restore them to their original value.
else
*      is needed for blocks in the sediment.  all block type
*      words normally lie in the range b$aaa to p$yyy.  blocks
*      can be marked by adding an offset (created in gbcmk) to
*      move type words out of this range.  during pass three the
*      offset is subtracted to restore them to their original
*      value.
fi

```

```

*
* gbcoll (continued)
*
*
* the variable dnams contains the number of bytes of memory
* currently in the sediment. setting dnams to zero will
* eliminate the sediment and force it to be included in a
* full garbage collection. gbcoll returns a suggested new
* value for dnams (usually dnamp-dnamb) in xr which the
* caller can store in dnams if it wishes to maintain the
* sediment. that is, data remaining after a garbage
* collection is considered to be sediment. if one accepts
* the common lore that most objects are either very short-
* or very long-lived, then this naive setting of dnams
* probably includes some short-lived objects toward the end
* of the sediment.
*
* knowing when to reset dnams to zero to collect the sedi-
* ment is not precisely known. we force it to zero prior
* to producing a dump, when gbcoll is invoked by collect()
* (so that the sediment is invisible to the user), when
* sysmm is unable to obtain additional memory, and when
* gbcoll is called to relocate the dynamic area up in memory
* (to make room for enlarging the static area). if there
* are no other reset situations, this leads to the inexo-
* rable growth of the sediment, possible forcing a modest
* program to begin to use virtual memory that it otherwise
* would not.
*
* as we scan sediment blocks in pass three, we maintain
* aggregate counts of the amount of dead and live storage,
* which is used to decide when to reset dnams. when the
* ratio of free storage found in the sediment to total
* sediment size exceeds a threshold, the sediment is marked
* for collection on the next gbcoll call.
*

```

fi


```

*
*      gbc0l (continued)
*
gbc0l  prc    e,0                      entry point
      bnz    dmvc h,gbc14             fail if in mid-dump
      mnz    gbcfl                    note gbc0l entered
      mov    wa,gb sva                save entry wa
      mov    wb,gb svb                save entry wb
      mov    wc,gb svc                save entry wc
      mov    xl,-(xs)                 save entry xl
      scp    wa                       get code pointer value
      sub    r$cod,wa                 make relative
      lcp    wa                       and restore

if .csed
      bze    wb,gbc0a                 check there is no move offset
      zer    dnams                    collect sediment if must move it
gbc0a  mov    dnamb,wa                 start of dynamic area
      add    dnams,wa                 size of sediment
      mov    wa,gbc s d               first location past sediment

if .cepp
else
      mov    =p$yyy,wa                last entry point
      icv    wa                       address past last entry point
      sub    =b$aaa,wa                size of entry point area
      mov    wa,gbc mk                use to mark processed sed. blocks

fi

fi

if .cgbc
*
*      inform sysgc that collection to commence
*
      mnz    xr                       non-zero flags start of collection
      mov    dnamb,wa                 start of dynamic area
      mov    dnamp,wb                 next available location
      mov    dname,wc                 last available location + 1
      jsr    sysgc                    inform of collection

fi

*
*      process stack entries
*
      mov    xs,xr                    point to stack front
      mov    stbas,xl                 point past end of stack
      bge    xl,xr,gbc00              ok if d-stack
      mov    xl,xr                    reverse if ...
      mov    xs,xl                    ... u-stack

*
*      process the stack
*
gbc00  jsr    gbc pf                  process pointers on stack

```

```

*
*      process special work locations
*
      mov  =r$aaa,xr          point to start of relocatable locs
      mov  =r$yyy,xl          point past end of relocatable locs
      jsr   gbcpf             process work fields
*
*      prepare to process variable blocks
*
      mov  hshtb,wa           point to first hash slot pointer
*
*      loop through hash slots
*
gbc01  mov  wa,xl             point to next slot
      ica   wa               bump bucket pointer
      mov  wa,gbcnm          save bucket pointer

```

```

*
*      gbc01 (continued)
*
*      loop through variables on one hash chain
*
gbc02  mov  (x1),xr          load ptr to next vrbk
      bze  xr,gbc03         jump if end of chain
      mov  xr,x1            else copy vrbk pointer
      add  *vrval,xr        point to first reloc fld
      add  *vrnxt,x1        point past last (and to link ptr)
      jsr  gbcpf            process reloc fields in vrbk
      brn  gbc02            loop back for next block

*
*      here at end of one hash chain
*
gbc03  mov  gbcnm,wa        restore bucket pointer
      bne  wa,hshste,gbc01  loop back if more buckets to go

```

```

*
*      gbc01 (continued)
*
*      now we are ready to start pass two. registers are used
*      as follows in pass two.
*
*      (xr)                scans through all blocks
*      (wc)                pointer to eventual location
*
*      the move description blocks built in this pass have
*      the following format.
*
*      word 1              pointer to next move block,
*                          zero if end of chain of blocks
*
*      word 2              length of blocks to be moved in
*                          bytes. set to the address of the
*                          first byte while actually scanning
*                          the blocks.
*
*      the first entry on this chain is a special entry
*      consisting of the two words gbcnm and gbcns. after
*      building the chain of move descriptors, gbcnm points to
*      the first real move block, and gbcns is the length of
*      blocks in use at the start of storage which need not
*      be moved since they are in the correct position.
*
if .csed
    mov  dnamb,xr          point to first block
    zer  wb               accumulate size of dead blocks
gbc04  beq  xr,gbc04c      jump if end of sediment
    mov  (xr),wa          else get first word
    if .cepp
        bod  wa,gbc4b      jump if entry pointer (unused)
        dcv  wa           restore entry pointer
    else
        bhi  wa,=$yyy,gbc4a skip if not entry ptr (in use)
        bhi  wa,=$aaa,gbc4b jump if entry pointer (unused)
gbc4a  sub  gbcmk,wa       restore entry pointer
    fi
        mov  wa,(xr)       restore first word
        jsr  blkln         get length of this block
        add  wa,xr         bump actual pointer
        brn  gbc04         continue scan through sediment
*
*      here for unused sediment block
*
gbc4b  jsr  blkln         get length of this block
        add  wa,xr         bump actual pointer
        add  wa,wb         count size of unused blocks
        brn  gbc04         continue scan through sediment

```

```

*
*      here at end of sediment.  remember size of free blocks
*      within the sediment.  this will be used later to decide
*      how to set the sediment size returned to caller.
*
*      then scan rest of dynamic area above sediment.
*
*      (wb) = aggregate size of free blocks in sediment
*      (xr) = first location past sediment
*
gbc4c  mov  wb,gbcsf          size of sediment free space
else
      mov  dnamb,xr          point to first block
fi

      mov  xr,wc             set as first eventual location
      add  gbsvb,wc          add offset for eventual move up
      zer  gbcnm             clear initial forward pointer
      mov  =gbcnm,gbc1m      initialize ptr to last move block
      mov  xr,gbcns          initialize first address

*
*      loop through a series of blocks in use
*
gbc05  beq  xr,dnamp,gbc07    jump if end of used region
      mov  (xr),wa           else get first word
if .cepp
      bod  wa,gbc07          jump if entry pointer (unused)
else
      bhi  wa,=p$yyy,gbc06    skip if not entry ptr (in use)
      bhi  wa,=b$aaa,gbc07    jump if entry pointer (unused)
fi

*
*      here for block in use, loop to relocate references
*
gbc06  mov  wa,x1            copy pointer
      mov  (x1),wa           load forward pointer
      mov  wc,(x1)           relocate reference
if .cepp
      bev  wa,gbc06          loop back if not end of chain
else
      bhi  wa,=p$yyy,gbc06    loop back if not end of chain
      blo  wa,=b$aaa,gbc06    loop back if not end of chain
fi

```

```

*
*      gbc01 (continued)
*
*      at end of chain, restore first word and bump past
*
      mov  wa,(xr)                restore first word
      jsr  blkln                  get length of this block
      add  wa,xr                  bump actual pointer
      add  wa,wc                  bump eventual pointer
      brn  gbc05                  loop back for next block

*
*      here at end of a series of blocks in use
*
gbc07  mov  xr,wa                  copy pointer past last block
      mov  gbclm,xl               point to previous move block
      sub  num01(xl),wa           subtract starting address
      mov  wa,num01(xl)          store length of block to be moved

*
*      loop through a series of blocks not in use
*
gbc08  beq  xr,dnamp,gbc10        jump if end of used region
      mov  (xr),wa               else load first word of next block
if .cepp
      bev  wa,gbc09              jump if in use
else
      bhi  wa,=p$yyy,gbc09       jump if in use
      blo  wa,=b$aaa,gbc09       jump if in use
fi

      jsr  blkln                  else get length of next block
      add  wa,xr                  push pointer
      brn  gbc08                  and loop back

*
*      here for a block in use after processing a series of
*      blocks which were not in use, build new move block.
*
gbc09  sub  *num02,xr             point 2 words behind for move block
      mov  gbclm,xl               point to previous move block
      mov  xr,(xl)               set forward ptr in previous block
      zer  (xr)                  zero forward ptr of new block
      mov  xr,gbclm              remember address of this block
      mov  xr,xl                 copy ptr to move block
      add  *num02,xr             point back to block in use
      mov  xr,num01(xl)          store starting address
      brn  gbc06                  jump to process block in use

```

```

*
*      gbc10 (continued)
*
*      here for pass three -- actually move the blocks down
*
*      (x1)                pointer to old location
*      (xr)                pointer to new location
*
if .csed
gbc10  mov  gbc10,xr                point to storage above sediment
else
gbc10  mov  dnamb,xr              point to start of storage
fi

      add  gbcns,xr              bump past unmoved blocks at start
*
*      loop through move descriptors
*
gbc11  mov  gbcnm,xl              point to next move block
      bze  x1,gbc12              jump if end of chain
      mov  (x1)+,gbcnm            move pointer down chain
      mov  (x1)+,wa              get length to move
      mvw
      brn  gbc11                 loop back
*
*      now test for move up
*
gbc12  mov  xr,dnamp              set next available loc ptr
      mov  gbsvb,wb              reload move offset
      bze  wb,gbc13              jump if no move required
      mov  xr,xl                 else copy old top of core
      add  wb,xr                 point to new top of core
      mov  xr,dnamp              save new top of core pointer
      mov  xl,wa                 copy old top
      sub  dnamb,wa              minus old bottom = length
      add  wb,dnamb              bump bottom to get new value
      mwb                        perform move (backwards)
*
*      merge here to exit
*
gbc13  zer  xr                    clear garbage value in xr
      mov  xr,gbcfl              note exit from gbc10
if .cgbc
      mov  dnamb,wa              start of dynamic area
      mov  dnamp,wb              next available location
      mov  dname,wc              last available location + 1
      jsr  sysgc                 inform sysgc of completion
fi
if .csed
*
*      decide whether to mark sediment for collection next time.

```

```

*      this is done by examining the ratio of previous sediment
*      free space to the new sediment size.
*
      sti   gbcia                save ia
      zer   xr                   presume no sediment will remain
      mov   gbcsf,wb             free space in sediment
      btw   wb                   convert bytes to words
      mti   wb                   put sediment free store in ia
      mli   gbsed                multiply by sediment factor
      iov   gb13a                jump if overflowed
      mov   dnamp,wb             end of dynamic area in use
      sub   dnamb,wb             minus start is sediment remaining
      btw   wb                   convert to words
      mov   wb,gbcsf            store it
      sbi   gbcsf                subtract from scaled up free store
      igt   gb13a                jump if large free store in sedimnt
      mov   dnamp,xr             below threshold, return sediment
      sub   dnamb,xr             for use by caller
gbc13a  ldi   gbcia                restore ia
fi

      mov   gbsva,wa            restore wa
      mov   gbsvb,wb            restore wb
      scp   wc                   get code pointer
      add   r$cod,wc            make absolute again
      lcp   wc                   and replace absolute value
      mov   gbsvc,wc            restore wc
      mov   (xs)+,xl            restore entry xl
      icv   gbcnt                increment count of collections
      exi                       exit to gbcol caller

*
*      garbage collection not allowed whilst dumping
*
gbc14  icv   errft                fatal error
      erb   250,insufficient      memory to complete dump
      enp                       end procedure gbcol

```



```

*
*      gbcpf -- process fields for garbage collector
*
*      this procedure is used by the garbage collector to
*      process fields in pass one. see gbcol for full details.
*
*      (xr)                ptr to first location to process
*      (xl)                ptr past last location to process
*      jsr  gbcpf           call to process fields
*      (xr,wa,wb,wc,ia)    destroyed
*
*      note that although this procedure uses a recursive
*      approach, it controls its own stack and is not recursive.
*
gbcpf  prc  e,0                entry point
       zer  -(xs)             set zero to mark bottom of stack
       mov  xl,-(xs)          save end pointer
*
*      merge here to go down a level and start a new loop
*
*      1(xs)                next lvl field ptr (0 at outer lvl)
*      0(xs)                ptr past last field to process
*      (xr)                ptr to first field to process
*
*      loop to process successive fields
*
gpf01  mov  (xr),xl           load field contents
       mov  xr,wc             save field pointer
if .crpp
       bod  xl,gpf2a          jump if not ptr into dynamic area
fi
       blt  xl,dnamb,gpf2a    jump if not ptr into dynamic area
       bge  xl,dnamp,gpf2a    jump if not ptr into dynamic area
*
*      here we have a ptr to a block in the dynamic area.
*      link this field onto the reference backchain.
*
       mov  (xl),wa           load ptr to chain (or entry ptr)
if .csed
       blt  xl,gbcasd,gpf1a    do not chain if within sediment
fi
       mov  xr,(xl)           set this field as new head of chain
       mov  wa,(xr)           set forward pointer
*
*      now see if this block has been processed before
*
if .cepp
gpf1a  bod  wa,gpf03          jump if not already processed
else
gpf1a  bhi  wa,=p$yyy,gpf2a   jump if already processed

```

```

        bhi  wa,=b$aaa,gpf03          jump if not already processed
fi
        *
        *      here to restore pointer in xr to field just processed
        *
gpf02   mov  wc,xr                    restore field pointer
        *
        *      here to move to next field
        *
gpf2a   ica  xr                      bump to next field
        bne  xr,(xs),gpf01          loop back if more to go

```

```

*
*      gbcpf (continued)
*
*      here we pop up a level after finishing a block
*
      mov  (xs)+,x1          restore pointer past end
      mov  (xs)+,xr          restore block pointer
      bnz  xr,gpf2a          continue loop unless outer level
      exi                    return to caller if outer level

*
*      here to process an active block which has not been done
*
if .csed
*
*      since sediment blocks are not marked by putting them on
*      the back chain, they must be explicitly marked in another
*      manner.  if odd parity entry points are present, mark by
*      temporarily converting to even parity.  if odd parity not
*      available, the entry point is adjusted by the value in
*      gbcmk.
*
gpf03  bge  x1,gbcscd,gpf3a    if not within sediment
      if .cepp
          icv  (x1)            mark by making entry point even
      else
          add  gbcmk,(x1)      mark by biasing entry point
      fi
gpf3a  mov  x1,xr              copy block pointer
      else
gpf03  mov  x1,xr              copy block pointer
      fi

      mov  wa,x1              copy first word of block
      lei  x1                  load entry point id (bl$xx)

*
*      block type switch. note that blocks with no relocatable
*      fields just return to gpf02 here to continue to next fld.
*
      bsw  x1,bl$$$$          switch on block type
      iff  bl$ar,gpf06         arblk
if .cnbf
      iff  bl$bc,gpf02         bcbk - dummy to fill out iffs
else
      iff  bl$bc,gpf18         bcbk
fi

      iff  bl$bf,gpf02         bfbk
      iff  bl$cc,gpf07         ccblk
if .csln
      iff  bl$cd,gpf19         cdbk
else
      iff  bl$cd,gpf08         cdbk

```

fi

iff	bl\$cm,gpf04	cmbblk
iff	bl\$df,gpf02	dfblk
iff	bl\$ev,gpf10	evblk
iff	bl\$ex,gpf17	exblk
iff	bl\$ff,gpf11	ffblk
iff	bl\$nm,gpf10	nmbblk
iff	bl\$p0,gpf10	p0blk
iff	bl\$p1,gpf12	p1blk
iff	bl\$p2,gpf12	p2blk
iff	bl\$pd,gpf13	pdblk
iff	bl\$pf,gpf14	pfblk
iff	bl\$tb,gpf08	tbblk
iff	bl\$te,gpf15	teblk
iff	bl\$tr,gpf16	trblk
iff	bl\$vc,gpf08	vcblk
iff	bl\$xr,gpf09	xrbblk
iff	bl\$ct,gpf02	ctblk
iff	bl\$ef,gpf02	efblk
iff	bl\$ic,gpf02	icblk
iff	bl\$kv,gpf02	kvblk
iff	bl\$rc,gpf02	rcblk
iff	bl\$sc,gpf02	scblk
iff	bl\$se,gpf02	seblk
iff	bl\$xn,gpf02	xnblk
esw		end of jump table

```

*
*      gbcpf (continued)
*
*      cmbblk
*
gpf04  mov  cmlen(xr),wa      load length
      mov  *cmtyp,wb        set offset
*
*      here to push down to new level
*
*      (wc)                  field ptr at previous level
*      (xr)                  ptr to new block
*      (wa)                  length (reloc flds + flds at start)
*      (wb)                  offset to first reloc field
*
gpf05  add  xr,wa            point past last reloc field
      add  wb,xr            point to first reloc field
      mov  wc,-(xs)        stack old field pointer
      mov  wa,-(xs)        stack new limit pointer
      chk
      brn  gpf01          if ok, back to process
*
*      arblk
*
gpf06  mov  arlen(xr),wa    load length
      mov  arofs(xr),wb    set offset to 1st reloc fld (arpro)
      brn  gpf05          all set
*
*      ccblk
*
gpf07  mov  ccuse(xr),wa    set length in use
      mov  *ccuse,wb        1st word (make sure at least one)
      brn  gpf05          all set

```

```

*
*      gbcpf (continued)
*
if .csln
*      cdblk
*
gpf19  mov  cdlen(xr),wa      load length
      mov  *cdfal,wb        set offset
      brn  gpf05            jump back

*
*      tbbblk, vcblk
else
*      cdblk, tbbblk, vcblk
fi

*
gpf08  mov  offs2(xr),wa     load length
      mov  *offs3,wb        set offset
      brn  gpf05            jump back

*
*      xrbblk
*
gpf09  mov  xrllen(xr),wa    load length
      mov  *xrptra,wb        set offset
      brn  gpf05            jump back

*
*      evblk, nmblk, p0blk
*
gpf10  mov  *offs2,wa        point past second field
      mov  *offs1,wb        offset is one (only reloc fld is 2)
      brn  gpf05            all set

*
*      ffblk
*
gpf11  mov  *ffofs,wa        set length
      mov  *ffnxt,wb        set offset
      brn  gpf05            all set

*
*      p1blk, p2blk
*
gpf12  mov  *parm2,wa        length (parm2 is non-relocatable)
      mov  *pthen,wb        set offset
      brn  gpf05            all set

```

```

*
*      gbcpf (continued)
*
*      pdblk
*
gpf13  mov  pddfp(xr),xl      load ptr to dfblk
        mov  dfpdl(xl),wa    get pdblk length
        mov  *pdfld,wb       set offset
        brn  gpf05           all set
*
*      pfblk
*
gpf14  mov  *pfarg,wa        length past last reloc
        mov  *pfcod,wb       offset to first reloc
        brn  gpf05           all set
*
*      teblk
*
gpf15  mov  *tesi$,wa        set length
        mov  *tesub,wb       and offset
        brn  gpf05           all set
*
*      trblk
*
gpf16  mov  *trsi$,wa        set length
        mov  *trval,wb       and offset
        brn  gpf05           all set
*
*      exblk
*
gpf17  mov  exlen(xr),wa     load length
        mov  *exflc,wb       set offset
        brn  gpf05           jump back
if .cnbf
else
*
*      bcblk
*
gpf18  mov  *bcsi$,wa        set length
        mov  *bcbuf,wb       and offset
        brn  gpf05           all set
fi

enp                                end procedure gbcpf

```

```

*
*      gtarr -- get array
*
*      gtarr is passed an object and returns an array if possibl
*
*      (xr)                value to be converted
*      (wa)                0 to place table addresses in array
*                        non-zero for keys/values in array
*      jsr  gtarr           call to get array
*      ppm  loc            transfer loc for all null table
*      ppm  loc            transfer loc if convert impossible
*      (xr)                resulting array
*      (xl,wa,wb,wc)       destroyed
*
gtarr  prc  e,2             entry point
       mov  wa,gtawa        save wa indicator
       mov  (xr),wa         load type word
       beq  wa,=$art,gtar8   exit if already an array
       beq  wa,=$vct,gtar8   exit if already an array
       bne  wa,=$tbt,gtar9a   else fail if not a table (sgd02)
*
*      here we convert a table to an array
*
       mov  xr,-(xs)         replace tbbk pointer on stack
       zer  xr               signal first pass
       zer  wb               zero non-null element count
*
*      the following code is executed twice. on the first pass,
*      signalled by xr=0, the number of non-null elements in
*      the table is counted in wb. in the second pass, where
*      xr is a pointer into the arblk, the name and value are
*      entered into the current arblk location provided gtawa
*      is non-zero. if gtawa is zero, the address of the teblk
*      is entered into the arblk twice (c3.762).
*
gtarl1  mov  (xs),xl         point to table
       add  tlen(xl),xl       point past last bucket
       sub  *tbbuk,xl         set first bucket offset
       mov  xl,wa             copy adjusted pointer
*
*      loop through buckets in table block
*      next three lines of code rely on tenxt having a value
*      1 less than tbbuk.
*
gtar2   mov  wa,xl           copy bucket pointer
       dca  wa               decrement bucket pointer
*
*      loop through teblks on one bucket chain
*
gtar3   mov  tenxt(xl),xl     point to next teblk
       beq  xl,(xs),gtar6     jump if chain end (tbbk ptr)

```


	mov x1,cnvtp	else save teblk pointer
*		
*	loop to find value down trblk chain	
*		
gtar4	mov teval(x1),x1	load value
	beq (x1),=b\$trt,gtar4	loop till value found
	mov x1,wc	copy value
	mov cnvtp,x1	restore teblk pointer

```

*
*      gtarr (continued)
*
*      now check for null and test cases
*
      beq  wc,=nulls,gtar3      loop back to ignore null value
      bnz  xr,gtar5             jump if second pass
      icv  wb                   for the first pass, bump count
      brn  gtar3                and loop back for next teblk
*
*      here in second pass
*
gtar5  bze  gtawa,gtar5a        jump if address wanted
      mov  tsub(xl),(xr)+       store subscript name
      mov  wc,(xr)+             store value in arblk
      brn  gtar3                loop back for next teblk
*
*      here to record teblk address in arblk.  this allows
*      a sort routine to sort by ascending address.
*
gtar5a mov  xl,(xr)+            store teblk address in name
      mov  xl,(xr)+            and value slots
      brn  gtar3                loop back for next teblk
*
*      here after scanning teblks on one chain
*
gtar6  bne  wa,(xs),gtar2       loop back if more buckets to go
      bnz  xr,gtar7             else jump if second pass
*
*      here after counting non-null elements
*
      bze  wb,gtar9             fail if no non-null elements
      mov  wb,wa                else copy count
      add  wb,wa                double (two words/element)
      add  =arv12,wa            add space for standard fields
      wtb  wa                   convert length to bytes
      bgt  wa,mxlen,gtar9b      error if too long for array
      jsr  alloc                else allocate space for arblk
      mov  =b$art,(xr)          store type word
      zer  idval(xr)             zero id for the moment
      mov  wa,arlen(xr)          store length
      mov  =num02,arndm(xr)     set dimensions = 2
      ldi  intv1                 get integer one
      sti  arlbd(xr)             store as lbd 1
      sti  arlb2(xr)             store as lbd 2
      ldi  intv2                 load integer two
      sti  ardm2(xr)             store as dim 2
      mti  wb                   get element count as integer
      sti  ardim(xr)             store as dim 1
      zer  arpr2(xr)             zero prototype field for now
      mov  *arpr2,arofs(xr)     set offset field (signal pass 2)

```

```
mov  xr,wb  
add  *arv12,xr  
brn  gtar1
```

```
save arblk pointer  
point to first element location  
jump back to fill in elements
```

```

*
*      gtarr (continued)
*
*      here after filling in element values
*
gtar7  mov  wb,xr                      restore arblk pointer
      mov  wb,(xs)                    store as result
*
*      now we need the array prototype which is of the form nn,2
*      this is obtained by building the string for nn02 and
*      changing the zero to a comma before storing it.
*
      ldi  ardim(xr)                  get number of elements (nn)
      mli  intvh                      multiply by 100
      adi  intv2                      add 2 (nn02)
      jsr  icbld                      build integer
      mov  xr,-(xs)                   store ptr for gtstg
      jsr  gtstg                      convert to string
      ppm                             convert fail is impossible
      mov  xr,xl                      copy string pointer
      mov  (xs)+,xr                   reload arblk pointer
      mov  xl,arpr2(xr)               store prototype ptr (nn02)
      sub  =num02,wa                  adjust length to point to zero
      psc  xl,wa                      point to zero
      mov  =ch$cm,wb                  load a comma
      sch  wb,(xl)                    store a comma over the zero
      csc  xl                         complete store characters
*
*      normal return
*
gtar8  exi                           return to caller
*
*      null table non-conversion return
*
gtar9  mov  (xs)+,xr                  restore stack for conv err (sgd02)
      exi  1                          return
*
*      impossible conversion return
*
gta9a  exi  2                        return
*
*      array size too large
*
gta9b  erb  260,conversion array      size exceeds maximum permitted
      enp                             procedure gtarr

```

```

*
*      gtcod -- convert to code
*
*      (xr)                object to be converted
*      jsr  gtcod           call to convert to code
*      ppm  loc             transfer loc if convert impossible
*      (xr)                pointer to resulting cdblk
*      (xl,wa,wb,wc,ra)     destroyed
*
*      if a spitbol error occurs during compilation or pre-
*      evaluation, control is passed via error section to exfal
*      without returning to this routine.
*
gtcod  prc  e,1             entry point
      beq  (xr),=b$cds,gtcd1  jump if already code
      beq  (xr),=b$cdc,gtcd1  jump if already code
*
*      here we must generate a cdblk by compilation
*
      mov  xr,-(xs)         stack argument for gtstg
      jsr  gtstg            convert argument to string
      ppm  gtcd2           jump if non-convertible
      mov  flptr,gtcef      save fail ptr in case of error
      mov  r$cod,r$gtc      also save code ptr
      mov  xr,r$cim         else set image pointer
      mov  wa,scnil        set image length
      zer  scnpt           set scan pointer
      mov  =stgxc,stage     set stage for execute compile
      mov  cmpsn,lstsn     in case listr called
if .csln
      icv  cmpln           bump line number
fi
      jsr  cmpil           compile string
      mov  =stgxt,stage    reset stage for execute time
      zer  r$cim           clear image
*
*      merge here if no convert required
*
gtcd1  exi                give normal gtcod return
*
*      here if unconvertible
*
gtcd2  exi  1             give error return
      enp                end procedure gtcod

```

```

*
*      gtxp -- convert to expression
*
if .cevb
*      (wb)                      0 if by value, 1 if by name
fi

*      (xr)                      input value to be converted
*      jsr  gtxp                  call to convert to expression
*      ppm  loc                   transfer loc if convert impossible
*      (xr)                      pointer to result exblk or seblk
*      (xl,wa,wb,wc,ra)          destroyed
*
*      if a spitbol error occurs during compilation or pre-
*      evaluation, control is passed via error section to exfal
*      without returning to this routine.
*
gtxp  prc  e,1                    entry point
      blo  (xr),=b$e$$,gtex1      jump if already an expression
      mov  xr,-(xs)                store argument for gtstg
      jsr  gtstg                   convert argument to string
      ppm  gtex2                   jump if unconvertible
*
*      check the last character of the string for colon or
*      semicolon.  these characters can legitimately end an
*      expression in open code, so expan will not detect them
*      as errors, but they are invalid as terminators for a
*      string that is being converted to expression form.
*
      mov  xr,xl                  copy input string pointer
      plc  xl,wa                  point one past the string end
      lch  xl,-(xl)               fetch the last character
      beq  xl,=ch$c1,gtex2         error if it is a semicolon
      beq  xl,=ch$sm,gtex2        or if it is a colon
*
*      here we convert a string by compilation
*
      mov  xr,r$cim               set input image pointer
      zer  scnpt                  set scan pointer
      mov  wa,scnil               set input image length
if .cevb
      mov  wb,-(xs)               save value/name flag
fi

      zer  wb                     set code for normal scan
      mov  flptr,gtcef            save fail ptr in case of error
      mov  r$cod,r$gtc           also save code ptr
      mov  =stgev,stage           adjust stage for compile
      mov  =t$uok,scntp          indicate unary operator acceptable
      jsr  expan                  build tree for expression
      zer  scnrs                  reset rescan flag
if .cevb
      mov  (xs)+,wa               restore value/name flag

```

fi

	bne	scnpt,scnil,gtex2	error if not end of image
	zer	wb	set ok value for cdgex call
	mov	xr,xl	copy tree pointer
	jsr	cdgex	build expression block
	zer	r\$cim	clear pointer
	mov	=stgxt,stage	restore stage for execute time
	*		
	*	merge here if no conversion required	
	*		
gtex1	exi		return to gtexp caller
	*		
	*	here if unconvertible	
	*		
gtex2	exi	1	take error exit
	enp		end procedure gtexp

```

*
*      gtint -- get integer value
*
*      gtint is passed an object and returns an integer after
*      performing any necessary conversions.
*
*      (xr)                value to be converted
*      jsr  gtint           call to convert to integer
*      ppm  loc             transfer loc for convert impossible
*      (xr)                resulting integer
*      (wc,ra)             destroyed
*      (wa,wb)             destroyed (only on conversion err)
*      (xr)                unchanged (on convert error)
*
gtint  prc  e,1              entry point
       beq  (xr),=b$ic1,gtin2  jump if already an integer
       mov  wa,gtina         else save wa
       mov  wb,gtinb        save wb
       jsr  gtnum           convert to numeric
       ppm  gtin3           jump if unconvertible
if .cnra
else
       beq  wa,=b$ic1,gtin1   jump if integer
*
*      here we convert a real to integer
*
       ldr  rcval(xr)        load real value
       rti  gtin3           convert to integer (err if overflow)
       jsr  icblk           if ok build icblk
fi
*
*      here after successful conversion to integer
*
gtin1  mov  gtina,wa         restore wa
       mov  gtinb,wb        restore wb
*
*      common exit point
*
gtin2  exi                  return to gtint caller
*
*      here on conversion error
*
gtin3  exi  1               take convert error exit
       enp                  end procedure gtint

```



```

*
*      gtnum -- get numeric value
*
*      gtnum is given an object and returns either an integer
*      or a real, performing any necessary conversions.
*
*      (xr)                object to be converted
*      jsr  gtnum           call to convert to numeric
*      ppm  loc             transfer loc if convert impossible
*      (xr)                pointer to result (int or real)
*      (wa)                first word of result block
*      (wb,wc,ra)          destroyed
*      (xr)                unchanged (on convert error)
*
gtnum  prc  e,1             entry point
       mov  (xr),wa         load first word of block
       beq  wa,=b$ic1,gtn34  jump if integer (no conversion)
if .cnra
else
       beq  wa,=b$rcl,gtn34  jump if real (no conversion)
fi

*
*      at this point the only possibility is to convert a string
*      to an integer or real as appropriate.
*
       mov  xr,-(xs)        stack argument in case convert err
       mov  xr,-(xs)        stack argument for gtstg
if .cnbf
       jsr  gtstg           convert argument to string
else
       jsr  gtstb           get argument as string or buffer
fi

       ppm  gtn36           jump if unconvertible

*
*      initialize numeric conversion
*
       ldi  intv0           initialize integer result to zero
       bze  wa,gtn32        jump to exit with zero if null
       lct  wa,wa           set bct counter for following loops
       zer  gtnnf          tentatively indicate result +
if .cnra
else
       sti  gtnex          initialise exponent to zero
       zer  gtnsc          zero scale in case real
       zer  gtndf          reset flag for dec point found
       zer  gtnrd          reset flag for digits found
       ldr  reav0          zero real accum in case real
fi

       plc  xr             point to argument characters
*

```

```

*      merge back here after ignoring leading blank
*
gtn01  lch   wb,(xr)+          load first character
      blt   wb,=ch$d0,gtn02    jump if not digit
      ble   wb,=ch$d9,gtn06    jump if first char is a digit

```

```

*
*      gtnum (continued)
*
*      here if first digit is non-digit
*
gtn02  bne  wb,=ch$b1,gtn03          jump if non-blank
gtna2  bct  wa,gtn01                else decr count and loop back
      brn  gtn07                    jump to return zero if all blanks
*
*      here for first character non-blank, non-digit
*
gtn03  beq  wb,=ch$p1,gtn04          jump if plus sign
if.caht      beq  wb,=ch$ht,gtna2      horizontal tab equiv to blank
fi
if.cavt      beq  wb,=ch$vt,gtna2      vertical tab equiv to blank
fi
if.cnra      bne  wb,=ch$mn,gtn36      else fail
else
      bne  wb,=ch$mn,gtn12            jump if not minus (may be real)
fi
      mnz  gtnnf                    if minus sign, set negative flag
*
*      merge here after processing sign
*
gtn04  bct  wa,gtn05                jump if chars left
      brn  gtn36                    else error
*
*      loop to fetch characters of an integer
*
gtn05  lch  wb,(xr)+                load next character
      blt  wb,=ch$d0,gtn08          jump if not a digit
      bgt  wb,=ch$d9,gtn08          jump if not a digit
*
*      merge here for first digit
*
gtn06  sti  gtnsi                    save current value
if.cnra      cvm  gtn36              current*10-(new dig) jump if overflow
else
      cvm  gtn35                    current*10-(new dig) jump if overflow
      mnz  gtnrd                    set digit read flag
fi
      bct  wa,gtn05                else loop back if more chars
*
*      here to exit with converted integer value

```

	*		
gtn07	bnz	gtnnf,gtn32	jump if negative (all set)
	ngi		else negate
	ino	gtn32	jump if no overflow
	brn	gtn36	else signal error

```

*
*      gtnum (continued)
*
*      here for a non-digit character while attempting to
*      convert an integer, check for trailing blanks or real.
*
gtn08  beq  wb,=ch$b1,gtna9          jump if a blank
if .caht
      beq  wb,=ch$ht,gtna9          jump if horizontal tab
fi
if .cavt
      beq  wb,=ch$vt,gtna9          jump if vertical tab
fi
if .cnra
      brn  gtn36                    error
else
      itr                                else convert integer to real
      ngr                                negate to get positive value
      brn  gtn12                    jump to try for real
fi

*
*      here we scan out blanks to end of string
*
gtn09  lch  wb,(xr)+                get next char
if .caht
      beq  wb,=ch$ht,gtna9          jump if horizontal tab
fi
if .cavt
      beq  wb,=ch$vt,gtna9          jump if vertical tab
fi
      bne  wb,=ch$b1,gtn36          error if non-blank
gtna9  bct  wa,gtn09                loop back if more chars to check
      brn  gtn07                    return integer if all blanks
if .cnra
else
*
*      loop to collect mantissa of real
*
gtn10  lch  wb,(xr)+                load next character
      blt  wb,=ch$d0,gtn12          jump if non-numeric
      bgt  wb,=ch$d9,gtn12          jump if non-numeric
*
*      merge here to collect first real digit
*
gtn11  sub  =ch$d0,wb              convert digit to number
      mlr  reavt                    multiply real by 10.0
      rov  gtn36                    convert error if overflow
      str  gtnsr                    save result
      mti  wb                        get new digit as integer

```

itr		convert new digit to real
adr	gtnsr	add to get new total
add	gtndf,gtnsc	increment scale if after dec point
mnz	gtnrd	set digit found flag
bct	wa,gtn10	loop back if more chars
brn	gtn22	else jump to scale

```

*
*      gtnum (continued)
*
*      here if non-digit found while collecting a real
*
gtn12  bne  wb,=ch$dt,gtn13      jump if not dec point
      bnz  gtndf,gtn36          if dec point, error if one already
      mov  =num01,gtndf        else set flag for dec point
      bct  wa,gtn10            loop back if more chars
      brn  gtn22              else jump to scale

*
*      here if not decimal point
*
gtn13  beq  wb,=ch$le,gtn15      jump if e for exponent
      beq  wb,=ch$ld,gtn15      jump if d for exponent
      if .culc
          beq  wb,=ch$$e,gtn15    jump if e for exponent
          beq  wb,=ch$$d,gtn15    jump if d for exponent
      fi

*
*      here check for trailing blanks
*
gtn14  beq  wb,=ch$bl,gtnb4      jump if blank
      if .caht
          beq  wb,=ch$ht,gtnb4    jump if horizontal tab
      fi
      if .cavt
          beq  wb,=ch$vt,gtnb4    jump if vertical tab
      fi
      brn  gtn36              error if non-blank

*
gtnb4  lch  wb,(xr)+            get next character
      bct  wa,gtn14            loop back to check if more
      brn  gtn22              else jump to scale

*
*      here to read and process an exponent
*
gtn15  zer  gtnes              set exponent sign positive
      ldi  intv0              initialize exponent to zero
      mnz  gtndf              reset no dec point indication
      bct  wa,gtn16            jump skipping past e or d
      brn  gtn36              error if null exponent

*
*      check for exponent sign
*
gtn16  lch  wb,(xr)+            load first exponent character
      beq  wb,=ch$pl,gtn17      jump if plus sign
      bne  wb,=ch$mn,gtn19      else jump if not minus sign
      mnz  gtnes              set sign negative if minus sign

```

```

*
*      merge here after processing exponent sign
*
gtn17  bct  wa,gtn18          jump if chars left
      brn  gtn36             else error
*
*      loop to convert exponent digits
*
gtn18  lch  wb,(xr)+         load next character

```



```

*
*      gtnum (continued)
*
*      merge here for first exponent digit
*
gtn19  blt   wb,=ch$d0,gtn20      jump if not digit
      bgt   wb,=ch$d9,gtn20      jump if not digit
      cvm   gtn36                else current*10, subtract new digit
      bct   wa,gtn18              loop back if more chars
      brn   gtn21                jump if exponent field is exhausted

*
*      here to check for trailing blanks after exponent
*
gtn20  beq   wb,=ch$b1,gtnc0      jump if blank
      if .caht
          beq   wb,=ch$ht,gtnc0    jump if horizontal tab
      fi
      if .cavt
          beq   wc,=ch$vt,gtnc0    jump if vertical tab
      fi
          brn   gtn36              error if non-blank
*
gtnc0  lch   wb,(xr)+             get next character
      bct   wa,gtn20              loop back till all blanks scanned
*
*      merge here after collecting exponent
*
gtn21  sti   gtnex                save collected exponent
      bnz   gtncs,gtn22           jump if it was negative
      ngi                      else complement
      iov   gtn36                error if overflow
      sti   gtnex                and store positive exponent
*
*      merge here with exponent (0 if none given)
*
gtn22  bze   gtnrd,gtn36          error if not digits collected
      bze   gtndf,gtn36          error if no exponent or dec point
      mti   gtnsc                else load scale as integer
      sbi   gtnex                subtract exponent
      iov   gtn36                error if overflow
      ilt   gtn26                jump if we must scale up
*
*      here we have a negative exponent, so scale down
*
      mfi   wa,gtn36              load scale factor, err if overflow
*
*      loop to scale down in steps of 10**10
*
gtn23  ble   wa,=num10,gtn24      jump if 10 or less to go

```

```
dvr  reatt
sub  =num10,wa
brn  gtn23
```

```
else divide by 10**10
decrement scale
and loop back
```

```

*
*      gtnum (continued)
*
*      here scale rest of way from powers of ten table
*
gtn24  bze  wa,gtn30          jump if scaled
      lct  wb,=cfp$r         else get indexing factor
      mov  =reav1,xr         point to powers of ten table
      wtb  wa                convert remaining scale to byte ofs
*
*      loop to point to powers of ten table entry
*
gtn25  add  wa,xr            bump pointer
      bct  wb,gtn25          once for each value word
      dvr  (xr)              scale down as required
      brn  gtn30             and jump
*
*      come here to scale result up (positive exponent)
*
gtn26  ngi                    get absolute value of exponent
      iov  gtn36             error if overflow
      mfi  wa,gtn36          acquire scale, error if overflow
*
*      loop to scale up in steps of 10**10
*
gtn27  ble  wa,=num10,gtn28  jump if 10 or less to go
      mlr  reatt             else multiply by 10**10
      rov  gtn36             error if overflow
      sub  =num10,wa         else decrement scale
      brn  gtn27             and loop back
*
*      here to scale up rest of way with table
*
gtn28  bze  wa,gtn30          jump if scaled
      lct  wb,=cfp$r         else get indexing factor
      mov  =reav1,xr         point to powers of ten table
      wtb  wa                convert remaining scale to byte ofs
*
*      loop to point to proper entry in powers of ten table
*
gtn29  add  wa,xr            bump pointer
      bct  wb,gtn29          once for each word in value
      mlr  (xr)              scale up
      rov  gtn36             error if overflow

```

```

*
*      gtnum (continued)
*
*      here with real value scaled and ready except for sign
*
gtn30  bze  gtnnf,gtn31      jump if positive
      ngr                      else negate
*
*      here with properly signed real value in (ra)
*
gtn31  jsr  rcblld          build real block
      brn  gtn33          merge to exit
fi
*
*      here with properly signed integer value in (ia)
*
gtn32  jsr  icblld          build icblk
*
*      real merges here
*
gtn33  mov  (xr),wa          load first word of result block
      ica  xs              pop argument off stack
*
*      common exit point
*
gtn34  exi                      return to gtnum caller
if .cnra
else
*
*      come here if overflow occurs during collection of integer
*      have to restore wb which cvm may have destroyed.
*
gtn35  lch  wb,-(xr)          reload current character
      lch  wb,(xr)+          bump character pointer
      ldi  gtinsi          reload integer so far
      itr                      convert to real
      ngr                      make value positive
      brn  gtn11          merge with real circuit
fi
*
*      here for unconvertible to string or conversion error
*
gtn36  mov  (xs)+,xr          reload original argument
      exi  1              take convert-error exit
      enp                      end procedure gtnum

```

```

*
*      gtnvr -- convert to natural variable
*
*      gtnvr locates a variable block (vrblk) given either an
*      appropriate name (nmblk) or a non-null string (scblk).
*
*      (xr)          argument
*      jsr  gtnvr     call to convert to natural variable
*      ppm  loc       transfer loc if convert impossible
*      (xr)          pointer to vrblk
*      (wa,wb)       destroyed (conversion error only)
*      (wc)          destroyed
*
gtnvr  prc   e,1              entry point
      bne   (xr),=b$nm1,gnv02  jump if not name
      mov   nmbas(xr),xr      else load name base if name
      blo   xr,state,gnv07    skip if vrblk (in static region)
*
*      common error exit
*
gnv01  exi   1              take convert-error exit
*
*      here if not name
*
gnv02  mov   wa,gnvsa        save wa
      mov   wb,gnvsb        save wb
      mov   xr,-(xs)        stack argument for gtstg
      jsr   gtstg           convert argument to string
      ppm   gnv01           jump if conversion error
      bze   wa,gnv01        null string is an error
if .culc
      jsr   flstg           fold lower case to upper case
fi
      mov   xl,-(xs)        save xl
      mov   xr,-(xs)        stack string ptr for later
      mov   xr,wb           copy string pointer
      add   *schar,wb       point to characters of string
      mov   wb,gnvst        save pointer to characters
      mov   wa,wb           copy length
      ctw   wb,0            get number of words in name
      mov   wb,gnvnw        save for later
      jsr   hashes          compute hash index for string
      rmi   hshnb           compute hash offset by taking mod
      mfi   wc              get as offset
      wtb   wc              convert offset to bytes
      add   hshtb,wc        point to proper hash chain
      sub   *vrnxt,wc       subtract offset to merge into loop

```

```

*
*      gtnvr (continued)
*
*      loop to search hash chain
*
gnv03  mov  wc,xl                copy hash chain pointer
      mov  vrnxt(xl),xl         point to next vrbk on chain
      bze  xl,gnv08             jump if end of chain
      mov  xl,wc                save pointer to this vrbk
      bnz  vrlen(xl),gnv04      jump if not system variable
      mov  vrsvp(xl),xl         else point to svblk
      sub  *vrsof,xl            adjust offset for merge
*
*      merge here with string ptr (like vrbk) in xl
*
gnv04  bne  wa,vrlen(xl),gnv03  back for next vrbk if lengths ne
      add  *vrchs,xl            else point to chars of chain entry
      lct  wb,gnvnw             get word counter to control loop
      mov  gnvst,xr             point to chars of new name
*
*      loop to compare characters of the two names
*
gnv05  cne  (xr),(xl),gnv03     jump if no match for next vrbk
      ica  xr                   bump new name pointer
      ica  xl                   bump vrbk in chain name pointer
      bct  wb,gnv05             else loop till all compared
      mov  wc,xr                we have found a match, get vrbk
*
*      exit point after finding vrbk or building new one
*
gnv06  mov  gnvsa,wa            restore wa
      mov  gnvsb,wb            restore wb
      ica  xs                   pop string pointer
      mov  (xs)+,xl            restore xl
*
*      common exit point
*
gnv07  exi                     return to gtnvr caller
*
*      not found, prepare to search system variable table
*
gnv08  zer  xr                  clear garbage xr pointer
      mov  wc,gnvhe             save ptr to end of hash chain
      bgt  wa,=num09,gnv14      cannot be system var if length gt 9
      mov  wa,xl                else copy length
      wtb  xl                   convert to byte offset
      mov  vsrch(xl),xl         point to first svblk of this length

```

```

*
*      gtnvr (continued)
*
*      loop to search entries in standard variable table
*
gnv09  mov  xl,gnvsp           save table pointer
      mov  (xl)+,wc          load svbit bit string
      mov  (xl)+,wb          load length from table entry
      bne  wa,wb,gnv14        jump if end of right length entries
      lct  wb,gnvnw          get word counter to control loop
      mov  gnvst,xr          point to chars of new name
*
*      loop to check for matching names
*
gnv10  cne  (xr),(xl),gnv11   jump if name mismatch
      ica  xr                else bump new name pointer
      ica  xl                bump svblk pointer
      bct  wb,gnv10          else loop until all checked
*
*      here we have a match in the standard variable table
*
      zer  wc                set vrlen value zero
      mov  *vrsl$,wa         set standard size
      brn  gnv15             jump to build vrbk
*
*      here if no match with table entry in svblks table
*
gnv11  ica  xl                bump past word of chars
      bct  wb,gnv11          loop back if more to go
      rsh  wc,svnbt          remove uninteresting bits
*
*      loop to bump table ptr for each flagged word
*
gnv12  mov  bits1,wb          load bit to test
      anb  wc,wb             test for word present
      zrb  wb,gnv13          jump if not present
      ica  xl                else bump table pointer
*
*      here after dealing with one word (one bit)
*
gnv13  rsh  wc,1             remove bit already processed
      nzb  wc,gnv12          loop back if more bits to test
      brn  gnv09             else loop back for next svblk
*
*      here if not system variable
*
gnv14  mov  wa,wc            copy vrlen value
      mov  =vrchs,wa         load standard size -chars
      add  gnvnw,wa          adjust for chars of name
      wtb  wa                convert length to bytes

```

```

*
*      gtnvr (continued)
*
*      merge here to build vrbk
*
gmv15  jsr   alost                allocate space for vrbk (static)
        mov  xr,wb                save vrbk pointer
        mov  =stnvr,xl           point to model variable block
        mov  *vrlen,wa           set length of standard fields
        mvw                     set initial fields of new block
        mov  gnvhe,xl            load pointer to end of hash chain
        mov  wb,vrnxt(xl)        add new block to end of chain
        mov  wc,(xr)+            set vrlen field, bump ptr
        mov  gnvnw,wa            get length in words
        wtb  wa                  convert to length in bytes
        bze  wc,gvn16            jump if system variable

*
*      here for non-system variable -- set chars of name
*
        mov  (xs),xl             point back to string name
        add  *schar,xl           point to chars of name
        mvw                     move characters into place
        mov  wb,xr               restore vrbk pointer
        brn  gnv06               jump back to exit

*
*      here for system variable case to fill in fields where
*      necessary from the fields present in the svblk.
*
gmv16  mov  gnvsp,xl             load pointer to svblk
        mov  xl,(xr)             set svblk ptr in vrbk
        mov  wb,xr               restore vrbk pointer
        mov  svbit(xl),wb        load bit indicators
        add  *svchs,xl           point to characters of name
        add  wa,xl               point past characters

*
*      skip past keyword number (svknm) if present
*
        mov  btknm,wc            load test bit
        anb  wb,wc               and to test
        zrb  wc,gvn17            jump if no keyword number
        ica  xl                  else bump pointer

```



```

*
*      gtnvr (continued)
*
*      here test for function (svfnc and svnar)
*
gnv17  mov  btfnc,wc          get test bit
      anb  wb,wc             and to test
      zrb  wc,gnv18          skip if no system function
      mov  xl,vrfnc(xr)      else point vrfnc to svfnc field
      add  *num02,xl         and bump past svfnc, svnar fields

*
*      now test for label (svlbl)
*
gnv18  mov  btlbl,wc         get test bit
      anb  wb,wc             and to test
      zrb  wc,gnv19          jump if bit is off (no system labl)
      mov  xl,vrlbl(xr)      else point vrlbl to svlbl field
      ica  xl                bump past svlbl field

*
*      now test for value (svval)
*
gnv19  mov  btval,wc         load test bit
      anb  wb,wc             and to test
      zrb  wc,gnv06          all done if no value
      mov  (xl),vrval(xr)    else set initial value
      mov  =b$vre,vrsto(xr)  set error store access
      brn  gnv06             merge back to exit to caller
      enp                   end procedure gtnvr

```

```

*
*      gtpat -- get pattern
*
*      gtpat is passed an object in (xr) and returns a
*      pattern after performing any necessary conversions
*
*      (xr)                input argument
*      jsr  gtpat           call to convert to pattern
*      ppm  loc             transfer loc if convert impossible
*      (xr)                resulting pattern
*      (wa)                destroyed
*      (wb)                destroyed (only on convert error)
*      (xr)                unchanged (only on convert error)
*
gtpat  prc   e,1            entry point
      bhi   (xr),=p$aaa,gtpt5  jump if pattern already
*
*      here if not pattern, try for string
*
      mov  wb,gtpsb         save wb
      mov  xr,-(xs)         stack argument for gtstg
      jsr  gtstg            convert argument to string
      ppm  gtpt2            jump if impossible
*
*      here we have a string
*
      bnz  wa,gtpt1         jump if non-null
*
*      here for null string. generate pointer to null pattern.
*
      mov  =ndnth,xr        point to nothen node
      brn  gtpt4            jump to exit

```

```

*
*      gtpat (continued)
*
*      here for non-null string
*
gtpt1  mov  =p$str,wb          load pcode for multi-char string
      bne  wa,=num01,gtpt3    jump if multi-char string
*
*      here for one character string, share one character any
*
      plc  xr                  point to character
      lch  wa,(xr)             load character
      mov  wa,xr               set as parm1
      mov  =p$ans,wb           point to pcode for 1-char any
      brn  gtpt3               jump to build node
*
*      here if argument is not convertible to string
*
gtpt2  mov  =p$exa,wb          set pcode for expression in case
      blo  (xr),=b$e$$,gtpt3  jump to build node if expression
*
*      here we have an error (conversion impossible)
*
      exi  1                    take convert error exit
*
*      merge here to build node for string or expression
*
gtpt3  jsr  pbild               call routine to build pattern node
*
*      common exit after successful conversion
*
gtpt4  mov  gtpsb,wb            restore wb
*
*      merge here to exit if no conversion required
*
gtpt5  exi                      return to gtpat caller
      enp                      end procedure gtpat
if .cnra
else

```

```

*
*      gtrea -- get real value
*
*      gtrea is passed an object and returns a real value
*      performing any necessary conversions.
*
*      (xr)          object to be converted
*      jsr  gtrea     call to convert object to real
*      ppm  loc       transfer loc if convert impossible
*      (xr)          pointer to resulting real
*      (wa,wb,wc,ra)  destroyed
*      (xr)          unchanged (convert error only)
*
gtrea  prc  e,1          entry point
       mov  (xr),wa      get first word of block
       beq  wa,=b$rc1,gtre2  jump if real
       jsr  gtnum        else convert argument to numeric
       ppm  gtrea3       jump if unconvertible
       beq  wa,=b$rc1,gtre2  jump if real was returned
*
*      here for case of an integer to convert to real
*
gtre1  ldi  icval(xr)    load integer
       itr          convert to real
       jsr  rcblk      build rcblk
*
*      exit with real
*
gtre2  exi          return to gtrea caller
*
*      here on conversion error
*
gtre3  exi  1          take convert error exit
       enp          end procedure gtrea
fi

```

```

*
*      gtsmi -- get small integer
*
*      gtsmi is passed a snobol object and returns an address
*      integer in the range (0 le n le dnamb). such a value can
*      only be derived from an integer in the appropriate range.
*      small integers never appear as snobol values. however,
*      they are used internally for a variety of purposes.
*
*      -(xs)                argument to convert (on stack)
*      jsr  gtsmi           call to convert to small integer
*      ppm  loc             transfer loc for not integer
*      ppm  loc             transfer loc for lt 0, gt dnamb
*      (xr,wc)              resulting small int (two copies)
*      (xs)                 popped
*      (ra)                 destroyed
*      (wa,wb)              destroyed (on convert error only)
*      (xr)                 input arg (convert error only)
*
gtsmi  prc  n,2              entry point
      mov  (xs)+,xr          load argument
      beq  (xr),=b$ic1,gtsm1 skip if already an integer
*
*      here if not an integer
*
      jsr  gtint             convert argument to integer
      ppm  gtasm2            jump if convert is impossible
*
*      merge here with integer
*
gtasm1 ldi  icval(xr)        load integer value
      mfi  wc,gtasm3         move as one word, jump if overflow
      bgt  wc,mxlen,gtasm3   or if too large
      mov  wc,xr             copy result to xr
      exi                    return to gtasm1 caller
*
*      here if unconvertible to integer
*
gtasm2 exi  1                take non-integer error exit
*
*      here if out of range
*
gtasm3 exi  2                take out-of-range error exit
      enp                    end procedure gtasm1

```

```

if .cnbf
else
*
*      gtstb -- get string or buffer
*
*      gtstb is passed an object and returns it unchanged if
*      it is a buffer block, else it returns it as a string with
*      any necessary conversions performed.
*
*      -(xs)          input argument (on stack)
*      jsr  gtstb      call to get buffer or cnvrt to stg
*      ppm  loc        transfer loc if convert impossible
*      (xr)            pointer to resulting scblk or bfblk
*      (wa)            length of string in characters
*      (wb)            zero/bcblk if string/buffer
*      (xs)            popped
*      (ra)            destroyed
*      (xr)            input arg (convert error only)
*
gtstb  prc  n,1          entry point
      mov  (xs),xr        load argument, leave on stack
      mov  (xr),wa        load block type
      beq  wa,=b$scl,gtstb2  jump if already a string
      beq  wa,=b$bct,gtstb3  jump if already a buffer
      jsr  gtstg          convert to string
      ppm  gtsb1          conversion failed
      zer  wb             signal string result
      exi                convert with string result
*
*      here if conversion failed
*
gtsb1  exi  1            take convert error exit
*
*      here if a string already
*
gtsb2  ica  xs            pop argument
      mov  sclen(xr),wa    load string length
      zer  wb             signal string result
      exi                return with string result
*
*      here if it is already a buffer
*
gtsb3  ica  xs            pop argument
      mov  bclen(xr),wa    load length of string in buffer
      mov  xr,wb           return bcblk pointer in wb
      mov  bcbuf(xr),xr    return bfblk pointer in xr
      exi                return with buffer result
      enp                end procedure gtstg

```

fi

```
*
*      gtstg -- get string
*
*      gtstg is passed an object and returns a string with
*      any necessary conversions performed.
*
*      -(xs)          input argument (on stack)
*      jsr  gtstg      call to convert to string
*      ppm  loc        transfer loc if convert impossible
*      (xr)           pointer to resulting string
*      (wa)           length of string in characters
*      (xs)           popped
*      (ra)           destroyed
*      (xr)           input arg (convert error only)
*
gtstg  prc  n,1          entry point
      mov  (xs)+,xr      load argument, pop stack
      beq  (xr),=b$scl, gts30  jump if already a string
*
*      here if not a string already
*
gts01  mov  xr,-(xs)      restack argument in case error
      mov  xl,-(xs)      save xl
      mov  wb,gtsvb       save wb
      mov  wc,gtsvc       save wc
      mov  (xr),wa        load first word of block
      beq  wa,=b$icl, gts05  jump to convert integer
if .cnra
else
      beq  wa,=b$rc1, gts10  jump to convert real
fi
      beq  wa,=b$nm1, gts03  jump to convert name
if .cnbf
else
      beq  wa,=b$bct, gts32  jump to convert buffer
fi
*
*      here on conversion error
*
gts02  mov  (xs)+,xl      restore xl
      mov  (xs)+,xr      reload input argument
      exi  1             take convert error exit
```

```

*
*      gtstg (continued)
*
*      here to convert a name (only possible if natural var)
*
gts03  mov  nmbas(xr),xl          load name base
      bhi  xl,state,gts02        error if not natural var (static)
      add  *vrsof,xl             else point to possible string name
      mov  sclen(xl),wa          load length
      bnz  wa,gts04              jump if not system variable
      mov  vrsvo(xl),xl         else point to svblk
      mov  svlen(xl),wa          and load name length

*
*      merge here with string in xr, length in wa
*
gts04  zer  wb                  set offset to zero
      jsr  sbstr                use sbstr to copy string
      brn  gts29                jump to exit

*
*      come here to convert an integer
*
gts05  ldi  icval(xr)           load integer value
if .cnci
      jsr  sysci                convert integer
      mov  sclen(xl),wa          get length
      zer  wb                  zero offset for sbstr
      jsr  sbstr                copy in result from sysci
      brn  gts29                exit
else
      mov  =num01,gtssf         set sign flag negative
      ilt  gts06                skip if integer is negative
      ngi  gtssf                else negate integer
      zer  gtssf                and reset negative flag

```



```

*
*      gtstg (continued)
*
*      here with sign flag set and sign forced negative as
*      required by the cvd instruction.
*
gts06  mov  gtswk,xr          point to result work area
      mov  =nstm,x,wb        initialize counter to max length
      psc  xr,wb             prepare to store (right-left)
*
*      loop to convert digits into work area
*
gts07  cvd                  convert one digit into wa
      sch  wa,-(xr)          store in work area
      dcw  wb                decrement counter
      ine  gts07             loop if more digits to go
      csc  xr                complete store characters
fi
*
*      merge here after converting integer or real into work
*      area. wb is set to nstm - (number of chars in result).
*
gts08  mov  =nstm,x,wa        get max number of characters
      sub  wb,wa             compute length of result
      mov  wa,xl             remember length for move later on
      add  gtssf,wa          add one for negative sign if needed
      jsr  alocs             allocate string for result
      mov  xr,wc             save result pointer for the moment
      psc  xr                point to chars of result block
      bze  gtssf,gts09       skip if positive
      mov  =ch$mn,wa         else load negative sign
      sch  wa,(xr)+          and store it
      csc  xr                complete store characters
*
*      here after dealing with sign
*
gts09  mov  xl,wa            recall length to move
      mov  gtswk,xl          point to result work area
      plc  xl,wb             point to first result character
      mvc                     move chars to result string
      mov  wc,xr             restore result pointer
if .cnra
else
      brn  gts29             jump to exit

```

```

*
*      gtstg (continued)
*
*      here to convert a real
*
gts10  ldr   rcval(xr)           load real
      if .cncr
          mov  =nstmr,wa         max number of result chars
          zer  xl                clear dud value
          jsr  alocs             allocate result area
          mov  =cfp$s,wa        significant digits to produce
          zer  wb                conversion type
          jsr  syscr            convert real to string
          mov  wa,sclen(xr)      store result size
          zer  wb                no trailing blanks to remove
          jsr  trimr            discard excess memory
      else
          zer  gtssf            reset negative flag
          req  gts31            skip if zero
          rge  gts11            jump if real is positive
          mov  =num01,gtssf     else set negative flag
          ngr                     and get absolute value of real
*
*      now scale the real to the range (0.1 le x lt 1.0)
*
gts11  ldi   intv0              initialize exponent to zero
*
*      loop to scale up in steps of 10**10
*
gts12  str   gtsrs              save real value
      sbr   reap1              subtract 0.1 to compare
      rge   gts13              jump if scale up not required
      ldr   gtsrs              else reload value
      mlr   reatt              multiply by 10**10
      sbi   intvt              decrement exponent by 10
      brn   gts12              loop back to test again
*
*      test for scale down required
*
gts13  ldr   gtsrs              reload value
      sbr   reav1              subtract 1.0
      rlt   gts17              jump if no scale down required
      ldr   gtsrs              else reload value
*
*      loop to scale down in steps of 10**10
*
gts14  sbr   reatt              subtract 10**10 to compare
      rlt   gts15              jump if large step not required
      ldr   gtsrs              else restore value
      dvr   reatt              divide by 10**10
      str   gtsrs              store new value

```

adi intvt
brn gts14

increment exponent by 10
loop back

```

*
*      gtstg (continued)
*
*      at this point we have (1.0 le x lt 10**10)
*      complete scaling with powers of ten table
*
gts15  mov  =reav1,xr                      point to powers of ten table
*
*      loop to locate correct entry in table
*
gts16  ldr  gtsrs                          reload value
      adi  intv1                          increment exponent
      add  *cfp$r,xr                      point to next entry in table
      sbr  (xr)                          subtract it to compare
      rge  gts16                          loop till we find a larger entry
      ldr  gtsrs                          then reload the value
      dvr  (xr)                          and complete scaling
      str  gtsrs                          store value
*
*      we are now scaled, so round by adding 0.5 * 10**(-cfp$s)
*
gts17  ldr  gtsrs                          get value again
      adr  gtsrn                          add rounding factor
      str  gtsrs                          store result
*
*      the rounding operation may have pushed us up past
*      1.0 again, so check one more time.
*
      sbr  reav1                          subtract 1.0 to compare
      rlt  gts18                          skip if ok
      adi  intv1                          else increment exponent
      ldr  gtsrs                          reload value
      dvr  reavt                          divide by 10.0 to rescale
      brn  gts19                          jump to merge
*
*      here if rounding did not muck up scaling
*
gts18  ldr  gtsrs                          reload rounded value

```

```

*
*      gtstg (continued)
*
*      now we have completed the scaling as follows
*
*      (ia)                signed exponent
*      (ra)                scaled real (absolute value)
*
*      if the exponent is negative or greater than cfp$$, then
*      we convert the number in the form.
*
*      (neg sign) 0 . (cpf$$ digits) e (exp sign) (exp digits)
*
*      if the exponent is positive and less than or equal to
*      cfp$$, the number is converted in the form.
*
*      (neg sign) (exponent digits) . (cfp$$-exponent digits)
*
*      in both cases, the formats obtained from the above
*      rules are modified by deleting trailing zeros after the
*      decimal point. there are no leading zeros in the exponent
*      and the exponent sign is always present.
*
gts19  mov  =cfp$$,xl          set num dec digits = cfp$$
      mov  =ch$mn,gtses      set exponent sign negative
      ilt  gts21             all set if exponent is negative
      mfi  wa               else fetch exponent
      ble  wa,=cfp$$,gts20   skip if we can use special format
      mti  wa               else restore exponent
      ngi                    set negative for cvd
      mov  =ch$pl,gtses      set plus sign for exponent sign
      brn  gts21             jump to generate exponent
*
*      here if we can use the format without an exponent
*
gts20  sub  wa,xl            compute digits after decimal point
      ldi  intv0             reset exponent to zero

```

```

*
*      gtstg (continued)
*
*      merge here as follows
*
*      (ia)          exponent absolute value
*      gtses         character for exponent sign
*      (ra)          positive fraction
*      (xl)          number of digits after dec point
*
gts21  mov  gtswk,xr          point to work area
      mov  =nstmx,wb        set character ctr to max length
      psc  xr,wb            prepare to store (right to left)
      ieq  gts23            skip exponent if it is zero
*
*      loop to generate digits of exponent
*
gts22  cvd                convert a digit into wa
      sch  wa,-(xr)        store in work area
      dcv  wb              decrement counter
      ine  gts22           loop back if more digits to go
*
*      here generate exponent sign and e
*
      mov  gtses,wa        load exponent sign
      sch  wa,-(xr)        store in work area
      mov  =ch$le,wa       get character letter e
      sch  wa,-(xr)        store in work area
      sub  =num02,wb       decrement counter for sign and e
*
*      here to generate the fraction
*
gts23  mlr  gtssc          convert real to integer (10**cfp$s)
      rti                get integer (overflow impossible)
      ngi                negate as required by cvd
*
*      loop to suppress trailing zeros
*
gts24  bze  xl,gts27        jump if no digits left to do
      cvd                else convert one digit
      bne  wa,=ch$d0,gts26  jump if not a zero
      dcv  xl              decrement counter
      brn  gts24           loop back for next digit

```

```

*
*      gtstg (continued)
*
*      loop to generate digits after decimal point
*
gts25  cvd                                convert a digit into wa
*
*      merge here first time
*
gts26  sch  wa,-(xr)                      store digit
      dcv  wb                            decrement counter
      dcv  x1                            decrement counter
      bnz  x1,gts25                      loop back if more to go
*
*      here generate the decimal point
*
gts27  mov  =ch$dt,wa                    load decimal point
      sch  wa,-(xr)                      store in work area
      dcv  wb                            decrement counter
*
*      here generate the digits before the decimal point
*
gts28  cvd                                convert a digit into wa
      sch  wa,-(xr)                      store in work area
      dcv  wb                            decrement counter
      ine  gts28                          loop back if more to go
      csc  xr                            complete store characters
      brn  gts08                          else jump back to exit
fi
fi

*
*      exit point after successful conversion
*
gts29  mov  (xs)+,x1                      restore x1
      ica  xs                            pop argument
      mov  gtsvb,wb                      restore wb
      mov  gtsvc,wc                      restore wc
*
*      merge here if no conversion required
*
gts30  mov  sclen(xr),wa                  load string length
      exi                                return to caller
if .cnra
else
*
*      here to return string for real zero
*
gts31  mov  =scre0,x1                    point to string
      mov  =num02,wa                    2 chars

```

	zer	wb	zero offset
	jsr	sbstr	copy string
	brn	gts29	return

fi

if **.cnbf**

else


```

*
*      here to convert a buffer block
*
gts32  mov  xr,xl                copy arg ptr
      mov  bclen(xl),wa          get size to allocate
      bze  wa,gts33              if null then return null
      jsr  alocs                 allocate string frame
      mov  xr,wb                 save string ptr
      mov  sclen(xr),wa          get length to move
      ctb  wa,0                  get as multiple of word size
      mov  bcbuf(xl),xl          point to bfbk
      add  *scsi$,xr             point to start of character area
      add  *bfsi$,xl             point to start of buffer chars
      mvw                      copy words
      mov  wb,xr                 restore scblk ptr
      brn  gts29                 exit with scblk

*
*      here when null buffer is being converted
*
gts33  mov  =nulls,xr            point to null
      brn  gts29                 exit with null
fi

      enp                        end procedure gtstg

```

```

*
*      gtvvar -- get variable for i/o/trace association
*
*      gtvvar is used to point to an actual variable location
*      for the detach,input,output,trace,stoptr system functions
*
*      (xr)                argument to function
*      jsr  gtvvar          call to locate variable pointer
*      ppm  loc             transfer loc if not ok variable
*      (x1,wa)              name base,offset of variable
*      (xr,ra)              destroyed
*      (wb,wc)              destroyed (convert error only)
*      (xr)                input arg (convert error only)
*
gtvvar  prc   e,1           entry point
        bne  (xr),=b$nm1,gtvr2      jump if not a name
        mov  nmofs(xr),wa           else load name offset
        mov  nmbas(xr),x1          load name base
        beq  (x1),=b$evt,gtvr1     error if expression variable
        bne  (x1),=b$kv1,gtvr3     all ok if not keyword variable
*
*      here on conversion error
*
gtvr1   exi   1             take convert error exit
*
*      here if not a name, try convert to natural variable
*
gtvr2   mov  wc,gtvrc        save wc
        jsr  gtnvr           locate vrb1k if possible
        ppm  gtv1            jump if convert error
        mov  xr,x1           else copy vrb1k name base
        mov  *vrval,wa       and set offset
        mov  gtvrc,wc        restore wc
*
*      here for name obtained
*
gtvr3   bhi  x1,state,gtvr4    all ok if not natural variable
        beq  vrsto(x1),=b$vre,gtvr1  error if protected variable
*
*      common exit point
*
gtvr4   exi
        enp                 return to caller
                             end procedure gtvvar

```

```

*
*      hashes -- compute hash index for string
*
*      hashes is used to convert a string to a unique integer
*      value. the resulting hash value is a positive integer
*      in the range 0 to cfp$m
*
*      (xr)                string to be hashed
*      jsr  hashes          call to hash string
*      (ia)                hash value
*      (xr,wb,wc)          destroyed
*
*      the hash function used is as follows.
*
*      start with the length of the string (sgd07)
*
*      take the first e$hnw words of the characters from
*      the string or all the words if fewer than e$hnw.
*
*      compute the exclusive or of all these words treating
*      them as one word bit string values.
*
*      move the result as an integer with the mti instruction.
*
hashs  prc  e,0                entry point
      mov  sclen(xr),wc        load string length in characters
      mov  wc,wb              initialize with length
      bze  wc,hshs3           jump if null string
      zgb  wb                 correct byte ordering if necessary
      ctw  wc,0               get number of words of chars
      add  *schar,xr          point to characters of string
      blo  wc,=e$hnw,hshs1    use whole string if short
      mov  =e$hnw,wc          else set to involve first e$hnw wds
*
*      here with count of words to check in wc
*
hshs1  lct  wc,wc              set counter to control loop
*
*      loop to compute exclusive or
*
hshs2  xob  (xr)+,wb          exclusive or next word of chars
      bct  wc,hshs2          loop till all processed
*
*      merge here with exclusive or in wb
*
hshs3  zgb  wb                zeroise undefined bits
      anb  bit$sm,wb          ensure in range 0 to cfp$m
      mti  wb                 move result as integer
      zer  xr                 clear garbage value in xr
      exi                                     return to hashes caller
      enp                                     end procedure hashes

```

```

*
*      icbld -- build integer block
*
*      (ia)          integer value for icblk
*      jsr icbld      call to build integer block
*      (xr)          pointer to result icblk
*      (wa)          destroyed
*
icbld  prc   e,0          entry point
      mfi   xr,icbl1      copy small integers
      ble   xr,=num02,icbl3  jump if 0,1 or 2
*
*      construct icblk
*
icbl1  mov   dnamp,xr      load pointer to next available loc
      add   *icsi$,xr      point past new icblk
      blo   xr,dname,icbl2  jump if there is room
      mov   *icsi$,wa      else load length of icblk
      jsr   alloc          use standard allocator to get block
      add   wa,xr          point past block to merge
*
*      merge here with xr pointing past the block obtained
*
icbl2  mov   xr,dnamp      set new pointer
      sub   *icsi$,xr      point back to start of block
      mov   =b$ic1,(xr)    store type word
      sti   icval(xr)      store integer value in icblk
      exi                    return to icbld caller
*
*      optimise by not building icblks for small integers
*
icbl3  wtb   xr          convert integer to offset
      mov   intab(xr),xr    point to pre-built icblk
      exi                    return
      enp                    end procedure icbld

```

```

*
*      ident -- compare two values
*
*      ident compares two values in the sense of the ident
*      differ functions available at the snobol level.
*
*      (xr)                first argument
*      (xl)                second argument
*      jsr  ident           call to compare arguments
*      ppm  loc             transfer loc if ident
*      (normal return if differ)
*      (xr,xl,wc,ra)       destroyed
*
ident  prc  e,1              entry point
       beq  xr,xl,iden7     jump if same pointer (ident)
       mov  (xr),wc         else load arg 1 type word
if .cnbf
       bne  wc,(xl),iden1   differ if arg 2 type word differ
else
       bne  wc,(xl),iden0   differ if arg 2 type word differ
fi
       beq  wc,=b$scl,iden2  jump if strings
       beq  wc,=b$icl,iden4  jump if integers
if .cnra
else
       beq  wc,=b$rc1,iden5  jump if reals
fi
       beq  wc,=b$nm1,iden6  jump if names
if .cnbf
else
       bne  wc,=b$bct,iden1  jump if not buffers
*
*      here for buffers, ident only if lengths and chars same
*
       mov  bclen(xr),wc     load arg 1 length
       bne  wc,bclen(xl),iden1  differ if lengths differ
       bze  wc,iden7         identical if length 0
       mov  bcbuf(xr),xr     arg 1 buffer block
       mov  bcbuf(xl),xl     arg 2 buffer block
       brn  idn2a            compare characters
*
*      here if the type words differ.
*      check if string/buffer comparison
*
iden0  beq  wc,=b$scl,idn0a   jump if arg 1 is a string
       bne  wc,=b$bct,iden1  jump if arg 1 not string or buffer
*
*      here if arg 1 is a buffer
*
       bne  (xl),=b$scl,iden1  jump if arg 2 is not string

```

	mov bclen(xr),wc	load arg 1 length
	bne wc,sclen(xl),iden1	differ if lengths differ
	bze wc,iden7	identical if length 0
	mov bcbuf(xr),xr	arg 1 buffer block
	brn idn2a	compare characters
	* * here if arg 1 is a string *	
iden0a	bne (xl),=b\$bct,iden1	jump if arg 2 is not buffer
	mov sclen(xr),wc	load arg 1 length
	bne wc,bclen(xl),iden1	differ if lengths differ
	bze wc,iden7	identical if length 0
	mov bcbuf(xl),xl	arg 2 buffer block
	brn idn2a	compare characters
<i>fi</i>		
	* * for all other datatypes, must be differ if xr ne xl * * merge here for differ *	
iden1	exi	take differ exit
	* * here for strings, ident only if lengths and chars same *	
iden2	mov sclen(xr),wc	load arg 1 length
	bne wc,sclen(xl),iden1	differ if lengths differ
	* * buffer and string comparisons merge here *	
iden2a	add *schar,xr	point to chars of arg 1
	add *schar,xl	point to chars of arg 2
	ctw wc,0	get number of words in strings
	lct wc,wc	set loop counter
	* * loop to compare characters. note that wc cannot be zero * since all null strings point to nulls and give xl=xr. *	
iden3	cne (xr),(xl),iden8	differ if chars do not match
	ica xr	else bump arg one pointer
	ica xl	bump arg two pointer
	bct wc,iden3	loop back till all checked

```

*
*      ident (continued)
*
*      here to exit for case of two ident strings
*
      zer  xl                      clear garbage value in xl
      zer  xr                      clear garbage value in xr
      exi  1                      take ident exit
*
*      here for integers, ident if same values
*
iden4  ldi  icval(xr)              load arg 1
      sbi  icval(xl)              subtract arg 2 to compare
      iov  iden1                  differ if overflow
      ine  iden1                  differ if result is not zero
      exi  1                      take ident exit
if.cnra
else
*
*      here for reals, ident if same values
*
iden5  ldr  rcval(xr)              load arg 1
      sbr  rcval(xl)              subtract arg 2 to compare
      rov  iden1                  differ if overflow
      rne  iden1                  differ if result is not zero
      exi  1                      take ident exit
fi
*
*      here for names, ident if bases and offsets same
*
iden6  bne  nmofs(xr),nmofs(xl),iden1    differ if different offset
      bne  nmbas(xr),nmbas(xl),iden1    differ if different base
*
*      merge here to signal ident for identical pointers
*
iden7  exi  1                      take ident exit
*
*      here for differ strings
*
iden8  zer  xr                      clear garbage ptr in xr
      zer  xl                      clear garbage ptr in xl
      exi                      return to caller (differ)
      enp                      end procedure ident

```

```

*
*      inout - used to initialise input and output variables
*
*      (xl)           pointer to vbl name string
*      (wb)           trblk type
*      jsr  inout      call to perform initialisation
*      (xl)           vrbk ptr
*      (xr)           trblk ptr
*      (wa,wc)        destroyed
*
*      note that trter (= trtrf) field of standard i/o variables
*      points to corresponding svblk not to a trblk as is the
*      case for ordinary variables.
*
inout  prc  e,0          entry point
      mov  wb,-(xs)      stack trblk type
      mov  sclen(xl),wa  get name length
      zer  wb           point to start of name
      jsr  sbstr         build a proper scblk
      jsr  gtnvr         build vrbk
      ppm              no error return
      mov  xr,wc         save vrbk pointer
      mov  (xs)+,wb      get trter field
      zer  xl           zero trfpt
      jsr  trbld         build trblk
      mov  wc,xl         recall vrbk pointer
      mov  vrsvp(xl),trter(xr) store svblk pointer
      mov  xr,vrval(xl)  store trblk ptr in vrbk
      mov  =b$vra,vrget(xl) set trapped access
      mov  =b$vrval,vrsto(xl) set trapped store
      exi              return to caller
      enp              end procedure inout

```


if .cnbf

else

```

*
*      insbf -- insert string in buffer
*
*      this routine will replace a section of a buffer with the
*      contents of a given string.  if the length of the
*      section to be replaced is different than the length of
*      the given string, and the replacement is not an append,
*      then the upper section of the buffer is shifted up or
*      down to create the proper space for the insert.
*
*      (xr)          pointer to bcbk
*      (xl)          object which is string convertible
*      (wa)          offset of start of insert in buffer
*      (wb)          length of section to replace
*      jsr  insbf     call to insert characters in buffer
*      ppm  loc       thread if (xl) not convertible
*      ppm  loc       thread if insert not possible
*
*      the second alternate exit is taken if the insert would
*      overflow the buffer, or if the insert is out past the
*      defined end of the buffer as given.
*
insbf  prc  e,2          entry point
      mov  wa,inssa      save entry wa
      mov  wb,inssb      save entry wb
      mov  wc,inssc      save entry wc
      add  wb,wa          add to get offset past replace part
      mov  wa,insab      save wa+wb
      mov  bclen(xr),wc  get current defined length
      bgt  inssa,wc,ins07 fail if start offset too big
      bgt  wa,wc,ins07   fail if final offset too big
      mov  xl,-(xs)      save entry xl
      mov  xr,-(xs)      save bcbk ptr
      mov  xl,-(xs)      stack again for gtstg or gtstb
      beq  xr,xl,ins08   b if inserting same buffer
      jsr  gtstb         call to get string or buffer
      ppm  ins05         take string convert err exit
*
*      merge here with xr pointing to the scblk or bfblk of
*      the object being inserted, and wa containing the
*      number of characters in that object.
*
ins09  mov  xr,xl        save string ptr
      mov  wa,insln      save its length
      mov  (xs),xr       restore bcbk ptr
      add  wc,wa          add buffer len to string len
      sub  inssb,wa       bias out component being replaced
      mov  bcbuf(xr),xr  point to bfblk
      bgt  wa,bfalc(xr),ins06 fail if result exceeds allocation
      mov  (xs),xr       restore bcbk ptr

```

mov wc,wa	get buffer length
sub insab,wa	subtract to get shift length
add insln,wc	add length of new
sub inssb,wc	subtract old to get total new len
mov bclen(xr),wb	get old bclen
mov wc,bclen(xr)	stuff new length
bze wa,ins04	skip shift if nothing to do
beq inssb,insln,ins04	skip shift if lengths match
mov bcbuf(xr),xr	point to bfbk
mov xl,-(xs)	save scblk ptr
blo inssb,insln,ins01	brn if shift is for more room

```

*
*      insbf (continued)
*
*      we are shifting the upper segment down to compact
*      the buffer. (the string length is smaller than the
*      segment being replaced.) registers are set as
*
*      (wa)          move (shift down) length
*      (wb)          old bclen
*      (wc)          new bclen
*      (xr)          bfbld ptr
*      (xl),(xs)     scblk or bfbld ptr
*
      mov  inssa,wb          get offset to insert
      add  insln,wb          add insert length to get dest off
      mov  xr,xl             make copy
      plc  xl,insab          prepare source for move
      psc  xr,wb             prepare destination reg for move
      mvc                     move em out
      brn  ins02             branch to pad
*
*      we are shifting the upper segment up to expand
*      the buffer. (the string length is larger than the
*      segment being replaced.)
*
ins01  mov  xr,xl             copy bfbld ptr
      plc  xl,wb             set source reg for move backwards
      psc  xr,wc             set destination ptr for move
      mcb                     move backwards (possible overlap)
*
*      merge here after move to adjust padding at new buffer end
*
ins02  mov  (xs)+,xl          restore scblk or bfbld ptr
      mov  wc,wa             copy new buffer end
      ctb  wa,0              round out
      sub  wc,wa             subtract to get remainder
      bze  wa,ins04          no pad if already even boundary
      mov  (xs),xr           get bcbld ptr
      mov  bcbuf(xr),xr      get bfbld ptr
      psc  xr,wc             prepare to pad
      zer  wb                clear wb
      lct  wa,wa             load loop count
*
*      loop here to stuff pad characters
*
ins03  sch  wb,(xr)+         stuff zero pad
      bct  wa,ins03          branch for more
      csc  xr                complete store character

```

```

*
*      insbf (continued)
*
*      merge here when padding ok.  now copy in the insert
*      string to the hole.
*
ins04  mov  insln,wa          get insert length
      bze  wa,ins4b          if nothing to insert
      mov  (xs),xr           get bcbblk ptr
      mov  bcbuf(xr),xr      get bfbblk ptr
      plc  xl                prepare to copy from first char
      psc  xr,inssa          prepare to store in hole
      mvc                     copy the characters

*
*      continue here after possible insertion copy
*
ins4b  mov  (xs)+,xr          restore entry xr
      mov  (xs)+,xl          restore entry xl
      mov  inssa,wa          restore entry wa
      mov  inssb,wb          restore entry wb
      mov  inssc,wc          restore entry wc
      exi                     return to caller

*
*      here to take string convert error exit
*
ins05  mov  (xs)+,xr          restore entry xr
      mov  (xs)+,xl          restore entry xl
      mov  inssa,wa          restore entry wa
      mov  inssb,wb          restore entry wb
      mov  inssc,wc          restore entry wc
      exi  1                  alternate exit

*
*      here for invalid offset or length
*
ins06  mov  (xs)+,xr          restore entry xr
      mov  (xs)+,xl          restore entry xl

*
*      merge for length failure exit with stack set
*
ins07  mov  inssa,wa          restore entry wa
      mov  inssb,wb          restore entry wb
      mov  inssc,wc          restore entry wc
      exi  2                  alternate exit

*
*      here if inserting the same buffer into itself.  have
*      to convert the inserted buffer to an intermediate
*      string to prevent garbled data.
*
ins08  jsr  gtstg             call to get string
      ppm  ins05              take string convert err exit
      brn  ins09              merge back to perform insertion

```

enp

end procedure insbf

fi

```

*
*      insta - used to initialize structures in static region
*
*      (xr)                pointer to starting static location
*      jsr  insta          call to initialize static structure
*      (xr)                ptr to next free static location
*      (wa,wb,wc)          destroyed
*
*      note that this procedure establishes the pointers
*      prbuf, gtswk, and kvalp.
*
insta  prc   e,0                      entry point
*
*      initialize print buffer with blank words
*
      mov  prlen,wc                    no. of chars in print bfr
      mov  xr,prbuf                    print bfr is put at static start
      mov  =b$sc1,(xr)+                store string type code
      mov  wc,(xr)+                    and string length
      ctw  wc,0                        get number of words in buffer
      mov  wc,prlnw                    store for buffer clear
      lct  wc,wc                       words to clear
*
*      loop to clear buffer
*
inst1  mov  nullw,(xr)+                store blank
      bct  wc,inst1                    loop
*
*      allocate work area for gtstg conversion procedure
*
      mov  =nstmx,wa                  get max num chars in output number
      ctb  wa,scsi$                    no of bytes needed
      mov  xr,gtswk                    store bfr adrs
      add  wa,xr                       bump for work bfr
*
*      build alphabet string for alphabet keyword and replace
*
      mov  xr,kvalp                    save alphabet pointer
      mov  =b$sc1,(xr)                string blk type
      mov  =cfp$a,wc                  no of chars in alphabet
      mov  wc,sc1en(xr)                store as string length
      mov  wc,wb                       copy char count
      ctb  wb,scsi$                    no. of bytes needed
      add  xr,wb                       current end address for static
      mov  wb,wa                       save adrs past alphabet string
      lct  wc,wc                       loop counter
      psc  xr                          point to chars of string
      zer  wb                          set initial character value
*

```

```

*      loop to enter character codes in order
*
inst2  sch  wb,(xr)+      store next code
       icv  wb           bump code value
       bct  wc,inst2     loop till all stored
       csc  xr          complete store characters
       mov  wa,xr        return current static ptr
       exi              return to caller
       enp              end procedure insta

```

```

*
*      iofcb -- get input/output fcbk pointer
*
*      used by endfile, eject and rewind to find the fcbk
*      (if any) corresponding to their argument.
*
*      -(xs)          argument
*      jsr  iofcb      call to find fcbk
*      ppm  loc        arg is an unsuitable name
*      ppm  loc        arg is null string
*      ppm  loc        arg file not found
*      (xs)          popped
*      (xl)          ptr to filearg1 vrbk
*      (xr)          argument
*      (wa)          fcbk ptr or 0
*      (wb,wc)       destroyed
*
iofcb  prc   n,3          entry point
      jsr   gtstg        get arg as string
      ppm   iofc2        fail
      mov   xr,xl        copy string ptr
      jsr   gtnvr        get as natural variable
      ppm   iofc3        fail if null
      mov   xl,wb        copy string pointer again
      mov   xr,xl        copy vrbk ptr for return
      zer   wa           in case no trblk found
*
*      loop to find file arg1 trblk
*
iofc1  mov   vrval(xr),xr  get possible trblk ptr
      bne   (xr),=b$trt,iofc4  fail if end of chain
      bne   trtyp(xr),=trtfc,iofc1  loop if not file arg trblk
      mov   trfpt(xr),wa  get fcbk ptr
      mov   wb,xr        copy arg
      exi                    return
*
*      fail return
*
iofc2  exi   1          fail
*
*      null arg
*
iofc3  exi   2          null arg return
*
*      file not found
*
iofc4  exi   3          file not found return
      enp                    end procedure iofcb

```



```

*
*      ioppf -- process filearg2 for ioput
*
*      (r$xsc)          filearg2 ptr
*      jsr  ioppf        call to process filearg2
*      (xl)             filearg1 ptr
*      (xr)             file arg2 ptr
*      -(xs)...-(xs)    fields extracted from filearg2
*      (wc)             no. of fields extracted
*      (wb)             input/output flag
*      (wa)             fcbblk ptr or 0
*
ioppf  prc  n,0          entry point
      zer  wb          to count fields extracted
*
*      loop to extract fields
*
iopp1  mov  =iodel,xl    get delimiter
      mov  xl,wc        copy it
      zer  wa          retain leading blanks in filearg2
      jsr  xscan        get next field
      mov  xr,-(xs)     stack it
      icv  wb          increment count
      bnz  wa,iopp1     loop
      mov  wb,wc        count of fields
      mov  ioptt,wb     i/o marker
      mov  r$iof,wa     fcbblk ptr or 0
      mov  r$io2,xr     file arg2 ptr
      mov  r$io1,xl     filearg1
      exi              return
      enp              end procedure ioppf

```

```

*
*      ioput -- routine used by input and output
*
*      ioput sets up input/output associations. it builds
*      such trace and file control blocks as are necessary and
*      calls sysfc,sysio to perform checks on the
*      arguments and to open the files.
*
*      +-----+ +-----+ +-----+
*      +-.i      i  i      i-----.i  =b$xrt  i
*      i +-----+ +-----+ +-----+
*      i /      /      (r$fc)      i  *4      i
*      i /      /      +-----+
*      i +-----+ +-----+      i      i-
*      i i  name  +--.i  =b$trt  i      +-----+
*      i /      /      +-----+      i      i
*      i (first arg)  i =trtin/=trtou i      +-----+
*      i      +-----+      i
*      i      i      value      i      i
*      i      +-----+      i
*      i      i(trtrf) 0      or i--+      i
*      i      +-----+      i      i
*      i      i(trfpt) 0      or i-----+      i
*      i      +-----+      i i      i
*      i      (i/o trblk)      i i      i
*      i +-----+      i i      i
*      i i      i      i i      i
*      i +-----+      i i      i
*      i i      i      i i      i
*      i +-----+ +-----+ i i      i
*      i i      +--.i  =b$trt  i.-+ i      i
*      i +-----+ +-----+      i      i
*      i /      /      i  =trtfc  i      i
*      i /      /      +-----+      i      i
*      i (filearg1  i      value  i      i
*      i      vrblk) +-----+      i      i
*      i      i(trtrf) 0      or i--+ i      .
*      i      +-----+      i .      +-----+
*      i      i(trfpt) 0      or i-----./  fcblk  /
*      i      +-----+      i      +-----+
*      i      (trtrf)      i
*      i      i
*      i      i
*      i      +-----+      i
*      i      i  =b$xrt  i.-+
*      i      +-----+
*      i      i      *5      i
*      i      +-----+
*      +-----i      i
*      +-----+ +-----+
*      i(trtrf) o      or i-----.i  =b$xrt  i
*      +-----+ +-----+
*      i  name offset  i      i      etc  i

```

```
*      +-----+
*      (iochn - chain of name pointers)
```

```

*
*      ioput (continued)
*
*      no additional trap blocks are used for standard input/out
*      files. otherwise an i/o trap block is attached to second
*      arg (filearg1) vrbk. see diagram above for details of
*      the structure built.
*
*      -(xs)          1st arg (vbl to be associated)
*      -(xs)          2nd arg (file arg1)
*      -(xs)          3rd arg (file arg2)
*      (wb)           0 for input, 3 for output assoc.
*      jsr  ioput      call for input/output association
*      ppm  loc        3rd arg not a string
*      ppm  loc        2nd arg not a suitable name
*      ppm  loc        1st arg not a suitable name
*      ppm  loc        inappropriate file spec for i/o
*      ppm  loc        i/o file does not exist
*      ppm  loc        i/o file cannot be read/written
*      ppm  loc        i/o fcbk currently in use
*      (xs)           popped
*      (xl,xr,wa,wb,wc) destroyed
*
ioput  prc  n,7          entry point
      zer  r$iot         in case no trtrf block used
      zer  r$iof         in case no fcbk allocated
      zer  r$iop         in case sysio fails
      mov  wb,iop00      store i/o trace type
      jsr  xscni         prepare to scan filearg2
      ppm  iop13         fail
      ppm  iopa0         null file arg2
*
iop00  mov  xr,r$io2     keep file arg2
      mov  wa,xl         copy length
      jsr  gtstg         convert filearg1 to string
      ppm  iop14         fail
      mov  xr,r$io1     keep filearg1 ptr
      jsr  gtnvr         convert to natural variable
      ppm  iop00         jump if null
      brn  iop04         jump to process non-null args
*
*      null filearg1
*
iop00  bze  xl,iop01     skip if both args null
      jsr  ioppf         process filearg2
      jsr  sysfc         call for filearg2 check
      ppm  iop16         fail
      ppm  iop26         fail
      brn  iop11         complete file association

```

```

*
*      ioput (continued)
*
*      here with 0 or fcbk ptr in (xl)
*
iop01  mov  ioptt,wb          get trace type
      mov  r$iot,xr          get 0 or trtrf ptr
      jsr  trbld             build trblk
      mov  xr,wc             copy trblk pointer
      mov  (xs)+,xr          get variable from stack
      mov  wc,-(xs)          make trblk collectable
      jsr  gtvar             point to variable
      ppm  iop15             fail
      mov  (xs)+,wc          recover trblk pointer
      mov  xl,r$ion          save name pointer
      mov  xl,xr             copy name pointer
      add  wa,xr             point to variable
      sub  *vrval,xr         subtract offset,merge into loop

*
*      loop to end of trblk chain if any
*
iop02  mov  xr,xl            copy blk ptr
      mov  vrval(xr),xr      load ptr to next trblk
      bne  (xr),=b$trt,iop03  jump if not trapped
      bne  trtyp(xr),ioptt,iop02  loop if not same assocn
      mov  trnxt(xr),xr      get value and delete old trblk

*
*      ioput (continued)
*
*      store new association
*
iop03  mov  wc,vrval(xl)     link to this trblk
      mov  wc,xl            copy pointer
      mov  xr,trnxt(xl)      store value in trblk
      mov  r$ion,xr          restore possible vrbk pointer
      mov  wa,wb            keep offset to name
      jsr  setvr            if vrbk, set vrget,vrsto
      mov  r$iot,xr          get 0 or trtrf ptr
      bnz  xr,iop19          jump if trtrf block exists
      exi                   return to caller

*
*      non standard file
*      see if an fcbk has already been allocated.
*
iop04  zer  wa              in case no fcbk found

```

```

*
*      ioput (continued)
*
*      search possible trblk chain to pick up the fcblk
*
iop05  mov  xr,wb                remember blk ptr
      mov  vrval(xr),xr          chain along
      bne  (xr),=b$trt,iop06     jump if end of trblk chain
      bne  trtyp(xr),=trtfc,iop05 loop if more to go
      mov  xr,r$iot              point to file arg1 trblk
      mov  trfpt(xr),wa          get fcblk ptr from trblk

*
*      wa = 0 or fcblk ptr
*      wb = ptr to preceding blk to which any trtrf block
*          for file arg1 must be chained.
*
iop06  mov  wa,r$iof              keep possible fcblk ptr
      mov  wb,r$iof              keep preceding blk ptr
      jsr  ioppf                  process filearg2
      jsr  sysfc                  see if fcblk required
      ppm  iop16                  fail
      ppm  iop26                  fail
      bze  wa,iop12               skip if no new fcblk wanted
      blt  wc,num02,iop6a         jump if fcblk in dynamic
      jsr  alost                  get it in static
      brn  iop6b                  skip

*
*      obtain fcblk in dynamic
*
iop6a  jsr  alloc                  get space for fcblk

*
*      merge
*
iop6b  mov  xr,xl                point to fcblk
      mov  wa,wb                  copy its length
      btw  wb                      get count as words (sgd apr80)
      lct  wb,wb                  loop counter

*
*      clear fcblk
*
iop07  zer  (xr)+                  clear a word
      bct  wb,iop07              loop
      beq  wc,num02,iop09         skip if in static - dont set fields
      mov  =b$xnt,(xl)           store xnblk code in case
      mov  wa,num01(xl)          store length
      bnz  wc,iop09              jump if xnblk wanted
      mov  =b$xrt,(xl)           xrbk code requested
*

```

```

*      ioput (continued)
*
*      complete fcbk initialisation
*
iop09  mov  r$iot,xr          get possible trblk ptr
      mov  xl,r$iof          store fcbk ptr
      bnz  xr,iop10          jump if trblk already found
*
*      a new trblk is needed
*
      mov  =trtfc,wb         trtyp for fcbk trap blk
      jsr  trbld             make the block
      mov  xr,r$iot          copy trtrf ptr
      mov  r$iop,xl          point to preceding blk
      mov  vrval(xl),vrval(xr) copy value field to trblk
      mov  xr,vrval(xl)      link new trblk into chain
      mov  xl,xr            point to predecessor blk
      jsr  setvr            set trace intercepts
      mov  vrval(xr),xr      recover trblk ptr
      brn  iop1a            store fcbk ptr
*
*      here if existing trblk
*
iop10  zer  r$iof            do not release if sysio fails
*
*      xr is ptr to trblk, xl is fcbk ptr or 0
*
iop1a  mov  r$iof,trfpt(xr)  store fcbk ptr
*
*      call sysio to complete file accessing
*
iop11  mov  r$iof,wa         copy fcbk ptr or 0
      mov  ioptt,wb         get input/output flag
      mov  r$io2,xr         get file arg2
      mov  r$io1,xl         get file arg1
      jsr  sysio            associate to the file
      ppm  iop17            fail
      ppm  iop18            fail
      bnz  r$iot,iop01       not std input if non-null trtrf blk
      bnz  ioptt,iop01       jump if output
      bze  wc,iop01         no change to standard read length
      mov  wc,cswin         store new read length for std file
      brn  iop01            merge to finish the task
*
*      sysfc may have returned a pointer to a private fcbk
*
iop12  bnz  xl,iop09         jump if private fcbk
      brn  iop11            finish the association
*
*      failure returns

```

*		
iop13	exi 1	3rd arg not a string
iop14	exi 2	2nd arg unsuitable
iop15	ica xs	discard trblk pointer
	exi 3	1st arg unsuitable
iop16	exi 4	file spec wrong
iop26	exi 7	fcblk in use
*		
* i/o file does not exist		
*		
iop17	mov r\$iop,xr	is there a trblk to release
	bze xr,iopa7	if not
	mov vrval(xr),xl	point to trblk
	mov vrval(xl),vrval(xr)	unssplice it
	jsr setvr	adjust trace intercepts
iopa7	exi 5	i/o file does not exist
*		
* i/o file cannot be read/written		
*		
iop18	mov r\$iop,xr	is there a trblk to release
	bze xr,iopa7	if not
	mov vrval(xr),xl	point to trblk
	mov vrval(xl),vrval(xr)	unssplice it
	jsr setvr	adjust trace intercepts
iopa8	exi 6	i/o file cannot be read/written


```

*
*      ioput (continued)
*
*      add to iochn chain of associated variables unless
*      already present.
*
iop19  mov  r$ion,wc                      wc = name base, wb = name offset
*
*      search loop
*
iop20  mov  trtrf(xr),xr                  next link of chain
      bze  xr,iop21                      not found
      bne  wc,ionmb(xr),iop20            no match
      beq  wb,ionmo(xr),iop22            exit if matched
      brn  iop20                        loop
*
*      not found
*
iop21  mov  *num05,wa                    space needed
      jsr  alloc                        get it
      mov  =b$xrt,(xr)                  store xrbk code
      mov  wa,num01(xr)                 store length
      mov  wc,ionmb(xr)                 store name base
      mov  wb,ionmo(xr)                 store name offset
      mov  r$iot,xl                     point to trtrf blk
      mov  trtrf(xl),wa                 get ptr field contents
      mov  xr,trtrf(xl)                 store ptr to new block
      mov  wa,trtrf(xr)                 complete the linking
*
*      insert fcblk on fcblk chain for sysej, sysxi
*
iop22  bze  r$iof,iop25                  skip if no fcblk
      mov  r$fcbl,xl                    ptr to head of existing chain
*
*      see if fcblk already on chain
*
iop23  bze  xl,iop24                     not on if end of chain
      beq  num03(xl),r$iof,iop25         dont duplicate if find it
      mov  num02(xl),xl                 get next link
      brn  iop23                        loop
*
*      not found so add an entry for this fcblk
*
iop24  mov  *num04,wa                    space needed
      jsr  alloc                        get it
      mov  =b$xrt,(xr)                  store block code
      mov  wa,num01(xr)                 store length
      mov  r$fcbl,num02(xr)             store previous link in this node
      mov  r$iof,num03(xr)              store fcblk ptr
      mov  xr,r$fcbl                    insert node into fcblk chain

```

```

      *
      *      return
      *
iop25  exi      return to caller
      enp      end procedure ioput

```

```

*
*      ktrex -- execute keyword trace
*
*      ktrex is used to execute a possible keyword trace. it
*      includes the test on trace and tests for trace active.
*
*      (x1)                ptr to trblk (or 0 if untraced)
*      jsr  ktrex           call to execute keyword trace
*      (x1,wa,wb,wc)       destroyed
*      (ra)                destroyed
*
ktrex  prc   r,0            entry point (recursive)
       bze  x1,ktrx3       immediate exit if keyword untraced
       bze  kvtra,ktrx3    immediate exit if trace = 0
       dcv  kvtra          else decrement trace
       mov  xr,-(xs)       save xr
       mov  x1,xr          copy trblk pointer
       mov  trkvr(xr),x1   load vrbk pointer (nmbas)
       mov  *vrval,wa      set name offset
       bze  trfnc(xr),ktrx1 jump if print trace
       jsr  trxeq          else execute full trace
       brn  ktrx2          and jump to exit

*
*      here for print trace
*
ktrx1  mov  x1,-(xs)       stack vrbk ptr for kwnam
       mov  wa,-(xs)       stack offset for kwnam
       jsr  prtsn          print statement number
       mov  =ch$am,wa      load ampersand
       jsr  prtch          print ampersand
       jsr  prtnm          print keyword name
       mov  =tmbeb,xr      point to blank-equal-blank
       jsr  prtst          print blank-equal-blank
       jsr  kwnam          get keyword pseudo-variable name
       mov  xr,dnamp        reset ptr to delete kvblk
       jsr  acess          get keyword value
       ppm                failure is impossible
       jsr  prtvl          print keyword value
       jsr  prtnl          terminate print line

*
*      here to exit after completing trace
*
ktrx2  mov  (xs)+,xr       restore entry xr

*
*      merge here to exit if no trace required
*
ktrx3  exi                return to ktrex caller
       enp                end procedure ktrex

```

*		
*	kwnam	-- get pseudo-variable name for keyword
*		
*	1(xs)	name base for vrblk
*	0(xs)	offset (should be *vrval)
*	jsr kwnam	call to get pseudo-variable name
*	(xs)	popped twice
*	(xl,wa)	resulting pseudo-variable name
*	(xr,wa,wb)	destroyed
*		
kwnam	prc n,0	entry point
	ica xs	ignore name offset
	mov (xs)+,xr	load name base
	bge xr,state,kwnm1	jump if not natural variable name
	bnz vrlen(xr),kwnm1	error if not system variable
	mov vrsvp(xr),xr	else point to svblk
	mov svbit(xr),wa	load bit mask
	anb btknm,wa	and with keyword bit
	zrb wa,kwnm1	error if no keyword association
	mov svlen(xr),wa	else load name length in characters
	ctb wa,svchs	compute offset to field we want
	add wa,xr	point to svknm field
	mov (xr),wb	load svknm value
	mov *kvsiz\$,wa	set size of kvblk
	jsr alloc	allocate kvblk
	mov =b\$kvst,(xr)	store type word
	mov wb,kvnum(xr)	store keyword number
	mov =trbkv,kvvar(xr)	set dummy trblk pointer
	mov xr,xl	copy kvblk pointer
	mov *kvvar,wa	set proper offset
	exi	return to kvnam caller
*		
*	here if not keyword name	
*		
kwnm1	erb 251,keyword operand	is not name of defined keyword
	enp	end procedure kwnam

```

*
*      lcomp-- compare two strings lexically
*
*      1(xs)                first argument
*      0(xs)                second argument
*      jsr  lcomp           call to compare arguments
*      ppm  loc             transfer loc for arg1 not string
*      ppm  loc             transfer loc for arg2 not string
*      ppm  loc             transfer loc if arg1 llt arg2
*      ppm  loc             transfer loc if arg1 leq arg2
*      ppm  loc             transfer loc if arg1 lgt arg2
*      (the normal return is never taken)
*      (xs)                 popped twice
*      (xr,xl)              destroyed
*      (wa,wb,wc,ra)        destroyed
*
lcomp  prc   n,5                entry point
if .cnbf
    jsr   gtstg                convert second arg to string
else
    jsr   gtstb                get second arg as string or buffer
fi

    ppm  lcmp6                jump if second arg not string
    mov  xr,xl                else save pointer
    mov  wa,wc                and length
if .cnbf
    jsr   gtstg                convert first argument to string
else
    jsr   gtstb                get first arg as string or buffer
fi

    ppm  lcmp5                jump if not string
    mov  wa,wb                save arg 1 length
    plc  xr                    point to chars of arg 1
    plc  xl                    point to chars of arg 2
if .ccmc
    mov  wc,wa                arg 2 length to wa
    jsr   syscm                compare (xl,wa=arg2 xr,wb=arg1)
    err  283,string length    exceeded for generalized lexical comparison
    ppm  lcmp4                arg 2 lt arg 1, lgt exit
    ppm  lcmp3                arg 2 gt arg 1, llt exit
    exi   4                    else identical strings, leq exit

```

<pre> * * lcomp (continued) else blo wa,wc,lcmp1 mov wc,wa * * here with smaller length in (wa) * lcmp1 bze wa,lcmp7 cmc lcmp4,lcmp3 lcmp7 bne wb,wc,lcmp2 exi 4 </pre>	<pre> jump if arg 1 length is smaller else set arg 2 length as smaller if null string, compare lengths compare strings, jump if unequal if equal, jump if lengths unequal else identical strings, leq exit </pre>
---	--

```

*
*      lcomp (continued)
*
*      here if initial strings identical, but lengths unequal
*
lcmp2  bhi  wb,wc,lcmp4          jump if arg 1 length gt arg 2 leng
fi
*
*      here if first arg llt second arg
*
lcmp3  exi  3                    take llt exit
*
*      here if first arg lgt second arg
*
lcmp4  exi  5                    take lgt exit
*
*      here if first arg is not a string
*
lcmp5  exi  1                    take bad first arg exit
*
*      here for second arg not a string
*
lcmp6  exi  2                    take bad second arg error exit
      enp                      end procedure lcomp

```

```

*
*      listr -- list source line
*
*      listr is used to list a source line during the initial
*      compilation. it is called from scane and scanl.
*
*      jsr  listr          call to list line
*      (xr,xl,wa,wb,wc)    destroyed
*
*      global locations used by listr
*
*      cntttl              flag for -title, -stttl
*
*      erlst              if listing on account of an error
*
if .cinc
*      lstid              include depth of current image
*
fi
*
*      lstlc              count lines on current page
*
*      lstnp              max number of lines/page
*
*      lstpf              set non-zero if the current source
*                        line has been listed, else zero.
*
*      lstpg              compiler listing page number
*
*      lstsn              set if stmt num to be listed
*
*      r$cim              pointer to current input line.
*
*      r$ttl              title for source listing
*
*      r$stl              ptr to sub-title string
*
*      entry point
*
listr  prc  e,0              entry point
      bnz  cntttl,list5    jump if -title or -stttl
      bnz  lstpf,list4     immediate exit if already listed
      bge  lstlc,lstnp,list6  jump if no room
*
*      here after printing title (if needed)
*
list0  mov  r$cim,xr        load pointer to current image
      bze  xr,list4        jump if no image to print
      plc  xr              point to characters
      lch  wa,(xr)         load first character
      mov  lstsn,xr        load statement number
      bze  xr,list2        jump if no statement number
      mti  xr              else get stmt number as integer

```


	bne stage,=stgic,list1	skip if execute time
	beq wa,=ch\$as,list2	no stmt number list if comment
	beq wa,=ch\$mn,list2	no stmt no. if control card
	 *	
	* print statement number	
	 *	
list1	jsr prtln	else print statement number
	zer lstsn	and clear for next time in
<i>if .cinc</i>		
	 *	
	* here to test for printing include depth	
	 *	
list2	mov lstid,xr	include depth of image
	bze xr,list8	if not from an include file
	mov =stnpd,wa	position for start of statement
	sub =num03,wa	position to place include depth
	mov wa,profs	set as starting position
	mti xr	include depth as integer
	jsr prtln	print include depth

```

*
*      listr (continued)
*
*      here after printing statement number and include depth
*
list8  mov  =stnpd,profs          point past statement number
else

```

```

*
*      listr (continued)
*
*      merge here after printing statement number (if required)
*
list2  mov  =stnpg,profs          point past statement number
fi

      mov  r$cim,xr              load pointer to current image
      jsr  prtst                 print it
      icv  lstlc                 bump line counter
      bnz  erlst,list3           jump if error copy to int.ch.
      jsr  prtln                 terminate line
      bze  cswdb,list3           jump if -single mode
      jsr  prtln                 else add a blank line
      icv  lstlc                 and bump line counter

*
*      here after printing source image
*
list3  mnz  lstpf                set flag for line printed
*
*      merge here to exit
*
list4  exi                      return to listr caller
*
*      print title after -title or -sttl card
*
list5  zer  cnttl                clear flag
*
*      eject to new page and list title
*
list6  jsr  prtps                eject
      bze  prich,list7           skip if listing to regular printer
      beq  r$ttl,=nulls,list0    terminal listing omits null title
*
*      list title
*
list7  jsr  listt                list title
      brn  list0                 merge
      enp                       end procedure listr

```

```

*
*      listt -- list title and subtitle
*
*      used during compilation to print page heading
*
*      jsr listt          call to list title
*      (xr,wa)            destroyed
*
listt  prc   e,0           entry point
      mov   r$ttl,xr      point to source listing title
      jsr   prtst         print title
      mov   lstpo,profs   set offset
      mov   =lstms,xr     set page message
      jsr   prtst         print page message
      icv   lstpg         bump page number
      mti   lstpg         load page number as integer
      jsr   prtin         print page number
      jsr   prtnl         terminate title line
      add   =num02,lstlc  count title line and blank line

*
*      print sub-title (if any)
*
      mov   r$stl,xr      load pointer to sub-title
      bze   xr,lstt1      jump if no sub-title
      jsr   prtst         else print sub-title
      jsr   prtnl         terminate line
      icv   lstlc         bump line count

*
*      return point
*
lstt1  jsr   prtnl        print a blank line
      exi                    return to caller
      enp                    end procedure listt

```

if.csfn

```

*
*      newfn -- record new source file name
*
*      newfn is used after switching to a new include file, or
*      after a -line statement which contains a file name.
*
*      (xr)                file name scblk
*      jsr  newfn
*      (wa,wb,wc,xl,xr,ra)  destroyed
*
*      on return, the table that maps statement numbers to file
*      names has been updated to include this new file name and
*      the current statement number.  the entry is made only if
*      the file name had changed from its previous value.
*
newfn  prc   e,0                entry point
        mov  xr,-(xs)          save new name
        mov  r$sfc,xl         load previous name
        jsr  ident            check for equality
        ppm  nwfn1            jump if identical
        mov  (xs)+,xr         different, restore name
        mov  xr,r$sfc         record current file name
        mov  cmpsn,wb         get current statement
        mti  wb               convert to integer
        jsr  icbld            build icblk for stmt number
        mov  r$sfn,xl         file name table
        mnz  wb               lookup statement number by name
        jsr  tfind            allocate new teblk
        ppm                          always possible to allocate block
        mov  r$sfc,teval(xl)   record file name as entry value
        exi  r$sfc,teval(xl)   record file name as entry value
*
*      ere if new name and old name identical
*
nwfn1  ica   xs                pop stack
        exi   xs                pop stack

```

fi

```

*
*      nexts -- acquire next source image
*
*      nexts is used to acquire the next source image at compile
*      time. it assumes that a prior call to readr has input
*      a line image (see procedure readr). before the current
*      image is finally lost it may be listed here.
*
*      jsr  nexts          call to acquire next input line
*      (xr,xl,wa,wb,wc)    destroyed
*
*      global values affected
*

```

if .cinc

```

*      lstid              include depth of next image
*

```

fi

```

*      r$cni              on input, next image. on
*                          exit reset to zero
*
*      r$cim              on exit, set to point to image
*
*      rdcln              current ln set from next line num
*
*      scnll              input image length on exit
*
*      scnse              reset to zero on exit
*
*      lstpf              set on exit if line is listed
*

```

```

nexts  prc  e,0            entry point
       bze  cswls,nexts2  jump if -nolist
       mov  r$cim,xr      point to image
       bze  xr,nexts2     jump if no image
       plc  xr            get char ptr
       lch  wa,(xr)       get first char
       bne  wa,=ch$mn,nexts1  jump if not ctrl card
       bze  cswpr,nexts2  jump if -noprnt

```

```

*
*      here to call lister
*

```

```

nexts1 jsr  listr          list line

```

```

*
*      here after possible listing
*

```

```

nexts2 mov  r$cni,xr      point to next image
       mov  xr,r$cim      set as next image
       mov  rdln,rdcln    set as current line number

```

if .cinc

```

       mov  cnind,lstid    set as current include depth

```

fi

zer	r\$cni	clear next image pointer
mov	sclen(xr),wa	get input image length
mov	cswin,wb	get max allowable length
blo	wa,wb,nxts3	skip if not too long
mov	wb,wa	else truncate
*		
*	here with length in (wa)	
*		
nxts3	mov wa,scnil	use as record length
	zer scnse	reset scnse
	zer lstpf	set line not listed yet
	exi	return to nexts caller
	enp	end procedure nexts

```

*
*      patin -- pattern construction for len,pos,rpos,tab,rtab
*
*      these pattern types all generate a similar node type. so
*      the construction code is shared. see functions section
*      for actual entry points for these five functions.
*
*      (wa)                pcode for expression arg case
*      (wb)                pcode for integer arg case
*      jsr  patin          call to build pattern node
*      ppm  loc            transfer loc for not integer or exp
*      ppm  loc            transfer loc for int out of range
*      (xr)                pointer to constructed node
*      (xl,wa,wb,wc,ia)    destroyed
*
patin  prc  n,2            entry point
      mov  wa,xl          preserve expression arg pcode
      jsr  gtsmi          try to convert arg as small integer
      ppm  ptin2          jump if not integer
      ppm  ptin3          jump if out of range
*
*      common successful exit point
*
ptin1  jsr  pbild          build pattern node
      exi                    return to caller
*
*      here if argument is not an integer
*
ptin2  mov  xl,wb          copy expr arg case pcode
      blo  (xr),=b$e$$,ptin1  all ok if expression arg
      exi  1              else take error exit for wrong type
*
*      here for error of out of range integer argument
*
ptin3  exi  2              take out-of-range error exit
      enp                    end procedure patin

```



```

*
* patst -- pattern construction for any,notany,
*         break,span and breakx pattern functions.
*
* these pattern functions build similar types of nodes and
* the construction code is shared. see functions section
* for actual entry points for these five pattern functions.
*
* 0(xs)          string argument
* (wb)           pcode for one char argument
* (xl)           pcode for multi-char argument
* (wc)           pcode for expression argument
* jsr patst      call to build node
* ppm loc        if not string or expr (or null)
* (xs)           popped past string argument
* (xr)           pointer to constructed node
* (xl)           destroyed
* (wa,wb,wc,ra)  destroyed
*
* note that there is a special call to patst in the evals
* procedure with a slightly different form. see evals
* for details of the form of this call.
*
patst  prc  n,1          entry point
      jsr  gtstg         convert argument as string
      ppm  pats7         jump if not string
      bze  wa,pats7      jump if null string (catspaw)
      bne  wa,=num01,pats2  jump if not one char string
*
*         here for one char string case
*
      bze  wb,pats2      treat as multi-char if evals call
      plc  xr            point to character
      lch  xr,(xr)       load character
*
*         common exit point after successful construction
*
pats1  jsr  pbild        call routine to build node
      exi                return to patst caller

```

```

*
*      patst (continued)
*
*      here for multi-character string case
*
pats2  mov  xl,-(xs)                save multi-char pcode
      mov  ctmsk,wc                load current mask bit
      beq  xr,r$cts,pats6          jump if same as last string c3.738
      mov  xr,-(xs)                save string pointer
      lsh  wc,1                    shift to next position
      nzb  wc,pats4                skip if position left in this tbl

*
*      here we must allocate a new character table
*
      mov  *ctsi$,wa                set size of ctblk
      jsr  alloc                    allocate ctblk
      mov  xr,r$ctp                  store ptr to new ctblk
      mov  =b$ctt,(xr)+              store type code, bump ptr
      lct  wb,=cfp$a                set number of words to clear
      mov  bits0,wc                 load all zero bits

*
*      loop to clear all bits in table to zeros
*
pats3  mov  wc,(xr)+                move word of zero bits
      bct  wb,pats3                loop till all cleared
      mov  bits1,wc                 set initial bit position

*
*      merge here with bit position available
*
pats4  mov  wc,ctmsk                save parm2 (new bit position)
      mov  (xs)+,xl                restore pointer to argument string
      mov  xl,r$cts                save for next time c3.738
      mov  sclen(xl),wb             load string length
      bze  wb,pats6                jump if null string case
      lct  wb,wb                    else set loop counter
      plc  xl                       point to characters in argument

```

```

*
*      patst (continued)
*
*      loop to set bits in column of table
*
pats5  lch   wa,(xl)+          load next character
      wtb   wa                convert to byte offset
      mov   r$ctp,xr          point to ctblk
      add   wa,xr             point to ctblk entry
      mov   wc,wa             copy bit mask
      orb   ctchs(xr),wa      or in bits already set
      mov   wa,ctchs(xr)      store resulting bit string
      bct   wb,pats5          loop till all bits set

*
*      complete processing for multi-char string case
*
pats6  mov   r$ctp,xr          load ctblk ptr as parm1 for pbild
      zer   xl                clear garbage ptr in xl
      mov   (xs)+,wb          load pcode for multi-char str case
      brn   pats1             back to exit (wc=bitstring=parm2)

*
*      here if argument is not a string
*
*      note that the call from evals cannot pass an expression
*      since evalp always reevaluates expressions.
*
pats7  mov   wc,wb            set pcode for expression argument
      blo   (xr),=b$e$$,pats1 jump to exit if expression arg
      exi   1                 else take wrong type error exit
      enp                     end procedure patst

```

```

*
*      pbild -- build pattern node
*
*      (xr)          parm1 (only if required)
*      (wb)          pcode for node
*      (wc)          parm2 (only if required)
*      jsr  pbild     call to build node
*      (xr)          pointer to constructed node
*      (wa)          destroyed
*
pbild  prc  e,0        entry point
      mov  xr,-(xs)    stack possible parm1
      mov  wb,xr       copy pcode
      lei  xr          load entry point id (bl$px)
      beq  xr,=bl$p1,pbld1  jump if one parameter
      beq  xr,=bl$p0,pbld3  jump if no parameters
*
*      here for two parameter case
*
      mov  *pcsi$,wa   set size of p2blk
      jsr  alloc       allocate block
      mov  wc,parm2(xr) store second parameter
      brn  pbld2        merge with one parm case
*
*      here for one parameter case
*
pbld1  mov  *pbsi$,wa  set size of p1blk
      jsr  alloc       allocate node
*
*      merge here from two parm case
*
pbld2  mov  (xs),parm1(xr) store first parameter
      brn  pbld4        merge with no parameter case
*
*      here for case of no parameters
*
pbld3  mov  *pasi$,wa  set size of p0blk
      jsr  alloc       allocate node
*
*      merge here from other cases
*
pbld4  mov  wb,(xr)    store pcode
      ica  xs          pop first parameter
      mov  =ndnth,pthen(xr) set nothen successor pointer
      exi             return to pbild caller
      enp             end procedure pbild

```

```

*
*      pconc -- concatenate two patterns
*
*      (xl)                ptr to right pattern
*      (xr)                ptr to left pattern
*      jsr pconc           call to concatenate patterns
*      (xr)                ptr to concatenated pattern
*      (xl,wa,wb,wc)       destroyed
*
*
*      to concatenate two patterns, all successors in the left
*      pattern which point to the nothen node must be changed to
*      point to the right pattern. however, this modification
*      must be performed on a copy of the left argument rather
*      than the left argument itself, since the left argument
*      may be pointed to by some other variable value.
*
*      accordingly, it is necessary to copy the left argument.
*      this is not a trivial process since we must avoid copying
*      nodes more than once and the pattern is a graph structure
*      the following algorithm is employed.
*
*      the stack is used to store a list of nodes which
*      have already been copied. the format of the entries on
*      this list consists of a two word block. the first word
*      is the old address and the second word is the address
*      of the copy. this list is searched by the pcopy
*      routine to avoid making duplicate copies. a trick is
*      used to accomplish the concatenation at the same time.
*      a special entry is made to start with on the stack. this
*      entry records that the nothen node has been copied
*      already and the address of its copy is the right pattern.
*      this automatically performs the correct replacements.
*
pconc  prc  e,0                entry point
       zer  -(xs)             make room for one entry at bottom
       mov  xs,wc             store pointer to start of list
       mov  =ndnth,-(xs)      stack nothen node as old node
       mov  xl,-(xs)          store right arg as copy of nothen
       mov  xs,xt             initialize pointer to stack entries
       jsr  pcopy             copy first node of left arg
       mov  wa,num02(xt)      store as result under list

```

```

*
*      pconc (continued)
*
*      the following loop scans entries in the list and makes
*      sure that their successors have been copied.
*
pcnc1  beq  xt,xs,pcnc2          jump if all entries processed
      mov  -(xt),xr             else load next old address
      mov  pthen(xr),xr         load pointer to successor
      jsr  pcopy                copy successor node
      mov  -(xt),xr             load pointer to new node (copy)
      mov  wa,pthen(xr)         store ptr to new successor

*
*      now check for special case of alternation node where
*      parm1 points to a node and must be copied like pthen.
*
      bne  (xr),=p$alt,pcnc1     loop back if not
      mov  parm1(xr),xr          else load pointer to alternative
      jsr  pcopy                 copy it
      mov  (xt),xr              restore ptr to new node
      mov  wa,parm1(xr)          store ptr to copied alternative
      brn  pcnc1                loop back for next entry

*
*      here at end of copy process
*
pcnc2  mov  wc,xs                restore stack pointer
      mov  (xs)+,xr              load pointer to copy
      exi                          return to pconc caller
      enp                          end procedure pconc

```

```

*
*      pcopy -- copy a pattern node
*
*      pcopy is called from the pconc procedure to copy a single
*      pattern node. the copy is only carried out if the node
*      has not been copied already.
*
*      (xr)          pointer to node to be copied
*      (xt)          ptr to current loc in copy list
*      (wc)          pointer to list of copied nodes
*      jsr pcopy      call to copy a node
*      (wa)          pointer to copy
*      (wb,xr)        destroyed
*
pcopy  prc  n,0          entry point
       mov  xt,wb        save xt
       mov  wc,xt        point to start of list
*
*      loop to search list of nodes copied already
*
pcop1  dca  xt          point to next entry on list
       beq  xr,(xt),pcop2  jump if match
       dca  xt          else skip over copied address
       bne  xt,xs,pcop1   loop back if more to test
*
*      here if not in list, perform copy
*
       mov  (xr),wa      load first word of block
       jsr  blkln        get length of block
       mov  xr,xl        save pointer to old node
       jsr  alloc        allocate space for copy
       mov  xl,-(xs)      store old address on list
       mov  xr,-(xs)      store new address on list
       chk                check for stack overflow
       mvw                move words from old block to copy
       mov  (xs),wa      load pointer to copy
       brn  pcop3        jump to exit
*
*      here if we find entry in list
*
pcop2  mov  -(xt),wa      load address of copy from list
*
*      common exit point
*
pcop3  mov  wb,xt        restore xt
       exi                return to pcopy caller
       enp                end procedure pcopy

```

```

if .cnpf
else
    *
    *      prflr -- print profile
    *      prflr is called to print the contents of the profile
    *      table in a fairly readable tabular format.
    *
    *      jsr  prflr          call to print profile
    *      (wa,ia)            destroyed
    *
prflr  prc
      bze  pfdmp,prfl4          no printing if no profiling done
      mov  xr,-(xs)             preserve entry xr
      mov  wb,pfsvw             and also wb
      jsr  prtpg                eject
      mov  =pfms1,xr            load msg /program profile/
      jsr  prtst                and print it
      jsr  prtln                followed by newline
      jsr  prtln                and another
      mov  =pfms2,xr            point to first hdr
      jsr  prtst                print it
      jsr  prtln                new line
      mov  =pfms3,xr            second hdr
      jsr  prtst                print it
      jsr  prtln                new line
      jsr  prtln                and another blank line
      zer  wb                   initial stmt count
      mov  pftbl,xr             point to table origin
      add  *xndta,xr            bias past xnblk header (sgd07)

    *
    *      loop here to print successive entries
    *
prfl1  icv  wb                  bump stmt nr
      ldi  (xr)                 load nr of executions
      ieq  prfl3                no printing if zero
      mov  =pfpd1,profs         point where to print
      jsr  prtln                and print it
      zer  profs                back to start of line
      mti  wb                   load stmt nr
      jsr  prtln                print it there
      mov  =pfpd2,profs         and pad past count
      ldi  cfp$i(xr)            load total exec time
      jsr  prtln                print that too
      ldi  cfp$i(xr)            reload time
      mli  intth                convert to microsec
      iov  prfl2                omit next bit if overflow
      dvi  (xr)                 divide by executions
      mov  =pfpd3,profs         pad last print
      jsr  prtln                and print mcsec/execn

    *
    *      merge after printing time

```


<pre> * prfl2 jsr prtnl * * here to go to next entry * prfl3 add *pf\$i2,xr blt wb,pfnte,prfl1 mov (xs)+,xr mov pfsvw,wb * * here to exit * prfl4 exi enp </pre>	<pre> thats another line bump index ptr (sgd07) loop if more stmts restore callers xr and wb too return end of prflr </pre>
--	---

```

*
*      prflu -- update an entry in the profile table
*
*      on entry, kvstn contains nr of stmt to profile
*
*      jsr  prflu      call to update entry
*      (ia)            destroyed
*
prflu  prc
      bnz  pffnc,pflu4      skip if just entered function
      mov  xr,-(xs)         preserve entry xr
      mov  wa,pfsvw         save wa (sgd07)
      bnz  pftbl,pflu2      branch if table allocated

*
*      here if space for profile table not yet allocated.
*      calculate size needed, allocate a static xnblk, and
*      initialize it all to zero.
*      the time taken for this will be attributed to the current
*      statement (assignment to keywd profile), but since the
*      timing for this statement is up the pole anyway, this
*      doesnt really matter...
*
      sub  =num01,pfnte      adjust for extra count (sgd07)
      mti  pfi2a             convrt entry size to int
      sti  pfste             and store safely for later
      mti  pfnte             load table length as integer
      mli  pfste             multiply by entry size
      mfi  wa                get back address-style
      add  =num02,wa         add on 2 word overhead
      wtb  wa                convert the whole lot to bytes
      jsr  alast            gimme the space
      mov  xr,pftbl          save block pointer
      mov  =b$xt,(xr)+       put block type and ...
      mov  wa,(xr)+          ... length into header
      mfi  wa                get back nr of wds in data area
      lct  wa,wa             load the counter

*
*      loop here to zero the block data
*
pflu1  zer  (xr)+             blank a word
      bct  wa,pflu1          and alllllll the rest

*
*      end of allocation. merge back into routine
*
pflu2  mti  kvstn            load nr of stmt just ended
      sbi  intv1             make into index offset
      mli  pfste             make offset of table entry
      mfi  wa                convert to address
      wtb  wa                get as bauss
      add  *num02,wa         offset includes table header
      mov  pftbl,xr          get table start
      bge  wa,num01(xr),pflu3 if out of table, skip it

```

	add wa,xr	else point to entry
	ldi (xr)	get nr of executions so far
	adi intv1	nudge up one
	sti (xr)	and put back
	jsr systm	get time now
	sti pfetm	stash ending time
	sbi pfstm	subtract start time
	adi cfp\$(xr)	add cumulative time so far
	sti cfp\$(xr)	and put back new total
	ldi pfetm	load end time of this stmt ...
	sti pfstm	... which is start time of next
	 *	
	* merge here to exit	
	* pflu3	
	mov (xs)+,xr	restore callers xr
	mov pfsvw,wa	restore saved reg
	exi	and return
	 *	
	* here if profile is suppressed because a program defined	
	* function is about to be entered, and so the current stmt	
	* has not yet finished	
	* pflu4	
	zer pffnc	reset the condition flag
	exi	and immediate return
	enp	end of procedure prflu

fi

```

*
*      prpar - process print parameters
*
*      (wc)                if nonzero associate terminal only
*      jsr  prpar          call to process print parameters
*      (xl,xr,wa,wb,wc)    destroyed
*
*      since memory allocation is undecided on initial call,
*      terminal cannot be associated. the entry with wc non-zero
*      is provided so a later call can be made to complete this.
*
prpar  prc   e,0                entry point
        bnz  wc,prpa8          jump to associate terminal
        jsr  syspp             get print parameters
        bnz  wb,prpa1          jump if lines/page specified
        mov  =cfp$m,wb         else use a large value
        rsh  wb,1              but not too large
*
*      store line count/page
*
prpa1  mov  wb,lstnp           store number of lines/page
        mov  wb,lstlc         pretend page is full initially
        zer  lstpg            clear page number
        mov  prlen,wb         get prior length if any
        bze  wb,prpa2         skip if no length
        bgt  wa,wb,prpa3      skip storing if too big
*
*      store print buffer length
*
prpa2  mov  wa,prlen           store value
*
*      process bits options
*
prpa3  mov  bits3,wb          bit 3 mask
        anb  wc,wb            get -nolist bit
        zrb  wb,prpa4         skip if clear
        zer  cswls            set -nolist
*
*      check if fail reports goto interactive channel
*
prpa4  mov  bits1,wb          bit 1 mask
        anb  wc,wb            get bit
        mov  wb,erich         store int. chan. error flag
        mov  bits2,wb         bit 2 mask
        anb  wc,wb            get bit
        mov  wb,prich         flag for std printer on int. chan.
        mov  bits4,wb         bit 4 mask
        anb  wc,wb            get bit
        mov  wb,cpsts         flag for compile stats suppressn.

```

```
mov bits5,wb  
anb  wc,wb  
mov  wb,exsts
```

```
bit 5 mask  
get bit  
flag for exec stats suppression
```

<pre> * * prpar (continued) * mov bits6,wb anb wc,wb mov wb,precl sub =num08,wa zrb wb,prpa5 mov wa,lstpo * * continue option processing * prpa5 mov bits7,wb anb wc,wb mov wb,cswex mov bit10,wb anb wc,wb mov wb,headp mov bits9,wb anb wc,wb mov wb,prsto if .culc mov wc,wb rsh wb,12 anb bits1,wb mov wb,kvcas fi mov bit12,wb anb wc,wb mov wb,cswer zrb wb,prpa6 mov prlen,wa sub =num08,wa mov wa,lstpo * * check for -print/-noprnt * prpa6 mov bit11,wb anb wc,wb mov wb,cswpr * * check for terminal * anb bits8,wc bnz wc,prpa8 bze intr,prpa9 mov =v\$ter,x1 jsr gtnvr ppm mov =nulls,vrval(xr) jsr setvr </pre>	<pre> bit 6 mask get bit extended/compact listing flag point 8 chars from line end jump if not extended store for listing page headings bit 7 mask get bit 7 set -noexecute if non-zero bit 10 mask get bit 10 pretend printed to omit headers bit 9 mask get bit 9 keep it as std listing option copy flags right justify bit 13 get bit set -case bit 12 mask get bit 12 keep it as errors/noerrors option skip if clear get print buffer length point 8 chars from line end store page offset bit 11 mask get bit 11 set -print if non-zero see if terminal to be activated jump if terminal required jump if no terminal to detach ptr to /terminal/ get vrbk pointer cant fail clear value of terminal remove association </pre>
---	--

	brn prpa9	return
*		
*	associate terminal	
*		
prpa8	mnz initr	note terminal associated
	bze dnamb,prpa9	cant if memory not organised
	mov =v\$ter,xl	point to terminal string
	mov =trtou,wb	output trace type
	jsr inout	attach output trblk to vrblk
	mov xr,-(xs)	stack trblk ptr
	mov =v\$ter,xl	point to terminal string
	mov =trtin,wb	input trace type
	jsr inout	attach input trace blk
	mov (xs)+,vrval(xr)	add output trblk to chain
*		
*	return point	
*		
prpa9	exi	return
	enp	end procedure prpar

```

*
*      prtch -- print a character
*
*      prtch is used to print a single character
*
*      (wa)                character to be printed
*      jsr  prtch          call to print character
*
prtch  prc   e,0            entry point
      mov  xr,-(xs)        save xr
      bne  profs,prlen,prch1  jump if room in buffer
      jsr  prtnl          else print this line
*
*      here after making sure we have room
*
prch1  mov  prbuf,xr        point to print buffer
      psc  xr,profs        point to next character location
      sch  wa,(xr)         store new character
      csc  xr              complete store characters
      icv  profs           bump pointer
      mov  (xs)+,xr        restore entry xr
      exi                  return to prtch caller
      enp                  end procedure prtch

```



```

*
*      prtict -- print to interactive channel
*
*      prtict is called to print the contents of the standard
*      print buffer to the interactive channel. it is only
*      called after prtst has set up the string for printing.
*      it does not clear the buffer.
*
*      jsr  prtict          call for print
*      (wa,wb)             destroyed
*
prtict  prc  e,0            entry point
        mov  xr,-(xs)       save xr
        mov  prbuf,xr      point to buffer
        mov  profs,wa       no of chars
        jsr  syspi         print
        ppm  prtict2       fail return
*
*      return
*
prtict1  mov  (xs)+,xr      restore xr
        exi                return
*
*      error occurred
*
prtict2  zer  erich         prevent looping
        erb  252,error on printing to interactive channel
        brn  prtict1       return
        enp                procedure prtict

```

```

*
*      prtis -- print to interactive and standard printer
*
*      prtis puts a line from the print buffer onto the
*      interactive channel (if any) and the standard printer.
*      it always prints to the standard printer but does
*      not duplicate lines if the standard printer is
*      interactive.  it clears down the print buffer.
*
*      jsr  prtis          call for printing
*      (wa,wb)            destroyed
*
prtis  prc   e,0                entry point
      bnz   prich,prts1        jump if standard printer is int.ch.
      bze   erich,prts1        skip if not doing int. error reps.
      jsr   prtich              print to interactive channel
*
*      merge and exit
*
prts1  jsr   prtnl              print to standard printer
      exi                                return
      enp                                end procedure prtis

```

```

*
*      prtin -- print an integer
*
*      prtin prints the integer value which is in the integer
*      accumulator. blocks built in dynamic storage
*      during this process are immediately deleted.
*
*      (ia)                integer value to be printed
*      jsr prtin           call to print integer
*      (ia,ra)             destroyed
*
prtln  prc   e,0            entry point
      mov  xr,-(xs)        save xr
      jsr  icbld           build integer block
      blo  xr,dnamb,pti1   jump if icblk below dynamic
      bhi  xr,dnamp,pti1   jump if above dynamic
      mov  xr,dnamp        immediately delete it
*
*      delete icblk from dynamic store
*
pti1   mov  xr,-(xs)       stack ptr for gtstg
      jsr  gtstg           convert to string
      ppm                    convert error is impossible
      mov  xr,dnamp        reset pointer to delete scblk
      jsr  prtst           print integer string
      mov  (xs)+,xr        restore entry xr
      exi                    return to prtin caller
      enp                    end procedure prtin

```

```

*
*      prtmi -- print message and integer
*
*      prtmi is used to print messages together with an integer
*      value starting in column 15 (used by the routines at
*      the end of compilation).
*
*      jsr  prtmi          call to print message and integer
*
prtmi  prc   e,0            entry point
      jsr   prtst          print string message
      mov   =prtmf,profs   set column offset
      jsr   prtln          print integer
      jsr   prtnl          print line
      exi                    return to prtmi caller
      enp                    end procedure prtmi

```

```

*
*      prtmm -- print memory used and available
*
*      prtmm is used to provide memory usage information in
*      both the end-of-compile and end-of-run statistics.
*
*      jsr  prtmm          call to print memory stats
*
prtmm  prc
      mov  dnamp,wa          next available loc
      sub  statb,wa          minus start
if .cbyt
else
      btw  wa              convert to words
fi

      mti  wa              convert to integer
      mov  =encm1,xr        point to /memory used (words)/
      jsr  prtmi            print message
      mov  dname,wa         end of memory
      sub  dnamp,wa         minus next available loc
if .cbyt
else
      btw  wa              convert to words
fi

      mti  wa              convert to integer
      mov  =encm2,xr        point to /memory available (words)/
      jsr  prtmi            print line
      exi                  return to prtmm caller
      enp                  end of procedure prtmm

```

```

*
*      prtmx  -- as prtmi with extra copy to interactive chan.
*
*      jsr  prtmx      call for printing
*      (wa,wb)         destroyed
*
prtmx  prc   e,0          entry point
      jsr   prtst        print string message
      mov   =prtmf,profs  set column offset
      jsr   prtln        print integer
      jsr   prtis        print line
      exi                    return
      enp                    end procedure prtmx

```

```

*
*      prtnl -- print new line (end print line)
*
*      prtnl prints the contents of the print buffer, resets
*      the buffer to all blanks and resets the print pointer.
*
*      jsr  prtnl          call to print line
*
prtnl  prc   r,0            entry point
      bnz   headp,prnl0    were headers printed
      jsr   prtps          no - print them
*
*      call syspr
*
prnl0  mov   xr,-(xs)       save entry xr
      mov   wa,prtsa       save wa
      mov   wb,prtsb       save wb
      mov   prbuf,xr       load pointer to buffer
      mov   profs,wa       load number of chars in buffer
      jsr   syspr          call system print routine
      ppm   prnl2          jump if failed
      lct   wa,prlnw       load length of buffer in words
      add   *schar,xr      point to chars of buffer
      mov   nullw,wb       get word of blanks
*
*      loop to blank buffer
*
prnl1  mov   wb,(xr)+      store word of blanks, bump ptr
      bct   wa,prnl1       loop till all blanked
*
*      exit point
*
      mov   prtsb,wb       restore wb
      mov   prtsa,wa       restore wa
      mov   (xs)+,xr       restore entry xr
      zer   profs          reset print buffer pointer
      exi                    return to prtnl caller
*
*      file full or no output file for load module
*
prnl2  bnz   prtef,prnl3   jump if not first time
      mnz   prtef          mark first occurrence
      erb   253,print limit exceeded on standard output channel
*
*      stop at once
*
prnl3  mov   =nini8,wb     ending code
      mov   kvstn,wa       statement number
      mov   r$fcbl,xl      get fcblk chain head
      jsr   sysej          stop
      enp                    end procedure prtnl

```

```

*
*      prtnm -- print variable name
*
*      prtnm is used to print a character representation of the
*      name of a variable (not a value of datatype name)
*      names of pseudo-variables may not be passed to prtnm.
*
*      (x1)          name base
*      (wa)          name offset
*      jsr prtnm      call to print name
*      (wb,wc,ra)     destroyed
*
prtnm  prc  r,0          entry point (recursive, see prtv1)
        mov  wa,-(xs)     save wa (offset is collectable)
        mov  xr,-(xs)     save entry xr
        mov  x1,-(xs)     save name base
        bhi  x1,state,prn02  jump if not natural variable
*
*      here for natural variable name, recognized by the fact
*      that the name base points into the static area.
*
        mov  x1,xr        point to vrb1k
        jsr  prtvn        print name of variable
*
*      common exit point
*
prn01  mov  (xs)+,x1      restore name base
        mov  (xs)+,xr     restore entry value of xr
        mov  (xs)+,wa     restore wa
        exi              return to prtnm caller
*
*      here for case of non-natural variable
*
prn02  mov  wa,wb        copy name offset
        bne  (x1),=b$pd,prn03  jump if array or table
*
*      for program defined datatype, prt fld name, left paren
*
        mov  pddfp(x1),xr  load pointer to dfblk
        add  wa,xr        add name offset
        mov  pdfof(xr),xr  load vrb1k pointer for field
        jsr  prtvn        print field name
        mov  =ch$pp,wa     load left paren
        jsr  prtch        print character

```



```

*
*      prtnm (continued)
*
*      now we print an identifying name for the object if one
*      can be found. the following code searches for a natural
*      variable which contains this object as value. if such a
*      variable is found, its name is printed, else the value
*      of the object (as printed by prtvl) is used instead.
*
*      first we point to the parent tbbk if this is the case of
*      a table element. to do this, chase down the trnxt chain.
*
prn03  bne  (xl),=b$tet,prn04      jump if we got there (or not te)
      mov  tenxt(xl),xl          else move out on chain
      brn  prn03                 and loop back
*
*      now we are ready for the search. to speed things up in
*      the case of calls from dump where the same name base
*      will occur repeatedly while dumping an array or table,
*      we remember the last vrbk pointer found in prnmv. so
*      first check to see if we have this one again.
*
prn04  mov  prnmv,xr              point to vrbk we found last time
      mov  hshtb,wa              point to hash table in case not
      brn  prn07                 jump into search for special check
*
*      loop through hash slots
*
prn05  mov  wa,xr                copy slot pointer
      ica  wa                    bump slot pointer
      sub  *vrnxt,xr             introduce standard vrbk offset
*
*      loop through vrblks on one hash chain
*
prn06  mov  vrnxt(xr),xr          point to next vrbk on hash chain
*
*      merge here first time to check block we found last time
*
prn07  mov  xr,wc                copy vrbk pointer
      bze  wc,prn09              jump if chain end (or prnmv zero)

```

```

*
*      prtnm (continued)
*
*      loop to find value (chase down possible trblk chain)
*
prn08  mov  vrval(xr),xr          load value
      beq  (xr),=b$trt,prn08      loop if that was a trblk
*
*      now we have the value, is this the block we want
*
      beq  xr,xl,prn10            jump if this matches the name base
      mov  wc,xr                  else point back to that vrbk
      brn  prn06                  and loop back
*
*      here to move to next hash slot
*
prn09  blt  wa,hshte,prn05        loop back if more to go
      mov  xl,xr                  else not found, copy value pointer
      jsr  prtv1                  print value
      brn  prn11                  and merge ahead
*
*      here when we find a matching entry
*
prn10  mov  wc,xr                  copy vrbk pointer
      mov  xr,prnmv              save for next time in
      jsr  prtvn                  print variable name
*
*      merge here if no entry found
*
prn11  mov  (xl),wc               load first word of name base
      bne  wc,=b$pdtd,prn13      jump if not program defined
*
*      for program defined datatype, add right paren and exit
*
      mov  =ch$rp,wa              load right paren, merge
*
*      merge here to print final right paren or bracket
*
prn12  jsr  prtch                  print final character
      mov  wb,wa                  restore name offset
      brn  prn01                  merge back to exit

```

```

*
*      prtnm (continued)
*
*      here for array or table
*
prn13  mov  =ch$bb,wa          load left bracket
      jsr  prtch              and print it
      mov  (xs),xl            restore block pointer
      mov  (xl),wc            load type word again
      bne  wc,=b$tet,prn15     jump if not table

*
*      here for table, print subscript value
*
      mov  tesub(xl),xr        load subscript value
      mov  wb,xl              save name offset
      jsr  prtvl              print subscript value
      mov  xl,wb              restore name offset

*
*      merge here from array case to print right bracket
*
prn14  mov  =ch$rb,wa          load right bracket
      brn  prn12              merge back to print it

*
*      here for array or vector, to print subscript(s)
*
prn15  mov  wb,wa              copy name offset
      btw  wa                  convert to words
      beq  wc,=b$art,prn16     jump if arblk

*
*      here for vector
*
      sub  =vcv1b,wa          adjust for standard fields
      mti  wa                  move to integer accum
      jsr  prtln              print linear subscript
      brn  prn14              merge back for right bracket

```

```

*
*      prtnm (continued)
*
*      here for array. first calculate absolute subscript
*      offsets by successive divisions by the dimension values.
*      this must be done right to left since the elements are
*      stored row-wise. the subscripts are stacked as integers.
*
prn16  mov  arofs(xl),wc          load length of bounds info
      ica  wc                    adjust for arpro field
      btw  wc                    convert to words
      sub  wc,wa                 get linear zero-origin subscript
      mti  wa                    get integer value
      lct  wa,arndm(xl)          set num of dimensions as loop count
      add  arofs(xl),xl          point past bounds information
      sub  *arlbld,xl            set ok offset for proper ptr later
*
*      loop to stack subscript offsets
*
prn17  sub  *ardms,xl            point to next set of bounds
      sti  prnsi                 save current offset
      rmi  ardim(xl)             get remainder on dividing by dimens
      mfi  -(xs)                 store on stack (one word)
      ldi  prnsi                 reload argument
      dvi  ardim(xl)             divide to get quotient
      bct  wa,prn17              loop till all stacked
      zer  xr                    set offset to first set of bounds
      lct  wb,arndm(xl)          load count of dims to control loop
      brn  prn19                 jump into print loop
*
*      loop to print subscripts from stack adjusting by adding
*      the appropriate low bound value from the arblk
*
prn18  mov  =ch$cm,wa            load a comma
      jsr  prtch                 print it
*
*      merge here first time in (no comma required)
*
prn19  mti  (xs)+                load subscript offset as integer
      add  xr,xl                 point to current lbd
      adi  arlbld(xl)            add lbd to get signed subscript
      sub  xr,xl                 point back to start of arblk
      jsr  prtln                 print subscript
      add  *ardms,xr             bump offset to next bounds
      bct  wb,prn18              loop back till all printed
      brn  prn14                 merge back to print right bracket
      enp                       end procedure prtnm

```

```

*
*      prtnv -- print name value
*
*      prtnv is used by the trace and dump routines to print
*      a line of the form
*
*      name = value
*
*      note that the name involved can never be a pseudo-var
*
*      (xl)          name base
*      (wa)          name offset
*      jsr prtnv      call to print name = value
*      (wb,wc,ra)     destroyed
*
prtnv  prc   e,0          entry point
      jsr   prtnm        print argument name
      mov   xr,-(xs)      save entry xr
      mov   wa,-(xs)      save name offset (collectable)
      mov   =tmbeb,xr     point to blank equal blank
      jsr   prtst        print it
      mov   xl,xr        copy name base
      add   wa,xr        point to value
      mov   (xr),xr       load value pointer
      jsr   prtvl        print value
      jsr   prtnl        terminate line
      mov   (xs)+,wa      restore name offset
      mov   (xs)+,xr      restore entry xr
      exi                return to caller
      enp                end procedure prtnv

```

```

*
*      prtpg  -- print a page throw
*
*      prints a page throw or a few blank lines on the standard
*      listing channel depending on the listing options chosen.
*
*      jsr  prtpg          call for page eject
*
prtpg  prc   e,0              entry point
      beq   stage,=stgxt,prp01  jump if execution time
      bze   lstlc,prp06         return if top of page already
      zer   lstlc              clear line count
*
*      check type of listing
*
prp01  mov   xr,-(xs)          preserve xr
      bnz   prstd,prp02         eject if flag set
      bnz   prich,prp03         jump if interactive listing channel
      bze   precl,prp03         jump if compact listing
*
*      perform an eject
*
prp02  jsr   sysep              eject
      brn   prp04              merge
*
*      compact or interactive channel listing. cant print
*      blanks until check made for headers printed and flag set.
*
*
prp03  mov   headp,xr          remember headp
      mnz   headp              set to avoid repeated prtpg calls
      jsr   prtln              print blank line
      jsr   prtln              print blank line
      jsr   prtln              print blank line
      mov   =num03,lstlc       count blank lines
      mov   xr,headp           restore header flag

```

<pre> * * prptg (continued) * * print the heading * prp04 bnz headp,prp05 mnz headp mov xl,-(xs) mov =headr,xr jsr prtst jsr sysid jsr prtst jsr prtnl mov xl,xr jsr prtst jsr prtnl jsr prtnl jsr prtnl add =num04,1stlc mov (xs)+,xl * * merge if header not printed * prp05 mov (xs)+,xr * * return * prp06 exi enp </pre>	<pre> jump if header listed mark headers printed keep xl point to listing header place it get system identification append extra chars print it extra header line place it print it print a blank and another four header lines printed restore xl restore xr return end procedure prptg </pre>
--	---

```

*
*      prtps - print page with test for standard listing option
*
*      if the standard listing option is selected, insist that
*      an eject be done
*
*      jsr  prtps          call for eject
*
prtps  prc   e,0           entry point
       mov  prsto,prstd    copy option flag
       jsr  prtpg          print page
       zer  prstd          clear flag
       exi                    return
       enp                    end procedure prtps

```



```

*
*      prtsn -- print statement number
*
*      prtsn is used to initiate a print trace line by printing
*      asterisks and the current statement number. the actual
*      format of the output generated is.
*
*      ***nnnnn*** iii....iiii
*
*      nnnnn is the statement number with leading zeros replaced
*      by asterisks (e.g. *****9****)
*
*      iii...iii represents a variable length output consisting
*      of a number of letter i characters equal to fnclevel.
*
*      jsr  prtsn          call to print statement number
*      (wc)                destroyed
*
prtsn  prc   e,0           entry point
      mov  xr,-(xs)       save entry xr
      mov  wa,prsna       save entry wa
      mov  =tmasb,xr      point to asterisks
      jsr  prtst          print asterisks
      mov  =num04,profs   point into middle of asterisks
      mti  kvstn          load statement number as integer
      jsr  prtln          print integer statement number
      mov  =prsnf,profs   point past asterisks plus blank
      mov  kvfnc,xr       get fnclevel
      mov  =ch$li,wa      set letter i
*
*      loop to generate letter i fnclevel times
*
prsn1  bze  xr,prsn2      jump if all set
      jsr  prtch          else print an i
      dcv  xr             decrement counter
      brn  prsn1          loop back
*
*      merge with all letter i characters generated
*
prsn2  mov  =ch$b1,wa     get blank
      jsr  prtch          print blank
      mov  prsna,wa       restore entry wa
      mov  (xs)+,xr       restore entry xr
      exi                return to prtsn caller
      enp                end procedure prtsn

```

```

*
*      prtst -- print string
*
*      prtst places a string of characters in the print buffer
*
*      see prtnl for global locations used
*
*      note that the first word of the block (normally b$scl)
*      is not used and need not be set correctly (see prtvn)
*
*      (xr)                string to be printed
*      jsr  prtst           call to print string
*      (profs)             updated past chars placed
*
prtst  prc   r,0                entry point
      bnz   headp,prst0        were headers printed
      jsr   prtps              no - print them
*
*      call syspr
*
prst0  mov   wa,prsva           save wa
      mov   wb,prsvb           save wb
      zer   wb                 set chars printed count to zero
*
*      loop to print successive lines for long string
*
prst1  mov   sclen(xr),wa       load string length
      sub   wb,wa              subtract count of chars already out
      bze   wa,prst4           jump to exit if none left
      mov   xl,-(xs)           else stack entry xl
      mov   xr,-(xs)           save argument
      mov   xr,xl              copy for eventual move
      mov   prlen,xr           load print buffer length
      sub   profs,xr           get chars left in print buffer
      bnz   xr,prst2           skip if room left on this line
      jsr   prtnl              else print this line
      mov   prlen,xr           and set full width available

```

```

*
*      prtst (continued)
*
*      here with chars to print and some room in buffer
*
prst2  blo   wa,xr,prst3          jump if room for rest of string
      mov   xr,wa                else set to fill line
*
*      merge here with character count in wa
*
prst3  mov   prbuf,xr            point to print buffer
      plc   xl,wb                point to location in string
      psc   xr,profs             point to location in buffer
      add   wa,wb                bump string chars count
      add   wa,profs             bump buffer pointer
      mov   wb,prsvc             preserve char counter
      mvc                   move characters to buffer
      mov   prsvc,wb             recover char counter
      mov   (xs)+,xr             restore argument pointer
      mov   (xs)+,xl             restore entry xl
      brn   prst1                loop back to test for more
*
*      here to exit after printing string
*
prst4  mov   prsvb,wb            restore entry wb
      mov   prsva,wa            restore entry wa
      exi                      return to prtst caller
      enp                      end procedure prtst

```

```

*
*      prttr -- print to terminal
*
*      called to print contents of standard print buffer to
*      online terminal. clears buffer down and resets profs.
*
*      jsr  prttr          call for print
*      (wa,wb)            destroyed
*
prttr  prc   e,0           entry point
      mov   xr,-(xs)      save xr
      jsr   prtcl         print buffer contents
      mov   prbuf,xr      point to print bfr to clear it
      lct   wa,prlnw      get buffer length
      add   *schar,xr     point past scblk header
      mov   nullw,wb      get blanks
*
*      loop to clear buffer
*
prttl  mov   wb,(xr)+     clear a word
      bct   wa,prttl      loop
      zer   profs         reset profs
      mov   (xs)+,xr      restore xr
      exi                    return
      enp                    end procedure prttr

```

```

*
*      prtv1 -- print a value
*
*      prtv1 places an appropriate character representation of
*      a data value in the print buffer for dump/trace use.
*
*      (xr)                value to be printed
*      jsr  prtv1          call to print value
*      (wa,wb,wc,ra)      destroyed
*
prtv1  prc   r,0                entry point, recursive
        mov  xl,-(xs)          save entry xl
        mov  xr,-(xs)          save argument
        chk                     check for stack overflow

*
*      loop back here after finding a trap block (trblk)
*
prv01  mov  idval(xr),prvsi      copy idval (if any)
        mov  (xr),xl           load first word of block
        lei   xl               load entry point id
        bsw  xl,bl$$t,prv02     switch on block type
        iff  bl$tr,prv04        trblk
        iff  bl$ar,prv05        arblk
        iff  bl$ic,prv08        icblk
        iff  bl$nm,prv09        nmblk
        iff  bl$pd,prv10        pdblk
if .cnra
else
        iff  bl$rc,prv08        rcblk
fi

        iff  bl$sc,prv11        scblk
        iff  bl$se,prv12        seblk
        iff  bl$tb,prv13        tbblk
        iff  bl$vc,prv13        vcblk
if .cnbf
else
        iff  bl$bc,prv15        bcblk
fi

        esw                     end of switch on block type

*
*      here for blocks for which we just print datatype name
*
prv02  jsr   dtype             get datatype name
        jsr   prtst            print datatype name

*
*      common exit point
*
prv03  mov  (xs)+,xr           reload argument
        mov  (xs)+,xl         restore xl
        exi                     return to prtv1 caller

```

```

*
*      here for trblk
*
prv04  mov  trval(xr),xr      load real value
      brn  prv01             and loop back

```

```

*
*      prtv1 (continued)
*
*      here for array (arblk)
*
*      print array ( prototype ) blank number idval
*
prv05  mov  xr,x1                preserve argument
      mov  =scarr,xr            point to datatype name (array)
      jsr  prtst                print it
      mov  =ch$pp,wa            load left paren
      jsr  prtch                print left paren
      add  arofs(x1),x1          point to prototype
      mov  (x1),xr              load prototype
      jsr  prtst                print prototype
*
*      vcblk, tbblk, bcblk merge here for ) blank number idval
*
prv06  mov  =ch$rp,wa            load right paren
      jsr  prtch                print right paren
*
*      pdblk merges here to print blank number idval
*
prv07  mov  =ch$bl,wa            load blank
      jsr  prtch                print it
      mov  =ch$num,wa            load number sign
      jsr  prtch                print it
      mti  prvsi                get idval
      jsr  prtln                print id number
      brn  prv03                back to exit
*
*      here for integer (icblk), real (rcblk)
*
*      print character representation of value
*
prv08  mov  xr,-(xs)             stack argument for gtstg
      jsr  gtstg                convert to string
      ppm                      error return is impossible
      jsr  prtst                print the string
      mov  xr,dnamp              delete garbage string from storage
      brn  prv03                back to exit

```

```

*
*      prtv1 (continued)
*
*      name (nmb1k)
*
*      for pseudo-variable, just print datatype name (name)
*      for all other names, print dot followed by name rep
*
prv09  mov  nmbas(xr),x1          load name base
      mov  (x1),wa              load first word of block
      beq  wa,=b$kvt,prv02      just print name if keyword
      beq  wa,=b$evt,prv02      just print name if expression var
      mov  =ch$dt,wa           else get dot
      jsr  prtch                and print it
      mov  nmofs(xr),wa         load name offset
      jsr  prtnm                print name
      brn  prv03                back to exit

*
*      program datatype (pdbl1k)
*
*      print datatype name ch$b1 ch$nm idval
*
prv10  jsr  dtype              get datatype name
      jsr  prtst                print datatype name
      brn  prv07                merge back to print id

*
*      here for string (scbl1k)
*
*      print quote string-characters quote
*
prv11  mov  =ch$sq,wa          load single quote
      jsr  prtch                print quote
      jsr  prtst                print string value
      jsr  prtch                print another quote
      brn  prv03                back to exit

```



```

*
*      prtv1 (continued)
*
*      here for simple expression (seblk)
*
*      print asterisk variable-name
*
prv12  mov  =ch$as,wa          load asterisk
      jsr  prtch              print asterisk
      mov  sevar(xr),xr       load variable pointer
      jsr  prtvn              print variable name
      brn  prv03              jump back to exit

*
*      here for table (tbblk) and array (vcblk)
*
*      print datatype ( prototype ) blank number idval
*
prv13  mov  xr,x1              preserve argument
      jsr  dtype              get datatype name
      jsr  prtst              print datatype name
      mov  =ch$pp,wa          load left paren
      jsr  prtch              print left paren
      mov  tble(xl),wa        load length of block (=vclen)
      btw  wa                  convert to word count
      sub  =tbsi$,wa          allow for standard fields
      beq  (xl),=b$tb,prv14    jump if table
      add  =vctbd,wa          for vcblk, adjust size

*
*      print prototype
*
prv14  mti  wa                move as integer
      jsr  prtln              print integer prototype
      brn  prv06              merge back for rest
if .cnbf
else

```

	*		
	*	prtv1 (continued)	
	*		
	*	here for buffer (bcblk)	
	*		
prv15	mov	xr,x1	preserve argument
	mov	=scbuf,xr	point to datatype name (buffer)
	jsr	prtst	print it
	mov	=ch\$pp,wa	load left paren
	jsr	prtch	print left paren
	mov	bcbuf(x1),xr	point to bfbk
	mti	bfalc(xr)	load allocation size
	jsr	prtln	print it
	mov	=ch\$cm,wa	load comma
	jsr	prtch	print it
	mti	bcclen(x1)	load defined length
	jsr	prtln	print it
	brn	prv06	merge to finish up
<i>fi</i>			
	enp		end procedure prtv1

```

*
*      prtvn -- print natural variable name
*
*      prtvn prints the name of a natural variable
*
*      (xr)                pointer to vrbk
*      jsr  prtvn          call to print variable name
*
prtvn  prc   e,0                entry point
       mov  xr,-(xs)           stack vrbk pointer
       add  *vrsof,xr          point to possible string name
       bnz  sclen(xr),prvn1    jump if not system variable
       mov  vrsvo(xr),xr       point to svblk with name
*
*      merge here with dummy scblk pointer in xr
*
prvn1  jsr  prtst              print string name of variable
       mov  (xs)+,xr           restore vrbk pointer
       exi                      return to prtvn caller
       enp                      end procedure prtvn
if .cnra
else

```

```

*
*      rcblk -- build a real block
*
*      (ra)          real value for rcblk
*      jsr rcblk     call to build real block
*      (xr)          pointer to result rcblk
*      (wa)          destroyed
*
rcblk  prc   e,0          entry point
       mov  dnamp,xr      load pointer to next available loc
       add  *rcsi$,xr     point past new rcblk
       blo  xr,dname,rcbl1  jump if there is room
       mov  *rcsi$,wa     else load rcblk length
       jsr  alloc        use standard allocator to get block
       add  wa,xr         point past block to merge
*
*      merge here with xr pointing past the block obtained
*
rcbl1  mov  xr,dnamp      set new pointer
       sub  *rcsi$,xr     point back to start of block
       mov  =b$rc1,(xr)   store type word
       str  rcval(xr)     store real value in rcblk
       exi                return to rcblk caller
       enp                end procedure rcblk

```

fi

```

*
*      readr -- read next source image at compile time
*
*      readr is used to read the next source image. to process
*      continuation cards properly, the compiler must read one
*      line ahead. thus readr does not destroy the current image
*      see also the nexts routine which actually gets the image.
*
*      jsr  readr          call to read next image
*      (xr)                ptr to next image (0 if none)
*      (r$cni)             copy of pointer
*      (wa,wb,wc,xl)       destroyed
*
readr  prc  e,0             entry point
      mov  r$cni,xr        get ptr to next image
      bnz  xr,read3        exit if already read
if .cinc
      bnz  cnind,reada     if within include file
fi
      bne  stage,=stgic,read3  exit if not initial compile
reada  mov  cswin,wa       max read length
      zer  xl              clear any dud value in xl
      jsr  alocs           allocate buffer
      jsr  sysrd           read input image
      ppm  read4           jump if eof or new file name
      icv  rdnlm           increment next line number
if .cpol
      dcv  polct           test if time to poll interface
      bnz  polct,read0     not yet
      zer  wa              =0 for poll
      mov  rdnlm,wb        line number
      jsr  syspl           allow interactive access
      err  syspl           allow interactive access
      ppm                single step
      ppm                expression evaluation
      mov  wa,polcs        new countdown start value
      mov  wa,polct        new counter value
fi
read0  ble  sclen(xr),cswin,read1  use smaller of string lnth ...
      mov  cswin,sclen(xr)  ... and xxx of -inxxx
*
*      perform the trim
*
read1  mnz  wb             set trimr to perform trim
      jsr  trimr           trim trailing blanks
*
*      merge here after read
*
read2  mov  xr,r$cni       store copy of pointer
*

```

<pre> * merge here if no read attempted * read3 exi if.csfm * * here on end of file or new source file name. * if this is a new source file name, the r\$sfn table will * be augmented with a new table entry consisting of the * current compiler statement number as subscript, and the * file name as value. * read4 bze sclen(xr),read5 zer wb mov wb,rdnln jsr trimr jsr newfn brn reada * * here on end of file * read5 mov xr,dnamp if.cinc bze cnind,read6 zer xl jsr sysif ppm sysif mov cnind,wa add =vcvlb,wa wtb wa mov r\$ifa,xr add wa,xr mov (xr),r\$sfc mov =nulls,(xr) mov r\$ifl,xr add wa,xr mov (xr),xl ldi icval(xl) mfi rdlnln mov =inton,(xr) dcw cnind mov cmpsn,wb icv wb mti wb jsr icbld mov r\$sfn,xl mnz wb jsr tfind ppm mov r\$sfc,teval(xl) beq stage,=stgic,reada bnz cnind,reada </pre>	<pre> return to readr caller jump if true end of file new source file name restart line counter for new file remove unused space in block record new file name now reissue read for record data pop unused scblk jump if not within an include file eof within include file switch stream back to previous file switch stream back to previous file restore prev line number, file name vector offset in words convert to bytes file name array ptr to element change source file name release scblk line number array ptr to element icblk containing saved line number line number integer change source line number release icblk decrement nesting level current statement number anticipate end of previous stmt convert to integer build icblk for stmt number file name table lookup statement number by name allocate new teblk always possible to allocate block record file name as entry value if initial compile, reissue read still reading from include file </pre>
--	--

<pre> * * * outer nesting of execute-time compile of -include * resume with any string remaining prior to -include. * mov r\$ici,xl zer r\$ici mov cnsil,wa mov cnspt,wb sub wb,wa mov wa,scnil zer scnpt jsr sbstr mov xr,r\$cim brn read2 fi else * * here on end of file * read4 mov xr,dnamp if .cinc bze cnind,read6 zer xl jsr sysif ppm sysif dcv cnind brn reada fi fi read6 zer xr brn read2 enp </pre>	<pre> restore code argument string release original string get length of string offset of characters left number of characters left set new scan length scan from start of substring create substring of remainder set scan image return pop unused scblk jump if not within an include file eof within include file switch stream back to previous file switch stream back to previous file decrement nesting level reissue read from previous stream zero ptr as result merge end procedure readr </pre>
--	---

if .c370

```

*
*      sbool-- setup for boolean operations on strings
*
*      1(xs)          first argument (if two)
*      0(xs)          second argument
*      (wb)           number of arguments
*                     zero = one arguments
*                     non-zero = two arguments
*
*      jsr  sbool      call to perform operation
*      ppm  loc         transfer loc for arg1 not string
*      ppm  loc         transfer loc for arg2 not string
*      ppm  loc         transfer loc arg lengths not equal
*      ppm  loc         transfer loc if null string args
*      (xs)            arguments popped, result stacked
*      (xl)            arg 1 chars to operate upon
*      (xr)            copy of arg 2 if two arguments
*      (wa)            no. of characters to process
*      (wc)            no. of words to process (bct ready)
*      (wb)            destroyed
*
*      the second argument string block is copied to a result
*      block, and pointers returned to allow the caller to
*      proceed with the desired operation if two arguments.
*
*      operations like and/or that do not alter the trailing
*      zeros in the last word of the string block can be
*      performed a word at a time.  operations such as compl
*      may either be performed a character at a time or will
*      have to adjust the last word if done a word at a time.
*
sbool  prc   n,3          entry point
       jsr   gtstg        convert second arg to string
       ppm   sbl05        jump if second arg not string
       mov   xr,xl        else save pointer
       mov   wa,wc        and length
       bze   wb,sbl01     only one argument if compl
       jsr   gtstg        convert first argument to string
       ppm   sbl04        jump if not string
       bne   wa,wc,sbl03  jump if lengths unequal
*
*      merge here if only one argument
*
sbl01  mov   xr,-(xs)     stack first argument
       bze   wc,sbl02     return null if null argument
       jsr   alocs        allocate space for copy
       bze   wb,sbl06     only one argument if compl
       mov   wc,wa        string length
       mov   xr,wb        save address of copy
       ctb   wa,schar     get scblk length
       mvw                   move arg2 contents to copy
       mov   wb,xr        reload result ptr

```


sbl06	mov (xs)+,xl	reload first argument
	mov xr,-(xs)	stack result
	add *schar,xl	point to characters in arg 1 block
	add *schar,xr	point to characters in result block
	mov wc,wa	character count
	ctw wc,0	number of words of characters
	lct wc,wc	prepare counter
	exi wc,wc	prepare counter
	*	
	* here if null arguments	
	*	
sbl02	exi 4	take null string exit
	*	
	* here if argument lengths unequal	
	*	
sbl03	exi 3	take unequal length error exit
	*	
	* here if first arg is not a string	
	*	
sbl04	exi 1	take bad first arg error exit
	*	
	* here for second arg not a string	
	*	
sbl05	exi 2	take bad second arg error exit
	enp	end procedure sbool

fi

```

*
*      sbstr -- build a substring
*
*      (xl)          ptr to scblk/bfblk with chars
*      (wa)          number of chars in substring
*      (wb)          offset to first char in scblk
*      jsr  sbstr     call to build substring
*      (xr)          ptr to new scblk with substring
*      (xl)          zero
*      (wa,wb,wc,xl,ia)  destroyed
*
*      note that sbstr is called with a dummy string pointer
*      (pointing into a vrblk or svblk) to copy the name of a
*      variable as a standard string value.
*
sbstr  prc   e,0          entry point
      bze   wa,sbst2     jump if null substring
      jsr   alocs        else allocate scblk
      mov   wc,wa         move number of characters
      mov   xr,wc         save ptr to new scblk
      plc   xl,wb         prepare to load chars from old blk
      psc   xr           prepare to store chars in new blk
      mvc
      mov   wc,xr         move characters to new string
                          then restore scblk pointer
*
*      return point
*
sbst1  zer   xl          clear garbage pointer in xl
      exi
*
*      here for null substring
*
sbst2  mov   =nulls,xr   set null string as result
      brn   sbst1       return
      enp               end procedure sbstr

```

```

*
*      stgcc -- compute counters for stmt startup testing
*
*      jsr  stgcc          call to recompute counters
*      (wa,wb)            destroyed
*
*      on exit, stmcs and stmct contain the counter value to
*      tested in stmgo.
*
*
stgcc  prc
if .cpol
    mov  polcs,wa          assume no profiling or stcount tracing
    mov  =num01,wb        poll each time polcs expires
else
    mov  cfp$m,wa         assume no profiling or stcount tracing
fi

    ldi  kvstl            get stmt limit
    bnz  kvpfl,stgc1      jump if profiling enabled
    ilt  stgc3            no stcount tracing if negative
    bze  r$stc,stgc2      jump if not stcount tracing

*
*      here if profiling or if stcount tracing enabled
*
if .cpol
stgc1  mov  wa,wb          count polcs times within stmgo
    mov  =num01,wa        break out of stmgo on each stmt
else
stgc1  mov  =num01,wa      break out of stmgo on each stmt
fi

    brn  =num01,wa        break out of stmgo on each stmt

*
*      check that stmcs does not exceed kvstl
*
stgc2  mti  wa            breakout count start value
    sbi  kvstl           proposed stmcs minus stmt limit
    ile  stgc3           jump if stmt count does not limit
    ldi  kvstl           stlimit limits breakcount count
    mfi  wa              use it instead

*
*      re-initialize counter
*
stgc3  mov  wa,stmcs      update breakout count start value
    mov  wa,stmct        reset breakout counter
if .cpol
    mov  wa,stmct        reset breakout counter
fi

    exi  wa,stmct        reset breakout counter

```

```

*
*      tfind -- locate table element
*
*      (xr)                subscript value for element
*      (xl)                pointer to table
*      (wb)                zero by value, non-zero by name
*      jsr  tfind          call to locate element
*      ppm  loc            transfer location if access fails
*      (xr)                element value (if by value)
*      (xr)                destroyed (if by name)
*      (xl,wa)             teblk name (if by name)
*      (xl,wa)             destroyed (if by value)
*      (wc,ra)             destroyed
*
*      note that if a call by value specifies a non-existent
*      subscript, the default value is returned without building
*      a new teblk.
*
tfind  prc  e,1            entry point
      mov  wb,-(xs)        save name/value indicator
      mov  xr,-(xs)        save subscript value
      mov  xl,-(xs)        save table pointer
      mov  tble(xl),wa      load length of tbbk
      btw  wa              convert to word count
      sub  =tbbuk,wa        get number of buckets
      mti  wa              convert to integer value
      sti  tfnsi           save for later
      mov  (xr),xl         load first word of subscript
      lei  xl              load block entry id (bl$xx)
      bsw  xl,bl$$d,tfn00   switch on block type
      iff  bl$ic,tfn02      jump if integer
if .cnra
else
      iff  bl$rc,tfn02      real
fi

      iff  bl$p0,tfn03      jump if pattern
      iff  bl$p1,tfn03      jump if pattern
      iff  bl$p2,tfn03      jump if pattern
      iff  bl$nm,tfn04      jump if name
      iff  bl$sc,tfn05      jump if string
      esw                  end switch on block type

*
*      here for blocks for which we use the second word of the
*      block as the hash source (see block formats for details).
*
tfn00  mov  1(xr),wa        load second word
*
*      merge here with one word hash source in wa
*
tfn01  mti  wa              convert to integer
      brn  tfn06            jump to merge

```

```

*
*      tfind (continued)
*
*      here for integer or real
*      possibility of overflow exist on twos complement
*      machine if hash source is most negative integer or is
*      a real having the same bit pattern.
*
*
tfn02  ldi    1(xr)                load value as hash source
       ige    tfn06                ok if positive or zero
       ngi                    make positive
       iov    tfn06                clear possible overflow
       brn    tfn06                merge
*
*      for pattern, use first word (pcode) as source
*
tfn03  mov    (xr),wa              load first word as hash source
       brn    tfn01                merge back
*
*      for name, use offset as hash source
*
tfn04  mov    nmofs(xr),wa         load offset as hash source
       brn    tfn01                merge back
*
*      here for string
*
tfn05  jsr    hashes               call routine to compute hash
*
*      merge here with hash source in (ia)
*
tfn06  rmi    tfnsi                compute hash index by remaindering
       mfi    wc                  get as one word integer
       wtb    wc                  convert to byte offset
       mov    (xs),xl              get table ptr again
       add    wc,xl                point to proper bucket
       mov    tbbuk(xl),xr         load first teblk pointer
       beq    xr,(xs),tfn10        jump if no teblks on chain
*
*      loop through teblks on hash chain
*
tfn07  mov    xr,wb                save teblk pointer
       mov    tesub(xr),xr         load subscript value
       mov    1(xs),xl             load input argument subscript val
       jsr    ident                compare them
       ppm    tfn08                jump if equal (ident)
*
*      here if no match with that teblk
*
       mov    wb,xl                restore teblk pointer

```

mov	tenxt(xl),xr	point to next teblk on chain
bne	xr,(xs),tfn07	jump if there is one
*		
*	here if no match with any teblk on chain	
*		
mov	*tenxt,wc	set offset to link field (xl base)
brn	tfn11	jump to merge

```

*
*      tfind (continued)
*
*      here we have found a matching element
*
tfn08  mov  wb,xl                restore teblk pointer
      mov  *teval,wa            set teblk name offset
      mov  2(xs),wb             restore name/value indicator
      bnz  wb,tfn09             jump if called by name
      jsr  acess                else get value
      ppm  tfn12                jump if reference fails
      zer  wb                   restore name/value indicator

*
*      common exit for entry found
*
tfn09  add  *num03,xs            pop stack entries
      exi                      return to tfind caller

*
*      here if no teblks on the hash chain
*
tfn10  add  *tbbuk,wc            get offset to bucket ptr
      mov  (xs),xl              set tbbuk ptr as base

*
*      merge here with (xl,wc) base,offset of final link
*
tfn11  mov  (xs),xr              tbbuk pointer
      mov  tbinv(xr),xr          load default value in case
      mov  2(xs),wb             load name/value indicator
      bze  wb,tfn09             exit with default if value call
      mov  xr,wb                 copy default value

*
*      here we must build a new teblk
*
      mov  *tesi$,wa            set size of teblk
      jsr  alloc                 allocate teblk
      add  wc,xl                 point to hash link
      mov  xr,(xl)               link new teblk at end of chain
      mov  =b$tet,(xr)           store type word
      mov  wb,teval(xr)          set default as initial value
      mov  (xs)+,tenxt(xr)        set tbbuk ptr to mark end of chain
      mov  (xs)+,tesub(xr)        store subscript value
      mov  (xs)+,wb              restore name/value indicator
      mov  xr,xl                 copy teblk pointer (name base)
      mov  *teval,wa             set offset
      exi                       return to caller with new teblk

*
*      acess fail return
*
tfn12  exi  1                   alternative return
      enp                       end procedure tfind

```

```

*
*      tmake -- make new table
*
*      (xl)          initial lookup value
*      (wc)          number of buckets desired
*      jsr  tmake     call to make new table
*      (xr)          new table
*      (wa,wb)       destroyed
*
tmake  prc
      mov  wc,wa          copy number of headers
      add  =tbsi$,wa      adjust for standard fields
      wtb  wa             convert length to bytes
      jsr  alloc          allocate space for tbbk
      mov  xr,wb          copy pointer to tbbk
      mov  =b$tbtt,(xr)+  store type word
      zer  (xr)+          zero id for the moment
      mov  wa,(xr)+       store length (tbten)
      mov  xl,(xr)+       store initial lookup value
      lct  wc,wc          set loop counter (num headers)

*
*      loop to initialize all bucket pointers
*
tma01  mov  wb,(xr)+      store tbbk ptr in bucket header
      bct  wc,tma01      loop till all stored
      mov  wb,xr          recall pointer to tbbk
      exi  wb,xr          recall pointer to tbbk
      enp  wb,xr          recall pointer to tbbk

```



```

*
*      vmake -- create a vector
*
*      (wa)          number of elements in vector
*      (xl)          default value for vector elements
*      jsr  vmake     call to create vector
*      ppm  loc       if vector too large
*
*      (xr)          pointer to vcbk
*      (wa,wb,wc,xl) destroyed
*
vmake  prc  e,1          entry point
      lct  wb,wa         copy elements for loop later on
      add  =vcsi$,wa     add space for standard fields
      wtb  wa            convert length to bytes
      bgt  wa,mxlen,vmak2 fail if too large
      jsr  alloc         allocate space for vcbk
      mov  =b$vct,(xr)   store type word
      zer  idval(xr)     initialize idval
      mov  wa,vclen(xr)  set length
      mov  xl,wc         copy default value
      mov  xr,xl         copy vcbk pointer
      add  *vcvls,xl     point to first element value
*
*      loop to set vector elements to default value
*
vmak1  mov  wc,(xl)+     store one value
      bct  wb,vmak1     loop till all stored
      exi                    success return
*
*      here if desired vector size too large
*
vmak2  exi  1            fail return
      enp  1            fail return

```

```

*
*      scane -- scan an element
*
*      scane is called at compile time (by expan ,cmpil,cncrd)
*      to scan one element from the input image.
*
*      (scncc)          non-zero if called from cncrd
*      jsr  scane        call to scan element
*      (xr)              result pointer (see below)
*      (xl)              syntax type code (t$xxx)
*
*      the following global locations are used.
*
*      r$cim             pointer to string block (scblk)
*                       for current input image.
*
*      r$cnl             pointer to next input image string
*                       pointer (zero if none).
*
*      r$scp             save pointer (exit xr) from last
*                       call in case rescan is set.
*
*      scnbl             this location is set non-zero on
*                       exit if scane scanned past blanks
*                       before locating the current element
*                       the end of a line counts as blanks.
*
*      scncc             cncrd sets this non-zero to scan
*                       control card names and clears it
*                       on return
*
*      scnll             length of current input image
*
*      scngo             if set non-zero on entry, f and s
*                       are returned as separate syntax
*                       types (not letters) (goto pro-
*                       cessing). scngo is reset on exit.
*
*      scnpt             offset to current loc in r$cim
*
*      scnrs             if set non-zero on entry, scane
*                       returns the same result as on the
*                       last call (rescan). scnrs is reset
*                       on exit from any call to scane.
*
*      scnpt             save syntax type from last
*                       call (in case rescan is set).

```

```

*
*      scan (continued)
*
*
*      element scanned      xl      xr
*      -----      --      --
*
*      control card name      0      pointer to scblk for name
*
*      unary operator      t$uop      ptr to operator dvblk
*
*      left paren      t$lpr      t$lpr
*
*      left bracket      t$lbr      t$lbr
*
*      comma      t$cma      t$cma
*
*      function call      t$fnc      ptr to function vrblk
*
*      variable      t$var      ptr to vrblk
*
*      string constant      t$con      ptr to scblk
*
*      integer constant      t$con      ptr to icblk
*
if .cnra
else
*      real constant      t$con      ptr to rcblk
*
fi
*
*      binary operator      t$bop      ptr to operator dvblk
*
*      right paren      t$rpr      t$rpr
*
*      right bracket      t$rbr      t$rbr
*
*      colon      t$col      t$col
*
*      semi-colon      t$smc      t$smc
*
*      f (scngo ne 0)      t$fgo      t$fgo
*
*      s (scngo ne 0)      t$sgo      t$sgo

```

```

*
*      scane (continued)
*
*      entry point
*
scane  prc    e,0          entry point
      zer    scnbl        reset blanks flag
      mov    wa,scnsa     save wa
      mov    wb,scnsb     save wb
      mov    wc,scnsc     save wc
      bze    scnrs,scn03  jump if no rescan

*
*      here for rescan request
*
      mov    scnntp,xl    set previous returned scan type
      mov    r$scp,xr     set previous returned pointer
      zer    scnrs        reset rescan switch
      brn    scn13        jump to exit

*
*      come here to read new image to test for continuation
*
scn01  jsr    readr        read next image
      mov    *dvubs,wb    set wb for not reading name
      bze    xr,scn30     treat as semi-colon if none
      plc    xr           else point to first character
      lch    wc,(xr)      load first character
      beq    wc,=ch$dt,scn02  jump if dot for continuation
      bne    wc,=ch$pl,scn30  else treat as semicolon unless plus

*
*      here for continuation line
*
scn02  jsr    nexts        acquire next source image
      mov    =num01,scnpt  set scan pointer past continuation
      mnz    scnbl        set blanks flag

```

```

*
*      scan (continued)
*
*      merge here to scan next element on current line
*
scn03  mov  scnpt,wa          load current offset
      beq  wa,scnil,scn01     check continuation if end
      mov  r$cim,xl          point to current line
      plc  xl,wa             point to current character
      mov  wa,scnse          set start of element location
      mov  =opdvs,wc         point to operator dv list
      mov  *dvubs,wb         set constant for operator circuit
      brn  scn06             start scanning

*
*      loop here to ignore leading blanks and tabs
*
scn05  bze  wb,scn10          jump if trailing
      icv  scnse             increment start of element
      beq  wa,scnil,scn01     jump if end of image
      mnz  scnbl             note blanks seen

*
*      the following jump is used repeatedly for scanning out
*      the characters of a numeric constant or variable name.
*      the registers are used as follows.
*
*      (xr)          scratch
*      (xl)          ptr to next character
*      (wa)          current scan offset
*      (wb)          *dvubs (0 if scanning name,const)
*      (wc)          =opdvs (0 if scanning constant)
*
scn06  lch  xr,(xl)+          get next character
      icv  wa               bump scan offset
      mov  wa,scnpt          store offset past char scanned
if .cucf
      bsw  xr,cfp$u,scn07     switch on scanned character
else
      bsw  xr,cfp$a,scn07     switch on scanned character
fi

*
*      switch table for switch on character
*
      iff  ch$b1,scn05        blank
if .caht
      iff  ch$h1,scn05        horizontal tab
fi
if .cavt
      iff  ch$v1,scn05        vertical tab
fi
if .caex

```

<i>fi</i>	iff	ch\$ey,scn37	up arrow
	iff	ch\$d0,scn08	digit 0
	iff	ch\$d1,scn08	digit 1
	iff	ch\$d2,scn08	digit 2
	iff	ch\$d3,scn08	digit 3
	iff	ch\$d4,scn08	digit 4
	iff	ch\$d5,scn08	digit 5
	iff	ch\$d6,scn08	digit 6
	iff	ch\$d7,scn08	digit 7
	iff	ch\$d8,scn08	digit 8
	iff	ch\$d9,scn08	digit 9

```

*
*      scane (continued)
*
iff    ch$1a,scn09      letter a
iff    ch$1b,scn09      letter b
iff    ch$1c,scn09      letter c
iff    ch$1d,scn09      letter d
iff    ch$1e,scn09      letter e
iff    ch$1g,scn09      letter g
iff    ch$1h,scn09      letter h
iff    ch$1i,scn09      letter i
iff    ch$1j,scn09      letter j
iff    ch$1k,scn09      letter k
iff    ch$1l,scn09      letter l
iff    ch$1m,scn09      letter m
iff    ch$1n,scn09      letter n
iff    ch$1o,scn09      letter o
iff    ch$1p,scn09      letter p
iff    ch$1q,scn09      letter q
iff    ch$1r,scn09      letter r
iff    ch$1t,scn09      letter t
iff    ch$1u,scn09      letter u
iff    ch$1v,scn09      letter v
iff    ch$1w,scn09      letter w
iff    ch$1x,scn09      letter x
iff    ch$1y,scn09      letter y
iff    ch$1$,scn09      letter z

if .casl
iff    ch$$a,scn09      shifted a
iff    ch$$b,scn09      shifted b
iff    ch$$c,scn09      shifted c
iff    ch$$d,scn09      shifted d
iff    ch$$e,scn09      shifted e
iff    ch$$f,scn20      shifted f
iff    ch$$g,scn09      shifted g
iff    ch$$h,scn09      shifted h
iff    ch$$i,scn09      shifted i
iff    ch$$j,scn09      shifted j
iff    ch$$k,scn09      shifted k
iff    ch$$l,scn09      shifted l
iff    ch$$m,scn09      shifted m
iff    ch$$n,scn09      shifted n
iff    ch$$o,scn09      shifted o
iff    ch$$p,scn09      shifted p
iff    ch$$q,scn09      shifted q
iff    ch$$r,scn09      shifted r
iff    ch$$s,scn21      shifted s
iff    ch$$t,scn09      shifted t
iff    ch$$u,scn09      shifted u
iff    ch$$v,scn09      shifted v
iff    ch$$w,scn09      shifted w
iff    ch$$x,scn09      shifted x
iff    ch$$y,scn09      shifted y

```

f_i **iff** `ch$$$$,scn09` shifted z


```

*
*      scane (continued)
*
iff    ch$sq,scn16      single quote
iff    ch$dq,scn17      double quote
iff    ch$lf,scn20      letter f
iff    ch$ls,scn21      letter s
iff    ch$un,scn24      underline
iff    ch$pp,scn25      left paren
iff    ch$rp,scn26      right paren
iff    ch$rb,scn27      right bracket
iff    ch$bb,scn28      left bracket
iff    ch$cb,scn27      right bracket
iff    ch$ob,scn28      left bracket
iff    ch$cl,scn29      colon
iff    ch$sm,scn30      semi-colon
iff    ch$cm,scn31      comma
iff    ch$dt,scn32      dot
iff    ch$pl,scn33      plus
iff    ch$mn,scn34      minus
iff    ch$nt,scn35      not
iff    ch$dl,scn36      dollar
iff    ch$ex,scn37      exclamation mark
iff    ch$pc,scn38      percent
iff    ch$sl,scn40      slash
iff    ch$nm,scn41      number sign
iff    ch$at,scn42      at
iff    ch$br,scn43      vertical bar
iff    ch$am,scn44      ampersand
iff    ch$qu,scn45      question mark
iff    ch$eq,scn46      equal
iff    ch$as,scn49      asterisk
esw                                end switch on character

*
*      here for illegal character (underline merges)
*
scn07  bze  wb,scn10      jump if scanning name or constant
erb    230,syntax error:  illegal character

```

```

*
*      scane (continued)
*
*      here for digits 0-9
*
scn08  bze  wb,scn09          keep scanning if name/constant
      zer  wc                else set flag for scanning constant
*
*      here for letter. loop here when scanning name/constant
*
scn09  beq  wa,scn11,scn11    jump if end of image
      zer  wb                set flag for scanning name/const
      brn  scn06             merge back to continue scan
*
*      come here for delimiter ending name or constant
*
scn10  dcw  wa                reset offset to point to delimiter
*
*      come here after finishing scan of name or constant
*
scn11  mov  wa,scnpt          store updated scan offset
      mov  scnse,wb          point to start of element
      sub  wb,wa             get number of characters
      mov  r$cim,x1          point to line image
      bnz  wc,scn15          jump if name
*
*      here after scanning out numeric constant
*
      jsr  sbstr             get string for constant
      mov  xr,dnamp          delete from storage (not needed)
      jsr  gtnum            convert to numeric
      ppm  scn14             jump if conversion failure
*
*      merge here to exit with constant
*
scn12  mov  =t$con,x1        set result type of constant

```

```

*
*      scane (continued)
*
*      common exit point (xr,xl) set
*
scn13  mov  scnsa,wa          restore wa
      mov  scnsb,wb          restore wb
      mov  scnsc,wc          restore wc
      mov  xr,r$scp          save xr in case rescan
      mov  xl,scntp          save xl in case rescan
      zer  scngo             reset possible goto flag
      exi                   return to scane caller

*
*      here if conversion error on numeric item
*
scn14  erb  231,syntax error:      invalid numeric item

*
*      here after scanning out variable name
*
scn15  jsr  sbstr             build string name of variable
      bnz  scncc,scn13        return if cnrd call
      jsr  gtnvr             locate/build vrbk
      ppm                   dummy (unused) error return
      mov  =t$var,xl         set type as variable
      brn  scn13             back to exit

*
*      here for single quote (start of string constant)
*
scn16  bze  wb,scn10          terminator if scanning name or cnst
      mov  =ch$sq,wb         set terminator as single quote
      brn  scn18             merge

*
*      here for double quote (start of string constant)
*
scn17  bze  wb,scn10          terminator if scanning name or cnst
      mov  =ch$dq,wb         set double quote terminator, merge

*
*      loop to scan out string constant
*
scn18  beq  wa,scn1l,scn19    error if end of image
      lch  wc,(xl)+          else load next character
      icv  wa               bump offset
      bne  wc,wb,scn18        loop back if not terminator

```

```

*
*      scane (continued)
*
*      here after scanning out string constant
*
      mov  scnpt,wb          point to first character
      mov  wa,scnpt          save offset past final quote
      dcv  wa                point back past last character
      sub  wb,wa             get number of characters
      mov  r$cim,xl          point to input image
      jsr  sbstr             build substring value
      brn  scn12             back to exit with constant result

*
*      here if no matching quote found
*
scn19  mov  wa,scnpt          set updated scan pointer
      erb  232,syntax error:  unmatched string quote

*
*      here for f (possible failure goto)
*
scn20  mov  =t$fgo,xr        set return code for fail goto
      brn  scn22             jump to merge

*
*      here for s (possible success goto)
*
scn21  mov  =t$sgo,xr        set success goto as return code

*
*      special goto cases merge here
*
scn22  bze  scngo,scn09      treat as normal letter if not goto

*
*      merge here for special character exit
*
scn23  bze  wb,scn10         jump if end of name/constant
      mov  xr,xl             else copy code
      brn  scn13             and jump to exit

*
*      here for underline
*
scn24  bze  wb,scn09         part of name if scanning name
      brn  scn07             else illegal

```

```

*
*      scane (continued)
*
*      here for left paren
*
scn25  mov  =t$lpr,xr          set left paren return code
      bnz  wb,scn23          return left paren unless name
      bze  wc,scn10          delimiter if scanning constant
*
*      here for left paren after name (function call)
*
      mov  scnse,wb          point to start of name
      mov  wa,scnpt          set pointer past left paren
      dcv  wa                point back past last char of name
      sub  wb,wa             get name length
      mov  r$cim,xl          point to input image
      jsr  sbstr             get string name for function
      jsr  gtnvr            locate/build vrbk
      ppm                  dummy (unused) error return
      mov  =t$fnc,xl         set code for function call
      brn  scn13            back to exit
*
*      processing for special characters
*
scn26  mov  =t$rpr,xr        right paren, set code
      brn  scn23            take special character exit
*
scn27  mov  =t$rbr,xr        right bracket, set code
      brn  scn23            take special character exit
*
scn28  mov  =t$lbr,xr        left bracket, set code
      brn  scn23            take special character exit
*
scn29  mov  =t$col,xr        colon, set code
      brn  scn23            take special character exit
*
scn30  mov  =t$smc,xr        semi-colon, set code
      brn  scn23            take special character exit
*
scn31  mov  =t$cma,xr        comma, set code
      brn  scn23            take special character exit

```

```

*
*      scane (continued)
*
*      here for operators. on entry, wc points to the table of
*      operator dope vectors and wb is the increment to step
*      to the next pair (binary/unary) of dope vectors in the
*      list. on reaching scn46, the pointer has been adjusted to
*      point to the appropriate pair of dope vectors.
*      the first three entries are special since they can occur
*      as part of a variable name (.) or constant (.-).
*
scn32  bze  wb,scn09          dot can be part of name or constant
      add  wb,wc             else bump pointer
*
scn33  bze  wc,scn09          plus can be part of constant
      bze  wb,scn48          plus cannot be part of name
      add  wb,wc             else bump pointer
*
scn34  bze  wc,scn09          minus can be part of constant
      bze  wb,scn48          minus cannot be part of name
      add  wb,wc             else bump pointer
*
scn35  add  wb,wc             not
scn36  add  wb,wc             dollar
scn37  add  wb,wc             exclamation
scn38  add  wb,wc             percent
scn39  add  wb,wc             asterisk
scn40  add  wb,wc             slash
scn41  add  wb,wc             number sign
scn42  add  wb,wc             at sign
scn43  add  wb,wc             vertical bar
scn44  add  wb,wc             ampersand
scn45  add  wb,wc             question mark
*
*      all operators come here (equal merges directly)
*      (wc) points to the binary/unary pair of operator dvblks.
*
scn46  bze  wb,scn10          operator terminates name/constant
      mov  wc,xr              else copy dv pointer
      lch  wc,(x1)            load next character
      mov  =t$bop,x1          set binary op in case
      beq  wa,scn11,scn47      should be binary if image end
      beq  wc,=ch$b1,scn47     should be binary if followed by blk
if .caht
      beq  wc,=ch$ht,scn47     jump if horizontal tab
fi
if .cavt
      beq  wc,=ch$vt,scn47     jump if vertical tab
fi
      beq  wc,=ch$sm,scn47     semicolon can immediately follow =

```

```
beq  wc,=ch$c1,scn47
beq  wc,=ch$rp,scn47
beq  wc,=ch$rb,scn47
beq  wc,=ch$cb,scn47
```

colon can immediately follow =
right paren can immediately follow =
right bracket can immediately follow =
right bracket can immediately follow =

```
*
*      here for unary operator
*
```

```
add  *dvbs$,xr
mov  =t$uop,xl
ble  scntp,=t$uok,scn13
```

point to dv for unary op
set type for unary operator
ok unary if ok preceding element

```

*
*      scane (continued)
*
*      merge here to require preceding blanks
*
scn47  bnz  scnbl,scn13                      all ok if preceding blanks, exit
*
*      fail operator in this position
*
scn48  erb  233,syntax error:                invalid use of operator
*
*      here for asterisk, could be ** substitute for exclamation
*
scn49  bze  wb,scn10                        end of name if scanning name
      beq  wa,scnil,scn39                  not ** if * at image end
      mov  wa,xr                          else save offset past first *
      mov  wa,scnof                       save another copy
      lch  wa,(xl)+                       load next character
      bne  wa,=ch$as,scn50                not ** if next char not *
      icv  xr                             else step offset past second *
      beq  xr,scnil,scn51                  ok exclam if end of image
      lch  wa,(xl)                       else load next character
      beq  wa,=ch$bl,scn51                exclamation if blank
if .caht
      beq  wa,=ch$ht,scn51                exclamation if horizontal tab
fi
if .cavt
      beq  wa,=ch$vt,scn51                exclamation if vertical tab
fi
*
*      unary *
*
scn50  mov  scnof,wa                      recover stored offset
      mov  r$cim,xl                      point to line again
      plc  xl,wa                         point to current char
      brn  scn39                         merge with unary *
*
*      here for ** as substitute for exclamation
*
scn51  mov  xr,scnpt                      save scan pointer past 2nd *
      mov  xr,wa                         copy scan pointer
      brn  scn37                         merge with exclamation
      enp                               end procedure scane

```



```

*
*      scngf -- scan goto field
*
*      scngf is called from cmpil to scan and analyze a goto
*      field including the surrounding brackets or parentheses.
*      for a normal goto, the result returned is either a vrblk
*      pointer for a simple label operand, or a pointer to an
*      expression tree with a special outer unary operator
*      (o$goc). for a direct goto, the result returned is a
*      pointer to an expression tree with the special outer
*      unary operator o$god.
*
*      jsr  scngf          call to scan goto field
*      (xr)                result (see above)
*      (xl,wa,wb,wc)       destroyed
*
scngf  prc   e,0           entry point
      jsr   scan          scan initial element
      beq   xl,=$lpr,scng1 skip if left paren (normal goto)
      beq   xl,=$lbr,scng2 skip if left bracket (direct goto)
      erb   234,syntax error: goto field incorrect
*
*      here for left paren (normal goto)
*
scng1  mov   =num01,wb     set expan flag for normal goto
      jsr   expan          analyze goto field
      mov   =opdvn,wa      point to opdvn for complex goto
      ble   xr,statb,scng3 jump if not in static (sgd15)
      blo   xr,state,scng4 jump to exit if simple label name
      brn   scng3          complex goto - merge
*
*      here for left bracket (direct goto)
*
scng2  mov   =num02,wb     set expan flag for direct goto
      jsr   expan          scan goto field
      mov   =opdvd,wa      set opdvd pointer for direct goto

```

```

*
*      scngf (continued)
*
*      merge here to build outer unary operator block
*
scng3  mov  wa,-(xs)           stack operator dv pointer
      mov  xr,-(xs)           stack pointer to expression tree
      jsr  expop              pop operator off
      mov  (xs)+,xr           reload new expression tree pointer

*
*      common exit point
*
scng4  exi                   return to caller
      enp                    end procedure scngf

```

```

*
*      setvr -- set vrget,vrsto fields of vrbk
*
*      setvr sets the proper values in the vrget and vrsto
*      fields of a vrbk. it is called whenever trblks are
*      added or subtracted (trace,stoptr,input,output,detach)
*
*      (xr)                pointer to vrbk
*      jsr  setvr           call to set fields
*      (x1,wa)             destroyed
*
*      note that setvr ignores the call if xr does not point
*      into the static region (i.e. is some other name base)
*
setvr  prc   e,0                entry point
      bhi   xr,state,setv1      exit if not natural variable
*
*      here if we have a vrbk
*
      mov   xr,x1                copy vrbk pointer
      mov   =b$vr1,vrget(xr)     store normal get value
      beq   vrsto(xr),=b$vre,setv1 skip if protected variable
      mov   =b$vrs,vrsto(xr)     store normal store value
      mov   vrval(x1),x1         point to next entry on chain
      bne   (x1),=b$trt,setv1    jump if end of trblk chain
      mov   =b$vra,vrget(xr)     store trapped routine address
      mov   =b$rvr,vrsto(xr)     set trapped routine address
*
*      merge here to exit to caller
*
setv1  exi                return to setvr caller
      enp                end procedure setvr
if .cnsr
else

```

```

*
*      sorta -- sort array
*
*      routine to sort an array or table on same basis as in
*      sitbol. a table is converted to an array, leaving two
*      dimensional arrays and vectors as cases to be considered.
*      whole rows of arrays are permuted according to the
*      ordering of the keys they contain, and the stride
*      referred to, is the the length of a row. it is one
*      for a vector.
*      the sort used is heapsort, fundamentals of data structure
*      horowitz and sahani, pitman 1977, page 347.
*      it is an order  $n \log(n)$  algorithm. in order
*      to make it stable, comparands may not compare equal. this
*      is achieved by sorting a copy array (referred to as the
*      sort array) containing at its high address end, byte
*      offsets to the rows to be sorted held in the original
*      array (referred to as the key array). sortc, the
*      comparison routine, accesses the keys through these
*      offsets and in the case of equality, resolves it by
*      comparing the offsets themselves. the sort permutes the
*      offsets which are then used in a final operation to copy
*      the actual items into the new array in sorted order.
*      references to zeroth item are to notional item
*      preceding first actual item.
*      reverse sorting for rsort is done by having the less than
*      test for keys effectively be replaced by a
*      greater than test.
*
*      1(xs)                first arg - array or table
*      0(xs)                2nd arg - index or pdtype name
*      (wa)                 0 , non-zero for sort , rsort
*      jsr  sorta           call to sort array
*      ppm  loc             transfer loc if table is empty
*      (xr)                 sorted array
*      (xl,wa,wb,wc)        destroyed

```

<pre> * * sorta (continued) * sorta prc n,1 mov wa,srtsr mov *num01,srtst zer srtof mov =nulls,srtdf mov (xs)+,r\$sxr mov (xs)+,xr mnz wa jsr gtarr ppm srt18 ppm srt16 mov xr,-(xs) mov xr,-(xs) jsr copyb ppm mov xr,-(xs) mov r\$sxr,xr mov num01(xs),xl bne (xl),=b\$vct,srt02 beq xr,=nulls,srt01 jsr gtnvr err 257,erroneous 2nd mov xr,srtdf </pre>	<pre> entry point sort/rsort indicator default stride of 1 default zero offset to sort key clear datatype field name unstack argument 2 get first argument use key/values of table entries convert to array signal that table is empty error if non-convertable stack ptr to resulting key array another copy for copyb get copy array for sorting into cant fail stack pointer to sort array get second arg get ptr to key array jump if arblk jump if null second arg get vrbk ptr for it arg in sort/rsort of vector store datatype field name vrbk </pre>
<pre> * * compute n and offset to item a(0) in vector case * srt01 mov *vclen,wc mov *vcvls,wb mov vclen(xl),wa sub *vcsi\$,wa brn srt04 </pre>	<pre> offset to a(0) offset to first item get block length get no. of entries, n (in bytes) merge </pre>
<pre> * * here for array * srt02 ldi ardim(xl) mfi wa wtb wa mov *arvls,wb mov *arpro,wc beq arndm(xl),=num01,srt04 bne arndm(xl),=num02,srt16 ldi arlb2(xl) beq xr,=nulls,srt03 jsr gtint ppm srt17 ldi icval(xr) </pre>	<pre> get possible dimension convert to short integer further convert to baus offset to first value if one offset before values if one dim. jump in fact if one dim. fail unless two dimens get lower bound 2 as default jump if default second arg convert to integer fail get actual integer value </pre>

```

*
*      sorta (continued)
*
*      here with sort column index in ia in array case
*
srt03  sbi   arlb2(xl)           subtract low bound
      iov   srt17               fail if overflow
      ilt   srt17               fail if below low bound
      sbi   ardm2(xl)           check against dimension
      ige   srt17               fail if too large
      adi   ardm2(xl)           restore value
      mfi   wa                  get as small integer
      wtb   wa                  offset within row to key
      mov   wa,srtof             keep offset
      ldi   ardm2(xl)           second dimension is row length
      mfi   wa                  convert to short integer
      mov   wa,xr               copy row length
      wtb   wa                  convert to bytes
      mov   wa,srtst            store as stride
      ldi   ardim(xl)           get number of rows
      mfi   wa                  as a short integer
      wtb   wa                  convert n to bauss
      mov   arlen(xl),wc        offset past array end
      sub   wa,wc               adjust, giving space for n offsets
      dca   wc                  point to a(0)
      mov   arofs(xl),wb        offset to word before first item
      ica   wb                  offset to first item

*
*      separate pre-processing for arrays and vectors done.
*      to simplify later key comparisons, removal of any trblk
*      trap blocks from entries in key array is effected.
*
*      (xl) = 1(xs) = pointer to key array
*      (xs) = pointer to sort array
*      wa = number of items, n (converted to bytes).
*      wb = offset to first item of arrays.
*      wc = offset to a(0)
*
srt04  ble   wa,*num01,srt15     return if only a single item
      mov   wa,srtsn             store number of items (in bauss)
      mov   wc,srtso             store offset to a(0)
      mov   arlen(xl),wc         length of array or vec (=vcn)
      add   xl,wc                point past end of array or vector
      mov   wb,srtsf             store offset to first row
      add   wb,xl                point to first item in key array

*
*      loop through array
*
srt05  mov   (xl),xr             get an entry

*
*      hunt along trblk chain
*

```

srt06 bne (xr),=b\$trt,srt07 mov trval(xr),xr brn srt06	jump out if not trblk get value field loop
--	--

```

*
*      sorta (continued)
*
*      xr is value from end of chain
*
srt07  mov  xr,(xl)+          store as array entry
      blt   xl,wc,srt05      loop if not done
      mov   (xs),xl          get adrs of sort array
      mov   srtstf,xr        initial offset to first key
      mov   srtst,wb         get stride
      add   srtso,xl         offset to a(0)
      ica   xl              point to a(1)
      mov   srtstn,wc        get n
      btw   wc              convert from bytes
      mov   wc,srtstnr       store as row count
      lct   wc,wc           loop counter

*
*      store key offsets at top of sort array
*
srt08  mov  xr,(xl)+          store an offset
      add   wb,xr            bump offset by stride
      bct   wc,srt08         loop through rows

*
*      perform the sort on offsets in sort array.
*
*      (srtstn)              number of items to sort, n (bytes)
*      (srtso)               offset to a(0)
*
srt09  mov  srtstn,wa         get n
      mov  srtstnr,wc        get number of rows
      rsh   wc,1             i = n / 2 (wc=i, index into array)
      wtb   wc              convert back to bytes

*
*      loop to form initial heap
*
srt10  jsr   sorth           sorth(i,n)
      dca   wc              i = i - 1
      bnz   wc,srt10        loop if i gt 0
      mov   wa,wc           i = n

*
*      sorting loop. at this point, a(1) is the largest
*      item, since algorithm initialises it as, and then maintains
*      it as, root of tree.
*
srt11  dca   wc              i = i - 1 (n - 1 initially)
      bze   wc,srt12        jump if done
      mov   (xs),xr         get sort array address
      add   srtso,xr        point to a(0)
      mov   xr,xl           a(0) address
      add   wc,xl           a(i) address
      mov   num01(xl),wb    copy a(i+1)

```



```
mov  num01(xr),num01(xl)
mov  wb,num01(xr)
mov  wc,wa
mov  *num01,wc
jsr  sorth
mov  wa,wc
brn  srt11
```

```
    move a(1) to a(i+1)
complete exchange of a(1), a(i+1)
n = i for sorth
i = 1 for sorth
sorth(1,n)
restore wc
loop
```

```

*
*      sorta (continued)
*
*      offsets have been permuted into required order by sort.
*      copy array elements over them.
*
srt12  mov  (xs),xr          base adrs of key array
      mov  xr,wc            copy it
      add  srtso,wc         offset of a(0)
      add  srtsf,xr         adrs of first row of sort array
      mov  srtst,wb         get stride
*
*      copying loop for successive items. sorted offsets are
*      held at end of sort array.
*
srt13  ica  wc              adrs of next of sorted offsets
      mov  wc,xl            copy it for access
      mov  (xl),xl          get offset
      add  num01(xs),xl     add key array base adrs
      mov  wb,wa            get count of characters in row
      mvw                      copy a complete row
      dcv  srtnr            decrement row count
      bnz  srtnr,srt13      repeat till all rows done
*
*      return point
*
srt15  mov  (xs)+,xr        pop result array ptr
      ica  xs              pop key array ptr
      zer  r$axl            clear junk
      zer  r$axr            clear junk
      exi                      return
*
*      error point
*
srt16  erb  256,sort/rsort 1st  arg not suitable array or table
srt17  erb  258,sort/rsort 2nd  arg out of range or non-integer
*
*      return point if input table is empty
*
srt18  exi  1              return indication of null table
      enp                      end procedure sorta

```

```

*
*      sortc --  compare sort keys
*
*      compare two sort keys given their offsets.  if
*      equal, compare key offsets to give stable sort.
*      note that if srtsr is non-zero (request for reverse
*      sort), the quoted returns are inverted.
*      for objects of differing datatypes, the entry point
*      identifications are compared.
*
*      (xl)                base adrs for keys
*      (wa)                offset to key 1 item
*      (wb)                offset to key 2 item
*      (srtsr)             zero/non-zero for sort/rsort
*      (srtof)             offset within row to comparands
*      jsr  sortc           call to compare keys
*      ppm  loc             key1 less than key2
*                          normal return, key1 gt than key2
*      (xl,xr,wa,wb)       destroyed
*
sortc  prc  e,1             entry point
      mov  wa,srts1         save offset 1
      mov  wb,srts2         save offset 2
      mov  wc,srtsc         save wc
      add  srtof,xl         add offset to comparand field
      mov  xl,xr            copy base + offset
      add  wa,xl            add key1 offset
      add  wb,xr            add key2 offset
      mov  (xl),xl          get key1
      mov  (xr),xr          get key2
      bne  srtdf,=nulls,src12  jump if datatype field name used

```

```

*
*      sortc (continued)
*
*      merge after dealing with field name. try for strings.
*
src01  mov  (x1),wc                get type code
      bne  wc,(xr),src02          skip if not same datatype
      beq  wc,=b$scl,src09        jump if both strings
      beq  wc,=b$icl,src14        jump if both integers
if .cnbf
else
      beq  wc,=b$bct,src09        jump if both buffers
fi

*
*      datatypes different.  now try for numeric
*
src02  mov  x1,r$sx1              keep arg1
      mov  xr,r$sxr              keep arg2
if .cnbf
if .cnsc
      beq  wc,=b$scl,src11        do not allow conversion to number
      beq  (xr),=b$scl,src11      if either arg is a string
fi
else
*
*      first examine for string/buffer comparison.  if so,
*      allow lcomp to compare chars in string and buffer
*      without converting buffer to a string.
*
      beq  wc,=b$scl,src13        jump if key1 is a string
if .cnsc
      bne  wc,=b$bct,src15        j if key1 is not a string or buffer
else
      bne  wc,=b$bct,src14        try converting key 2 to a number
fi

*
*      here if key1 is a buffer, key2 known not to be a buffer.
*      if key2 is a string, then lcomp can proceed.
*
      beq  (xr),=b$scl,src09      j if keys 1/2 are buffer/string
if .cnsc
      brn  src11                  prevent convert of key 1 to number
else
      brn  src14                  try converting key 1 to number
fi

*
*      here if key1 is a string, key2 known not to be a string.
*      if key2 is a buffer, then lcomp can proceed.
*

```

```

src13  beq  (xr),=b$bct,src09          j if keys 1/2 are string/buffer
      if .cnsc
      brn  src11                      prevent convert of key 1 to number

*
*      here if key1 is not a string or buffer.
*      examine key2.  if it is a string or buffer, then do not
*      convert key2 to a number.
*
src15  beq  (xr),=b$scl,src11          j if key 2 is a string
      beq  (xr),=b$bct,src11          j if key 2 is a buffer

*
*      here with keys 1/2 not strings or buffers
*
      fi
      fi

src14  mov  x1,-(xs)                  stack
      mov  xr,-(xs)                  args
      jsr  acomp                     compare objects
      ppm  src10                     not numeric
      ppm  src10                     not numeric
      ppm  src03                     key1 less
      ppm  src08                     keys equal
      ppm  src05                     key1 greater

*
*      return if key1 smaller (sort), greater (rsort)
*
src03  bnz  rtsr,src06                jump if rsort

*
src04  mov  rtsr,wc                   restore wc
      exi  1                         return

*
*      return if key1 greater (sort), smaller (rsort)
*
src05  bnz  rtsr,src04                jump if rsort

*
src06  mov  rtsr,wc                   restore wc
      exi                             return

*
*      keys are of same datatype
*
src07  blt  x1,xr,src03               item first created is less
      bgt  x1,xr,src05               addresses rise in order of creation

*
*      drop through or merge for identical or equal objects
*
src08  blt  rts1,rts2,src04           test offsets or key addrss instead
      brn  src06                     offset 1 greater

```

```

*
*      sortc (continued)
*
if .cnbf
*      strings
else
*      strings or buffers or some combination of same
fi
*
src09  mov  xl,-(xs)          stack
      mov  xr,-(xs)          args
      jsr  lcomp             compare objects
      ppm                     cant
      ppm                     fail
      ppm  src03             key1 less
      ppm  src08             keys equal
      ppm  src05             key1 greater
*
*      arithmetic comparison failed - recover args
*
src10  mov  r$xl,xl          get arg1
      mov  r$xr,xr          get arg2
      mov  (xl),wc          get type of key1
      beq  wc,(xr),src07     jump if keys of same type
*
*      here to compare datatype ids
*
src11  mov  wc,xl            get block type word
      mov  (xr),xr          get block type word
      lei   xl              entry point id for key1
      lei   xr              entry point id for key2
      bgt  xl,xr,src05       jump if key1 gt key2
      brn  src03            key1 lt key2
*
*      datatype field name used
*
src12  jsr  sortf           call routine to find field 1
      mov  xl,-(xs)         stack item pointer
      mov  xr,xl            get key2
      jsr  sortf           find field 2
      mov  xl,xr            place as key2
      mov  (xs)+,xl         recover key1
      brn  src01            merge
      enp                  procedure sortc

```

```

*
*      sortf -- find field for sortc
*
*      routine used by sortc to obtain item corresponding
*      to a given field name, if this exists, in a programmer
*      defined object passed as argument.
*      if such a match occurs, record is kept of datatype
*      name, field name and offset to field in order to
*      short-circuit later searches on same type. note that
*      dfblks are stored in static and hence cannot be moved.
*
*      (srtdf)          vrbk pointer of field name
*      (xl)             possible pdblk pointer
*      jsr  sortf        call to search for field name
*      (xl)             item found or original pdblk ptr
*      (wc)             destroyed
*
sortf  prc  e,0          entry point
      bne  (xl),=b$pd, srtf3  return if not pdblk
      mov  xr,-(xs)         keep xr
      mov  srtfd,xr        get possible former dfblk ptr
      bze  xr,srtf4        jump if not
      bne  xr,pddfp(xl),srtf4  jump if not right datatype
      bne  srtdf,srtff,srtf4  jump if not right field name
      add  srtfo,xl        add offset to required field
*
*      here with xl pointing to found field
*
srtf1  mov  (xl),xl        get item from field
*
*      return point
*
srtf2  mov  (xs)+,xr       restore xr
*
srtf3  exi                return

```

*		
*	sortf (continued)	
*		
*	conduct a search	
*		
srtf4	mov xl,xr	copy original pointer
	mov pddfp(xr),xr	point to dfblk
	mov xr,srtfd	keep a copy
	mov fargs(xr),wc	get number of fields
	wtb wc	convert to bytes
	add dflen(xr),xr	point past last field
*		
*	loop to find name in pdfblk	
*		
srtf5	dca wc	count down
	dca xr	point in front
	beq (xr),srtdf,srtf6	skip out if found
	bnz wc,srtf5	loop
	brn srtf2	return - not found
*		
*	found	
*		
srtf6	mov (xr),srtff	keep field name ptr
	add *pdfld,wc	add offset to first field
	mov wc,srtfo	store as field offset
	add wc,xl	point to field
	brn srtf1	return
	enp	procedure sortf


```

*
*      sorth -- heap routine for sorta
*
*      this routine constructs a heap from elements of array, a.
*      in this application, the elements are offsets to keys in
*      a key array.
*
*      (xs)           pointer to sort array base
*      1(xs)          pointer to key array base
*      (wa)           max array index, n (in bytes)
*      (wc)           offset j in a to root (in *1 to *n)
*      jsr  sorth     call sorth(j,n) to make heap
*      (xl,xr,wb)     destroyed
*
sorth  prc  n,0                entry point
        mov  wa,srtsn          save n
        mov  wc,srtwc          keep wc
        mov  (xs),xl           sort array base adrs
        add  srtso,xl          add offset to a(0)
        add  wc,xl             point to a(j)
        mov  (xl),srtrt        get offset to root
        add  wc,wc             double j - cant exceed n
*
*      loop to move down tree using doubled index j
*
srh01  bgt  wc,srtsn,srh03      done if j gt n
        beq  wc,srtsn,srh02     skip if j equals n
        mov  (xs),xr            sort array base adrs
        mov  num01(xs),xl       key array base adrs
        add  srtso,xr           point to a(0)
        add  wc,xr              adrs of a(j)
        mov  num01(xr),wa       get a(j+1)
        mov  (xr),wb            get a(j)
*
*      compare sons. (wa) right son, (wb) left son
*
        jsr  sortc              compare keys - lt(a(j+1),a(j))
        ppm  srh02              a(j+1) lt a(j)
        ica  wc                 point to greater son, a(j+1)

```

```

*
*      sorth (continued)
*
*      compare root with greater son
*
srh02  mov  num01(xs),xl      key array base adrs
      mov  (xs),xr          get sort array address
      add  srtso,xr         adrs of a(0)
      mov  xr,wb            copy this adrs
      add  wc,xr            adrs of greater son, a(j)
      mov  (xr),wa          get a(j)
      mov  wb,xr            point back to a(0)
      mov  srtrt,wb         get root
      jsr  sortc            compare them - lt(a(j),root)
      ppm  srh03            father exceeds sons - done
      mov  (xs),xr          get sort array adrs
      add  srtso,xr         point to a(0)
      mov  xr,xl            copy it
      mov  wc,wa            copy j
      btw  wc               convert to words
      rsh  wc,1             get j/2
      wtb  wc               convert back to bytes
      add  wa,xl            point to a(j)
      add  wc,xr            adrs of a(j/2)
      mov  (xl),(xr)        a(j/2) = a(j)
      mov  wa,wc            recover j
      aov  wc,wc,srh03      j = j*2. done if too big
      brn  srh01            loop

*
*      finish by copying root offset back into array
*
srh03  btw  wc              convert to words
      rsh  wc,1             j = j/2
      wtb  wc               convert back to bytes
      mov  (xs),xr          sort array adrs
      add  srtso,xr         adrs of a(0)
      add  wc,xr            adrs of a(j/2)
      mov  srtrt,(xr)       a(j/2) = root
      mov  srtsn,wa         restore wa
      mov  srtwc,wc         restore wc
      exi                   return
      enp                   end procedure sorth

```

fi

```

*
*      trace -- set/reset a trace association
*
*      this procedure is shared by trace and stoptr to
*      either initiate or stop a trace respectively.
*
*      (xl)                trblk ptr (trace) or zero (stoptr)
*      1(xs)               first argument (name)
*      0(xs)               second argument (trace type)
*      jsr  trace           call to set/reset trace
*      ppm  loc             transfer loc if 1st arg is bad name
*      ppm  loc             transfer loc if 2nd arg is bad type
*      (xs)                popped
*      (xl,xr,wa,wb,wc,ia) destroyed
*
trace  prc   n,2            entry point
      jsr   gtstg           get trace type string
      ppm   trc15          jump if not string
      plc   xr              else point to string
      lch   wa,(xr)         load first character
if .culc
      flc   wa              fold to upper case
fi

      mov   (xs),xr         load name argument
      mov   xl,(xs)         stack trblk ptr or zero
      mov   =trtac,wc       set trtyp for access trace
      beq   wa,=ch$1a,trc10  jump if a (access)
      mov   =trtv1,wc       set trtyp for value trace
      beq   wa,=ch$1v,trc10  jump if v (value)
      beq   wa,=ch$b1,trc10  jump if blank (value)

*
*      here for l,k,f,c,r
*
      beq   wa,=ch$1f,trc01  jump if f (function)
      beq   wa,=ch$1r,trc01  jump if r (return)
      beq   wa,=ch$1l,trc03  jump if l (label)
      beq   wa,=ch$1k,trc06  jump if k (keyword)
      bne   wa,=ch$1c,trc15  else error if not c (call)

*
*      here for f,c,r
*
trc01  jsr   gtnvr          point to vrbk for name
      ppm   trc16          jump if bad name
      ica   xs              pop stack
      mov   vrfnc(xr),xr    point to function block
      bne   (xr),=b$pfnc,trc17 error if not program function
      beq   wa,=ch$1r,trc02  jump if r (return)

```

```

*
*      trace (continued)
*
*      here for f,c to set/reset call trace
*
      mov  xl,pfctr(xr)          set/reset call trace
      beq  wa,=ch$lc,exnul       exit with null if c (call)
*
*      here for f,r to set/reset return trace
*
trc02  mov  xl,pfrtr(xr)         set/reset return trace
      exi                      return
*
*      here for l to set/reset label trace
*
trc03  jsr  gtnvr                point to vrbk
      ppm  trc16                 jump if bad name
      mov  vrlbl(xr),xl          load label pointer
      bne  (xl),=b$trt,trc04     jump if no old trace
      mov  trlbl(xl),xl          else delete old trace association
*
*      here with old label trace association deleted
*
trc04  beq  xl,=stndl,trc16       error if undefined label
      mov  (xs)+,wb              get trblk ptr again
      bze  wb,trc05              jump if stoptr case
      mov  wb,vrlbl(xr)          else set new trblk pointer
      mov  =b$vrt,vrtra(xr)      set label trace routine address
      mov  wb,xr                 copy trblk pointer
      mov  xl,trlbl(xr)          store real label in trblk
      exi                      return
*
*      here for stoptr case for label
*
trc05  mov  xl,vrlbl(xr)         store label ptr back in vrbk
      mov  =b$vrg,vrtra(xr)      store normal transfer address
      exi                      return

```

```

*
*      trace (continued)
*
*      here for k (keyword)
*
trc06  jsr   gtnvr                point to vrbk
       ppm   trc16                error if not natural var
       bnz   vrln(xr),trc16       error if not system var
       ica   xs                  pop stack
       bze   xl,trc07             jump if stoptr case
       mov   xr,trkvr(xl)         store vrbk ptr in trblk for ktrex
*
*      merge here with trblk set up in wb (or zero)
*
trc07  mov   vrsvp(xr),xr         point to svblk
       beq   xr,=v$ert,trc08       jump if errtype
       beq   xr,=v$stc,trc09       jump if stcount
       bne   xr,=v$fnc,trc17       else error if not fnclevel
*
*      fnclevel
*
       mov   xl,r$fnc             set/reset fnclevel trace
       exi                               return
*
*      errtype
*
trc08  mov   xl,r$ert             set/reset errtype trace
       exi                               return
*
*      stcount
*
trc09  mov   xl,r$stc             set/reset stcount trace
       jsr   stgcc                update countdown counters
       exi                               return

```

```

*
*      trace (continued)
*
*      a,v merge here with trtyp value in wc
*
trc10  jsr  gtvar                locate variable
       ppm  trc16                error if not appropriate name
       mov  (xs)+,wb             get new trblk ptr again
       add  x1,wa                point to variable location
       mov  wa,xr                copy variable pointer
*
*      loop to search trblk chain
*
trc11  mov  (xr),x1              point to next entry
       bne  (x1),=b$trt,trc13    jump if not trblk
       blt  wc,trtyp(x1),trc13   jump if too far out on chain
       beq  wc,trtyp(x1),trc12   jump if this matches our type
       add  *trnxt,x1            else point to link field
       mov  x1,xr                copy pointer
       brn  trc11                and loop back
*
*      here to delete an old trblk of the type we were given
*
trc12  mov  trnxt(x1),x1         get ptr to next block or value
       mov  x1,(xr)              store to delete this trblk
*
*      here after deleting any old association of this type
*
trc13  bze  wb,trc14              jump if stoptr case
       mov  wb,(xr)              else link new trblk in
       mov  wb,xr                copy trblk pointer
       mov  x1,trnxt(xr)         store forward pointer
       mov  wc,trtyp(xr)         store appropriate trap type code
*
*      here to make sure vrget,vrsto are set properly
*
trc14  mov  wa,xr                recall possible vrbk pointer
       sub  *vrval,xr            point back to vrbk
       jsr  setvr                set fields if vrbk
       exi                       return
*
*      here for bad trace type
*
trc15  exi  2                    take bad trace type error exit
*
*      pop stack before failing
*
trc16  ica  xs                  pop stack
*
*      here for bad name argument

```

```
      *  
trc17  exi  1  
      enp
```

```
take bad name error exit  
end procedure trace
```

```

*
*      trbld -- build trblk
*
*      trblk is used by the input, output and trace functions
*      to construct a trblk (trap block)
*
*      (xr)          trtag or trter
*      (xl)          trfnc or trfpt
*      (wb)          trtyp
*      jsr  trbld     call to build trblk
*      (xr)          pointer to trblk
*      (wa)          destroyed
*
trbld  prc   e,0          entry point
      mov  xr,-(xs)      stack trtag (or trfnm)
      mov  *trsi$,wa     set size of trblk
      jsr  alloc         allocate trblk
      mov  =b$trt,(xr)   store first word
      mov  xl,trfnc(xr)  store trfnc (or trfpt)
      mov  (xs)+,trtag(xr) store trtag (or trfnm)
      mov  wb,trtyp(xr)  store type
      mov  =nulls,trval(xr) for now, a null value
      exi               return to caller
      enp               end procedure trbld

```



```

*
*      trimr -- trim trailing blanks
*
*      trimr is passed a pointer to an scblk which must be the
*      last block in dynamic storage. trailing blanks are
*      trimmed off and the dynamic storage pointer reset to
*      the end of the (possibly) shortened block.
*
*      (wb)                non-zero to trim trailing blanks
*      (xr)                pointer to string to trim
*      jsr  trimr          call to trim string
*      (xr)                pointer to trimmed string
*      (xl,wa,wb,wc)       destroyed
*
*      the call with wb zero still performs the end zero pad
*      and dnamp readjustment. it is used from aces if kvtrm=0.
*
trimr  prc  e,0                entry point
      mov  xr,xl              copy string pointer
      mov  sclen(xr),wa       load string length
      bze  wa,trim2           jump if null input
      plc  xl,wa              else point past last character
      bze  wb,trim3           jump if no trim
      mov  =ch$b1,wc          load blank character
*
*      loop through characters from right to left
*
trim0  lch  wb,-(xl)          load next character
if .caht
      beq  wb,=ch$ht,trim1    jump if horizontal tab
fi
      bne  wb,wc,trim3        jump if non-blank found
trim1  dcw  wa                else decrement character count
      bnz  wa,trim0           loop back if more to check
*
*      here if result is null (null or all-blank input)
*
trim2  mov  xr,dnamp          wipe out input string block
      mov  =nulls,xr         load null result
      brn  trim5             merge to exit

```

```

*
*      trimr (continued)
*
*      here with non-blank found (merge for no trim)
*
trim3  mov  wa,sclen(xr)          set new length
      mov  xr,xl                 copy string pointer
      psc  xl,wa                 ready for storing blanks
      ctb  wa,schar              get length of block in bytes
      add  xr,wa                 point past new block
      mov  wa,dnamp              set new top of storage pointer
      lct  wa,=cfp$c            get count of chars in word
      zer  wc                   set zero char

*
*      loop to zero pad last word of characters
*
trim4  sch  wc,(xl)+             store zero character
      bct  wa,trim4             loop back till all stored
      csc  xl                   complete store characters

*
*      common exit point
*
trim5  zer  xl                  clear garbage xl pointer
      exi                      return to caller
      enp                      end procedure trimr

```

```

*
*      trxeq -- execute function type trace
*
*      trxeq is used to execute a trace when a fourth argument
*      has been supplied. trace has already been decremented.
*
*      (xr)                pointer to trblk
*      (xl,wa)              name base,offset for variable
*      jsr  trxeq           call to execute trace
*      (wb,wc,ra)           destroyed
*
*      the following stack entries are made before passing
*      control to the trace function using the cfunc routine.
*
*
*      trxeq return point word(s)
*      saved value of trace keyword
*      trblk pointer
*      name base
*      name offset
*      saved value of r$cod
*      saved code ptr (-r$cod)
*      saved value of flptr
*      flptr ----- zero (dummy fail offset)
*                      nmblok for variable name
*      xs ----- trace tag
*
*      r$cod and the code ptr are set to dummy values which
*      cause control to return to the trxeq procedure on success
*      or failure (trxeq ignores a failure condition).
*
trxeq  prc  r,0                entry point (recursive)
      mov  r$cod,wc            load code block pointer
      scp  wb                  get current code pointer
      sub  wc,wb               make code pointer into offset
      mov  kvtra,-(xs)         stack trace keyword value
      mov  xr,-(xs)            stack trblk pointer
      mov  xl,-(xs)            stack name base
      mov  wa,-(xs)            stack name offset
      mov  wc,-(xs)            stack code block pointer
      mov  wb,-(xs)            stack code pointer offset
      mov  flptr,-(xs)         stack old failure pointer
      zer  -(xs)               set dummy fail offset
      mov  xs,flptr            set new failure pointer
      zer  kvtra               reset trace keyword to zero
      mov  =trxdc,wc           load new (dummy) code blk pointer
      mov  wc,r$cod            set as code block pointer
      lcp  wc                  and new code pointer

```

```

*
*      trxeq (continued)
*
*      now prepare arguments for function
*
      mov  wa,wb              save name offset
      mov  *nmsi$,wa          load nmblk size
      jsr  alloc              allocate space for nmblk
      mov  =b$nm1,(xr)        set type word
      mov  x1,nmbas(xr)        store name base
      mov  wb,nmofs(xr)        store name offset
      mov  6(xs),x1            reload pointer to trblk
      mov  xr,-(xs)            stack nmblk pointer (1st argument)
      mov  trtag(x1),-(xs)     stack trace tag (2nd argument)
      mov  trfnc(x1),x1        load trace vrbk pointer
      mov  vrfnc(x1),x1        load trace function pointer
      beq  x1,=stndf,trxq2     jump if not a defined function
      mov  =num02,wa           set number of arguments to two
      brn  cfunc               jump to call function

*
*      see o$txr for details of return to this point
*
trxq1  mov  flptr,xs           point back to our stack entries
      ica  xs                 pop off garbage fail offset
      mov  (xs)+,flptr        restore old failure pointer
      mov  (xs)+,wb           reload code offset
      mov  (xs)+,wc           load old code base pointer
      mov  wc,xr              copy cdblk pointer
      mov  cdstm(xr),kvstn     restore stmtnt no
      mov  (xs)+,wa           reload name offset
      mov  (xs)+,x1           reload name base
      mov  (xs)+,xr           reload trblk pointer
      mov  (xs)+,kvtra         restore trace keyword value
      add  wc,wb              recompute absolute code pointer
      lcp  wb                 restore code pointer
      mov  wc,r$cod           and code block pointer
      exi                    return to trxeq caller

*
*      here if the target function is not defined
*
trxq2  erb  197,trace fourth   arg is not function name or null
*
      enp                    end procedure trxeq

```

```

*
*      xscan -- execution function argument scan
*
*      xscan scans out one token in a prototype argument in
*      array,clear,data,define,load function calls. xscan
*      calls must be preceded by a call to the initialization
*      procedure xscni. the following variables are used.
*
*      r$xsc          pointer to scblk for function arg
*      xsofs          offset (num chars scanned so far)
*
*      (wa)           non-zero to skip and trim blanks
*      (wc)           delimiter one (ch$xx)
*      (xl)           delimiter two (ch$xx)
*      jsr xscan      call to scan next item
*      (xr)           pointer to scblk for token scanned
*      (wa)           completion code (see below)
*      (wc,xl)        destroyed
*
*      the scan starts from the current position and continues
*      until one of the following three conditions occurs.
*
*      1)  delimiter one is encountered  (wa set to 1)
*
*      2)  delimiter two encountered  (wa set to 2)
*
*      3)  end of string encountered  (wa set to 0)
*
*      the result is a string containing all characters scanned
*      up to but not including any delimiter character.
*      the pointer is left pointing past the delimiter.
*
*      if only one delimiter is to be detected, delimiter one
*      and delimiter two should be set to the same value.
*
*      in the case where the end of string is encountered, the
*      string includes all the characters to the end of the
*      string. no further calls can be made to xscan until
*      xscni is called to initialize a new argument scan

```

<pre> * * xscan (continued) * xscan prc e,0 mov wb,xscwb mov wa,-(xs) mov wa,-(xs) mov r\$xsc,xr mov sclen(xr),wa mov xsofs,wb sub wb,wa bze wa,xscn3 plc xr,wb </pre>	<pre> entry point preserve wb record blank skip flag and second copy point to argument string load string length load current offset get number of remaining characters jump if no characters left point to current character </pre>
<pre> * * loop to search for delimiter * xscn1 lch wb,(xr)+ beq wb,wc,xscn4 beq wb,xl,xscn5 bze (xs),xscn2 icv xsofs </pre>	<pre> load next character jump if delimiter one found jump if delimiter two found jump if not skipping blanks assume blank and delete it </pre>
<pre> if .caht beq wb,=ch\$ht,xscn2 fi </pre>	<pre> jump if horizontal tab </pre>
<pre> if .cavt beq wb,=ch\$vt,xscn2 fi </pre>	<pre> jump if vertical tab </pre>
<pre> beq wb,=ch\$bl,xscn2 dcvt xsofs zer (xs) </pre>	<pre> jump if blank undelete non-blank character and discontinue blank checking </pre>
<pre> * * here after performing any leading blank trimming. * xscn2 dcvt wa bnz wa,xscn1 </pre>	<pre> decrement count of chars left loop back if more chars to go </pre>
<pre> * * here for runout * xscn3 mov r\$xsc,xl mov sclen(xl),wa mov xsofs,wb sub wb,wa zer r\$xsc zer xscrt brn xscn7 </pre>	<pre> point to string block get string length load offset get substring length clear string ptr for collector set zero (runout) return code jump to exit </pre>

```

*
*      xscan (continued)
*
*      here if delimiter one found
*
xscn4  mov  =num01,xscrt          set return code
      brn  xscn6                jump to merge
*
*      here if delimiter two found
*
xscn5  mov  =num02,xscrt          set return code
*
*      merge here after detecting a delimiter
*
xscn6  mov  r$xsc,xl             reload pointer to string
      mov  sclen(xl),wc          get original length of string
      sub  wa,wc                 minus chars left = chars scanned
      mov  wc,wa                 move to reg for sbstr
      mov  xsofs,wb              set offset
      sub  wb,wa                 compute length for sbstr
      icv  wc                    adjust new cursor past delimiter
      mov  wc,xsofs              store new offset
*
*      common exit point
*
xscn7  zer  xr                   clear garbage character ptr in xr
      jsr  sbstr                 build sub-string
      ica  xs                     remove copy of blank flag
      mov  (xs)+,wb              original blank skip/trim flag
      bze  sclen(xr),xscn8       cannot trim the null string
      jsr  trimr                 trim trailing blanks if requested
*
*      final exit point
*
xscn8  mov  xscrt,wa             load return code
      mov  xscwb,wb             restore wb
      exi                       return to xscan caller
      enp                       end procedure xscan

```

```

*
*      xscni -- execution function argument scan
*
*      xscni initializes the scan used for prototype arguments
*      in the clear, define, load, data, array functions. see
*      xscan for the procedure which is used after this call.
*
*      -(xs)                argument to be scanned (on stack)
*      jsr  xscni            call to scan argument
*      ppm  loc              transfer loc if arg is not string
*      ppm  loc              transfer loc if argument is null
*      (xs)                  popped
*      (xr,r$xsc)            argument (scblk ptr)
*      (wa)                  argument length
*      (ia,ra)               destroyed
*
xscni  prc   n,2              entry point
      jsr   gtstg            fetch argument as string
      ppm   xsci1            jump if not convertible
      mov   xr,r$xsc         else store scblk ptr for xscan
      zer   xsofs            set offset to zero
      bze   wa,xsci2         jump if null string
      exi                      return to xscni caller

*
*      here if argument is not a string
*
xsci1  exi   1              take not-string error exit
*
*      here for null string
*
xsci2  exi   2              take null-string error exit
      enp                      end procedure xscni

```


spitbol – stack overflow section

```
*
*      control comes here if the main stack overflows
*
      sec                                start of stack overflow section
*
      add  =num04,errft                 force conclusive fatal error
      mov  flptr,xs                     pop stack to avoid more fails
      bnz  gbcfl,stak1                  jump if garbage collecting
      erb  gbcfl,stak1                  jump if garbage collecting
*
*      no chance of recovery in mid garbage collection
*
stak1  mov  =endso,xr                   point to message
      zer  kvdmp                        memory is undumpable
      brn  stopr                       give up
```

spitbol – error section

```

*
*      this section of code is entered whenever a procedure
*      return via an err parameter or an erb opcode is obeyed.
*
*      (wa)                is the error code
*
*      the global variable stage indicates the point at which
*      the error occurred as follows.
*
*      stage=stgic          error during initial compile
*
*      stage=stgxc          error during compile at execute
*                          time (code, convert function calls)
*
*      stage=stgev          error during compilation of
*                          expression at execution time
*                          (eval, convert function call).
*
*      stage=stgxt          error at execute time. compiler
*                          not active.
*
*      stage=stgce          error during initial compile after
*                          scanning out the end line.
*
*      stage=stgxe          error during compile at execute
*                          time after scanning end line.
*
*      stage=stgee          error during expression evaluation
*
*      sec                  start of error section
*
error    beq  r$cim,=cmlab,cmple      jump if error in scanning label
        mov  wa,kvert                save error code
        zer  scnrs                    reset rescan switch for scane
        zer  scngo                    reset goto switch for scane
if.cpol
        mov  =num01,polcs            reset poll count
        mov  =num01,polct            reset poll count
fi
        mov  stage,xr                load current stage
        bsw  xr,stgno                jump to appropriate error circuit
        iff  stgic,err01             initial compile
        iff  stgxc,err04             execute time compile
        iff  stgev,err04             eval compiling expr.
        iff  stgee,err04             eval evaluating expr
        iff  stgxt,err05             execute time
        iff  stgce,err01             compile - after end

```

```
iff    stgxe,err04
esw
```

```
xeq compile-past end
end switch on error type
```

```

*
*      error during initial compile
*
*      the error message is printed as part of the compiler
*      output. this printout includes the offending line (if not
*      printed already) and an error flag under the appropriate
*      column as indicated by scnse unless scnse is set to zero.
*
*      after printing the message, the generated code is
*      modified to an error call and control is returned to
*      the cmpil procedure after resetting the stack pointer.
*
*      if the error occurs after the end line, control returns
*      in a slightly different manner to ensure proper cleanup.
*
err01  mov  cmpxs,xs          reset stack pointer
      ssl  cmpss             restore s-r stack ptr for cmpil
      bnz  errsp,err03       jump if error suppress flag set
if .cera
  if .csfn
    mov  cmpsn,wc           current statement
    jsr  filnm              obtain file name for this statement
  fi
    mov  scnse,wb           column number
    mov  rdcln,wc           line number
    mov  rdcln,wc           line number
    jsr  sysea              advise system of error
    ppm  erra3              if system does not want print
    mov  xr,-(xs)           save any provided print message
  fi
    mov  erich,erlst        set flag for listr
    jsr  listr              list line
    jsr  prtis              terminate listing
    zer  erlst              clear listr flag
    mov  scnse,wa           load scan element offset
    bze  wa,err02           skip if not set
if .caht
  lct  wb,wa               loop counter
  icv  wa                  increase for ch$ex
  mov  r$cim,xl            point to bad statement
  jsr  alocs               string block for error flag
  mov  xr,wa               remember string ptr
  psc  xr                  ready for character storing
  plc  xl                  ready to get chars
*
*      loop to replace all chars but tabs by blanks
*
err01  lch  wc,(xl)+        get next char
      beq  wc,=ch$ht,err02  skip if tab
      mov  =ch$b1,wc        get a blank

```

```

*
*      merge to store blank or tab in error line
*
err2 sch  wc,(xr)+      store char
      bct  wb,err2      loop
      mov  =ch$ex,xl     exclamation mark
      sch  xl,(xr)       store at end of error line
      csc  xr            end of sch loop
      mov  =stnpd,profs   allow for statement number
      mov  wa,xr          point to error line
      jsr  prtst         print error line
else
      mti  prlen         get print buffer length
      mfi  gtinsi        store as signed integer
      add  =stnpd,wa      adjust for statement number
      mti  wa            copy to integer accumulator
      rmi  gtinsi        remainder modulo print bfr length
      sti  profs         use as character offset
      mov  =ch$ex,wa     get exclamation mark
      jsr  prtch         generate under bad column
fi

*
*      here after placing error flag as required
*
err02 jsr  prtis         print blank line
if.cera
      mov  (xs)+,xr      restore any sysea message
      bze  xr,err2       did sysea provide message to print
      jsr  prtst         print sysea message
fi
err0  jsr  ermsg         generate flag and error message
      add  =num03,1stlc   bump page ctr for blank, error, blk
err3  zer  xr            in case of fatal error
      bhi  errft,=num03,stopr pack up if several fatals

*
*      count error, inhibit execution if required
*
icv   cmerc             bump error count
add   cswer,noxeq       inhibit xeq if -noerrors
bne   stage,=stgic,cmp10 special return if after end line

```

```

*
*      loop to scan to end of statement
*
err03  mov  r$cim,xr          point to start of image
      plc  xr                point to first char
      lch  xr,(xr)           get first char
      beq  xr,=ch$mn,cmpce   jump if error in control card
      zer  scnrs             clear rescan flag
      mnz  errsp            set error suppress flag
      jsr  scane             scan next element
      bne  xl,=t$smc,err03   loop back if not statement end
      zer  errsp            clear error suppress flag

*
*      generate error call in code and return to cmpil
*
      mov  *cdcod,cwcof      reset offset in ccbk
      mov  =ocer$,wa        load compile error call
      jsr  cdwrd             generate it
      mov  cwcof,cmsoc(xs)   set success fill in offset
      mnz  cmffc(xs)        set failure fill in flag
      jsr  cdwrd             generate succ. fill in word
      brn  cmpse            merge to generate error as cdfal

*
*      error during execute time compile or expression evaluatio
*
*      execute time compilation is initiated through gtcod or
*      gtxep which are called by compile, code or eval.
*      before causing statement failure through exfal it is
*      helpful to set keyword errtext and for generality
*      these errors may be handled by the setexit mechanism.
*
err04  bge  errft,=num03,labo1  abort if too many fatal errors
if .cpol
      beq  kvert,=nm320,err06   treat user interrupt specially
fi

      zer  r$ccb             forget garbage code block
      mov  *cccod,cwcof      set initial offset (mbe catspaw)
      ssl  iniss             restore main prog s-r stack ptr
      jsr  ertex             get fail message text
      dca  xs               ensure stack ok on loop start

*
*      pop stack until find flptr for most deeply nested prog.
*      defined function call or call of eval / code.
*
err04  ica  xs              pop stack
      beq  xs,flprt,errc4     jump if prog defined fn call found
      bne  xs,gtcef,err04     loop if not eval or code call yet
      mov  =stgxt,stage       re-set stage for execute
      mov  r$gtc,r$cod        recover code ptr
      mov  xs,flptr          restore fail pointer
      zer  r$cim             forget possible image

```

```

if .cinc
    zer    cnind                forget possible include
fi

    *
    *      test errlimit
    *
errb4  bnz  kverl,err07          jump if errlimit non-zero
      brn  exfal                fail

    *
    *      return from prog. defined function is outstanding
    *
errc4  mov  flptr,xs            restore stack from flptr
      brn  errb4                merge

```

```

*
*      error at execute time.
*
*      the action taken on an error is as follows.
*
*      if errlimit keyword is zero, an abort is signalled,
*      see coding for system label abort at l$abo.
*
*      otherwise, errlimit is decremented and an errtype trace
*      generated if required. control returns either via a jump
*      to continue (to take the failure exit) or a specified
*      setexit trap is executed and control passes to the trap.
*      if 3 or more fatal errors occur an abort is signalled
*      regardless of errlimit and setexit - looping is all too
*      probable otherwise. fatal errors include stack overflow
*      and exceeding stlimit.
*
err05  ssl   iniss                      restore main prog s-r stack ptr
      bnz   dmvch,err08                jump if in mid-dump
*
*      merge here from err08 and err04 (error 320)
*
err06  bze   kverl,labo1                abort if errlimit is zero
      jsr   ertex                      get fail message text
*
*      merge from err04
*
err07  bge   errft,=num03,labo1        abort if too many fatal errors
      dcw   kverl                      decrement errlimit
      mov   r$ert,xl                   load errtype trace pointer
      jsr   ktrex                      generate errtype trace if required
      mov   r$cod,wa                   get current code block
      mov   wa,r$cnt                   set cdblk ptr for continuation
      scp   wb                         current code pointer
      sub   wa,wb                      offset within code block
      mov   wb,ctxoc                   save code ptr offset for scontinue
      mov   flptr,xr                   set ptr to failure offset
      mov   (xr),ctxof                 save failure offset for continue
      mov   r$sxc,xr                   load setexit cdblk pointer
      bze   xr,lcnt1                   continue if no setexit trap
      zer   r$sxc                      else reset trap
      mov   =nulls,ctxvr               reset setexit arg to null
      mov   (xr),xl                   load ptr to code block routine
      bri   xl                         execute first trap statement
*
*      interrupted partly through a dump whilst store is in a
*      mess so do a tidy up operation. see dumph for details.
*
err08  mov   dmvch,xr                  chain head for affected vrbks
      bze   xr,err06                   done if zero
      mov   (xr),dmvch                 set next link as chain head
      jsr   setvr                      restore vrget field

```



```
*  
*      label to mark end of code  
*  
s$yyy  brn  err08                                loop through chain
```

spitbol – here endeth the code

*

* end of assembly

*

end

end macro-spitbol assembly