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SUPPLEMENT TO UCRL 81808,

"LSI-11 WRITABLE CONTROL STORE ENHANCEMENTS TO U.C.S.D. PASCAL"

Gordon Smith and Roger Anderson

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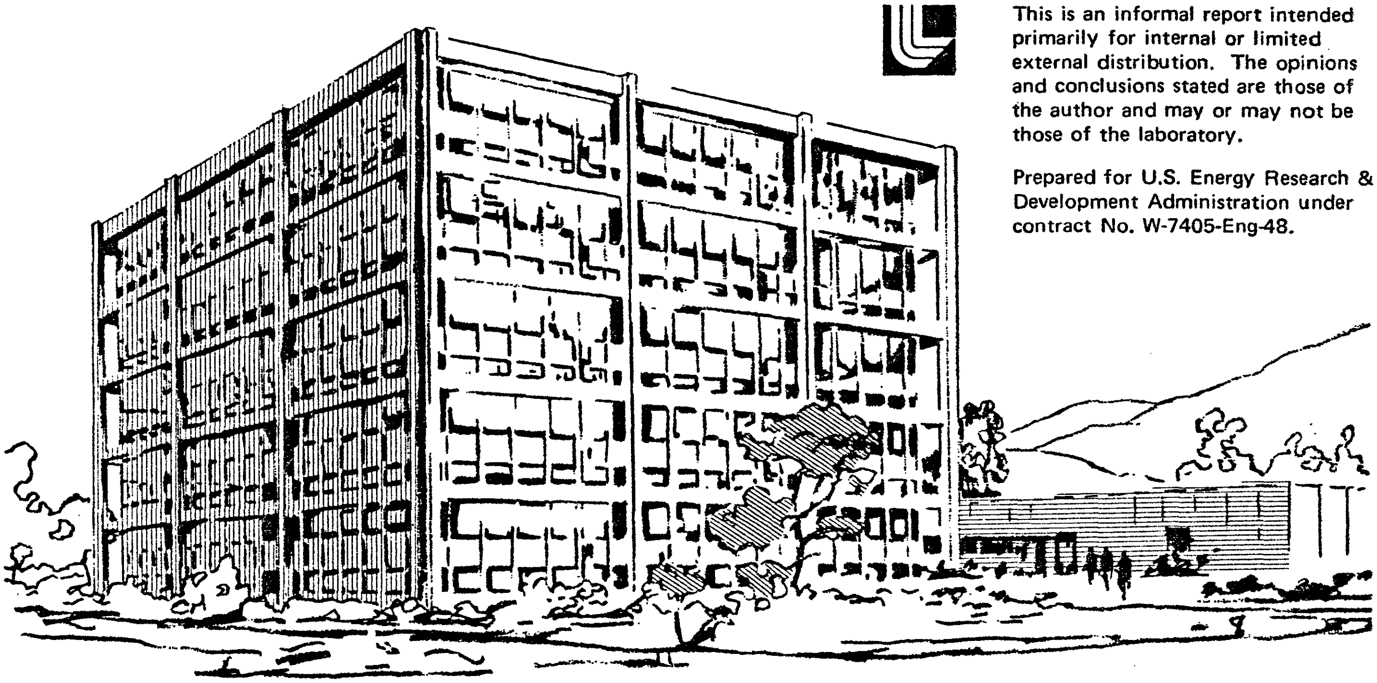

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SUPPLEMENT TO UCRL REPORT 81808 "LSI-11 WRITABLE CONTROL STORE ENHANCEMENTS TO U.C.S.D. PASCAL"

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This report is a supplement to UCRL report 81808. It contains detailed test results, more information regarding test procedures, listings of software used in the testing, and microcode listings. Tests were run using the LSI-11/2 (KD11-HA) with MSV11-DD 32K memory and the U.C.S.D. Pascal I.4 system.

Appendix A - P-machine Instruction Execution Speeds.
These results are from the test series described in UCRL 81808.

Report 1 - Compilations (partially listed in Table 1 of report)
Report 2 - Whetstone
Report 3 - Sorts
Report 4 - Cross-Referencer
Report 5 - Balanced Tree Search and Insertion

Appendix B - Standard Procedure Execution Speeds.
Execution speeds of standard procedures were measured in the same test series. Note, no microcode was used for these tests.

Report 8 - (five of six) Compilations
Report 9 - Whetstone
Report 10 - Sorts
Report 11 - Cross-Referencer
Report 12 - Balanced Tree Search and Insertion

Appendix C - Execution Speeds of Microcoded P-machine Instructions.
These results were summarized in Table 2 of UCRL 81808. Note, LDO, SRO, and LLA are not in microcode. They were removed to make room for microcode routines needed to do the timing.

Report 6 - Microcode Times
Report 7 - Macrocode Times

Appendix D - Program Execution Speeds.
These results were summarized, with regard to improvements derived from microcode, in Figure 1 of UCRL 81808. The U.C.S.D. P-machine interpreter can be conditionally assembled to make use of extended PDP-11 instruction sets. Four versions of

the interpreter were tested:

ANY 11 - only uses the base PDP-11 instruction set

LSI-11 - uses the base LSI-11 instruction set

LSI/EIS/FIS - uses the base LSI-11 instructions plus EIS/FIS instructions

LSI/EIS/FIS/MIC - uses base LSI-11 instructions, EIS/FIS instructions, and microcode

Report A - Compilations
Report B - Whetstone
Report C - Sorts
Report D - Cross-Referencer and Balanced Tree Search and Insertion

Appendix E - Report Generators

STATS - used to convert raw test scores to report 1-7

CSPSTATS - used to convert the raw test scores to report 8-12

Appendix F - Pascal Test Programs

WHETSTONE - Whetstone Synthetic Benchmark

BTSI - Balanced Tree Search and Insertion

RQUICKSORT - Quicksort (recursive)

QUICKSORT - Quicksort (nonrecursive)

HEAPSORT - Heapsort

Appendix G - Microcode Used for Timing

CNTER.MIC - used for reports 1-5 and 7

CNTINT.MIC - used for report6

Appendix H - MACRO-11 Code Used For Timing.
These are the key assembly code routines that were inserted into the U.C.S.D. P-machine interpreter to do the timing.

P-code Timer - used for reports 1-7

Standard Procedure Timer - used for reports 8-12

Appendix I - Microcode Listing

INTERP.MIC

Test Procedure Notes

Some of these tests included an interactive portion. In all cases instructions were enterred into the input buffer before the prompts occurred.

The timing method employed in these tests is as follows: A table was maintained in macro level code which contained two floating point numbers for each opcode or standard procedure being measured (see Appendix H). These two numbers were used to count the frequency of execution and number of microseconds spent executing each instruction. The timing mechanism was turned on manually by going into ODT and changing a branch instruction, which had been preventing the execution of the timing routine, to a NOP. When the data had been collected it was output to a blank floppy on volume #5 by manually causing the execution of a SYIORQ call. Next,the Pascal programs STATS or CSPSTATS were used to input the data from #5 by using a UNITREAD.

In STATS the raw test results were adjusted by the following factors to isolate the times for the individual instructions:

CNTOVH - Count overhead. The time required for turning the real time clock on and off.
COREOVH - Interpreter fetch sequence overhead. The average time spent in the interpreter fetch sequence for non SLDCI instructions.
SLDCIOVHD - Interpreter fetch sequence overhead for SLDCI instructions.

Note, these factors are estimates.

APPENDIX A - P-machine Instruction Execution Speeds

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REPORT1 - 6 COMPILATIONS



CNTOVH =  4.4 COREOVHD =  14.7 SLDCIOVHD =  7.4

 OPCODE     MNEM     FREQ    FPERC       MICS     AVEMICS  MPERC

   174        CIP    74795.0 . 203        4.7E7     632.4 .2158
   158        CSP    32362.0 .  88        3.8E7    1185.8 .1751
   161        FJP   318835.9 . 865        8.0E6      25.2 . 366
   173        RNP    91520.0 . 248        6.8E6      74.6 . 312
   171        SRO   174375.0 . 473        5.5E6      31.4 . 250
     0 SLDO-TOTAL   467642.0 .1268        5.4E6      11.6 . 248
   139        INN    40140.0 . 109        4.6E6     114.1 . 209
     0 SLDL-TOTAL   310613.9 . 842        3.6E6      11.6 . 165
   167        LDO   109881.9 . 298        3.6E6      32.4 . 162
   206        CLP    16692.0 .  45        3.4E6     205.1 . 156
   195       EQUI   166675.9 . 452        3.4E6      20.4 . 155
   185        UJP   144070.0 . 391        3.2E6      22.4 . 147
   188        LDM    44340.0 . 120        3.0E6      68.4 . 138
   204        STL    90584.0 . 246        2.8E6      31.4 . 130
   205        CXP     5025.0 .  14        2.4E6     486.8 . 112
   172        XJP    38080.0 . 103        2.4E6      62.8 . 109
   130        ADI   219366.0 . 595        2.1E6       9.7 .  97
   156        UNI    19840.0 .  54        1.8E6      91.8 .  83
   190        LDB    84842.0 . 230        1.8E6      20.8 .  81
   165        LAO    50730.0 . 138        1.6E6      31.0 .  72
     0 SIND-TOTAL    88608.0 . 240        1.5E6      17.0 .  69
   198        LLA    48589.0 . 132        1.5E6      30.7 .  68
   243     SLDO12   126586.9 . 343        1.5E6      11.6 .  67
   127 SLDC-TOTAL   565457.0 .1533        1.4E6       2.5 .  64
   164        IXA    15363.0 .  42        1.2E6      75.2 .  53
   234      SLDO3    94888.0 . 257        1.1E6      11.6 .  50
   203       NEQI    47859.0 . 130        1.0E6      21.1 .  46
   179        LDC    15250.0 .  41     960789.9      63.0 .  44
   163        IND    29679.0 .  80     957337.0      32.3 .  44
   216      SLDL1    81766.0 . 222     949907.3      11.6 .  43
   244     SLDO13    73143.0 . 198     850692.6      11.6 .  39
   142        MOD     3662.0 .  10     732287.8     200.0 .  33
   235      SLDO4    62186.0 . 169     722506.4      11.6 .  33
   218      SLDL3    61331.0 . 166     713398.9      11.6 .  33
   217      SLDL2    60326.0 . 164     701567.4      11.6 .  32
   182        LOD     9334.0 .  25     622686.5      66.7 .  28
   200       LEQI    27982.0 .  76     600088.8      21.4 .  27
   202        LDL    17580.0 .  48     593980.9      33.8 .  27
   132        AND    32472.0 .  88     551360.7      17.0 .  25
   193        RBP     6103.0 .  17     550577.6      90.2 .  25
   160        ADJ    19086.0 .  52     538684.4      28.2 .  25
   249      SIND1    26416.0 .  72     518219.4      19.6 .  24
   219      SLDL4    40801.0 . 111     474034.9      11.6 .  22
   199       LDCI    21163.0 .  57     457178.7      21.6 .  21
   159       LDCN    47142.0 . 128     420703.8       8.9 .  19
 162        INC    23078.0 .  63    417271.2     18.1 .  19
 197       GRTI    16856.0 .  46    388851.4     23.1 .  18
 233      SLDO2    30956.0 .  84    359833.4     11.6 .  16
 178        LDA     6829.0 .  19    348202.1     51.0 .  16
 175    COMPARE     2346.0 .   6    343229.4    146.3 .  16
 191        STB    27875.0 .  76    312584.4     11.2 .  14
 248      SINDO    27130.0 .  74    303608.9     11.2 .  14
 194        CBP     1085.0 .   3    278014.4    256.2 .  13
 168        MOV     3733.0 .  10    275516.7     73.8 .  13
 228     SLDL13    23345.0 .  63    271198.5     11.6 .  12
 149        SBI    27279.0 .  74    264305.0      9.7 .  12
 154        STO    25135.0 .  68    261939.5     10.4 .  12
 196       GEQI    12313.0 .  33    257588.7     20.9 .  12
 169        MVB     1515.0 .   4    203048.4    134.0 .   9
 236      SLDO5    17377.0 .  47    201954.2     11.6 .   9
 242     SLDO11    16266.0 .  44    188717.3     11.6 .   9
 147        NOT    22013.0 .  60    188366.6      8.6 .   9
 255      SIND7     8510.0 .  23    166848.0     19.6 .   8
 237      SLDO6    13534.0 .  37    157391.6     11.6 .   7
 170        SAS      880.0 .   2    135383.9    153.8 .   6
 134        DVI      638.0 .   2    127556.1    199.9 .   6
 250      SIND2     6283.0 .  17    123326.6     19.6 .   6
 141        IOR    11848.0 .  32    114837.2      9.7 .   5
 253      SIND5     5613.0 .  15    109940.6     19.6 .   5
 222      SLDL7     9247.0 .  25    107436.3     11.6 .   5
 252      SIND4     5356.0 .  15    104992.4     19.6 .   5
 143        MPI     1443.0 .   4    100441.6     69.6 .   5
 254      SIND6     5093.0 .  14     99864.7     19.6 .   5
 238      SLDO7     8203.0 .  22     95335.7     11.6 .   4
 220      SLDL5     7810.0 .  21     90825.0     11.6 .   4
 232      SLDO1     7522.0 .  20     87591.8     11.6 .   4
 251      SIND3     4207.0 .  11     82487.3     19.6 .   4
 241     SLDO10     6205.0 .  17     72054.5     11.6 .   3
 239      SLDO8     6138.0 .  17     71378.2     11.6 .   3
 201       LESI     2949.0 .   8     67435.1     22.9 .   3
 221      SLDL6     5487.0 .  15     63706.3     11.6 .   3
 225     SLDL10     4886.0 .  13     56741.4     11.6 .   3
 229     SLDL14     4576.0 .  12     53146.4     11.6 .   2
 223      SLDL8     3354.0 .   9     38946.6     11.6 .   2
 245     SLDO14     3121.0 .   8     36262.9     11.6 .   2
 189        STM      347.0 .   1     32715.3     94.3 .   1
 227     SLDL12     2629.0 .   7     30629.1     11.7 .   1
 224      SLDL9     2545.0 .   7     29598.5     11.6 .   1
 166        LCA     1396.0 .   4     28987.4     20.8 .   1
 148        SRS      104.0 .   0     24120.6    231.9 .   1
 138        FLT       86.0 .   0     22687.4    263.8 .   1
 184        STR      346.0 .   1     19764.4     57.1 .   1
 240      SLDO9     1516.0 .   4     17625.4     11.6 .   1
 226     SLDL11     1318.0 .   4     15317.2     11.6 .   1
 183    COMPARE       58.0 .   0     14672.2    253.0 .   1
 137        FLO       48.0 .   0     14576.2    303.7 .   1
 230     SLDL15     1165.0 .   3     13516.5     11.6 .   1
 186        LDP      158.0 .   0     10818.2     68.5 .   0
 135        DVR       48.0 .   0      5718.2    119.1 .   0
 208        S1P      606.0 .   2      5387.4      8.9 .   0
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207        CGP    21.0 .   0      4771.9     227.2 .   0
128        ABI   313.0 .   1      3633.7      11.6 .   0
131        ADR    77.0 .   0      2863.3      37.2 .   0
144        MPR    57.0 .   0      2595.3      45.5 .   0
187        STP    18.0 .   0      2200.2     122.2 .   0
145        NGI   220.0 .   1      1875.0       8.5 .   0
133        DIF    18.0 .   0      1442.2      80.1 .   0
231     SLDL16    28.0 .   0       325.2      11.6 .   0
129        ABR     0.0 .   0         0.0       0.0 .   0
136        CHK     0.0 .   0         0.0       0.0 .   0
140        INT     0.0 .   0         0.0       0.0 .   0
146        NGR     0.0 .   0         0.0       0.0 .   0
150        SBR     0.0 .   0         0.0       0.0 .   0
151        SGS     0.0 .   0         0.0       0.0 .   0
152        SQI     0.0 .   0         0.0       0.0 .   0
153        SQR     0.0 .   0         0.0       0.0 .   0
155        IXS     0.0 .   0         0.0       0.0 .   0
157        S2P     0.0 .   0         0.0       0.0 .   0
176    COMPARE     0.0 .   0         0.0       0.0 .   0
177    COMPARE     0.0 .   0         0.0       0.0 .   0
180    COMPARE     0.0 .   0         0.0       0.0 .   0
181    COMPARE     0.0 .   0         0.0       0.0 .   0
192        IXP     0.0 .   0         0.0       0.0 .   0
209        IXB     0.0 .   0         0.0       0.0 .   0
210        BYT     0.0 .   0         0.0       0.0 .   0
211        EFJ     0.0 .   0         0.0       0.0 .   0
212        NFJ     0.0 .   0         0.0       0.0 .   0
213        BPT     0.0 .   0         0.0       0.0 .   0
214        XIT     0.0 .   0         0.0       0.0 .   0
215        NOP     0.0 .   0         0.0       0.0 .   0
246     SLDO15     0.0 .   0         0.0       0.0 .   0
247     SLDO16     0.0 .   0         0.0       0.0 .   0

                 3.7E6               2.2E8             .8197
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REPORT2 - WHETSTONE



CNTOVH =  4.4 COREOVHD =  14.7 SLDCIOVHD =  7.4

 OPCODE      MNEM      FREQ    FPERC        MICS     AVEMICS  MPERC

   158        CSP    6985.0 .  53        1.6E7     2361.7 .2058
   188        LDM  111345.9 . 841        6.1E6       54.5 . 756
   167        LDO  138008.9 .1043        4.4E6       32.2 . 554
   164        IXA   60693.0 . 458        4.1E6       67.5 . 511
   189        STM   55392.0 . 418        3.5E6       62.4 . 431
   207        CGP    8990.0 .  68        2.4E6      271.1 . 304
   165        LAO   79184.0 . 598        2.4E6       30.7 . 303
   135        DVR   11400.0 .  86        2.3E6      203.1 . 289
   198        LLA   71920.0 . 543        2.2E6       30.7 . 276
   144        MPR   23199.0 . 175        2.2E6       93.4 . 270
   138        FLT    4897.0 .  37        1.8E6      362.1 . 221
   131        ADR   36890.0 . 279        1.7E6       45.5 . 209
   136        CHK   60383.0 . 456        1.6E6       26.2 . 197
   179        LDC   33674.0 . 254        1.4E6       42.6 . 179
   171        SRO   41378.0 . 313        1.3E6       31.4 . 162
   206        CLP    6727.0 .  51        1.2E6      175.9 . 148
   173        RNP   15718.0 . 119        1.1E6       71.2 . 140
   143        MPI   14700.0 . 111     983710.9       66.9 . 123
   185        UJP   34131.0 . 258     824235.9       24.1 . 103
   149        SBI   75763.0 . 572     736652.6        9.7 .  92
   161        FJP   36100.0 . 273     683429.0       18.9 .  85
   127 SLDC-TOTAL  256649.9 .1939     647375.0        2.5 .  81
     0 SLDL-TOTAL   44174.0 . 334     511997.6       11.6 .  64
   216      SLDL1   42128.0 . 318     488266.1       11.6 .  61
   200       LEQI   22375.0 . 169     456415.5       20.4 .  57
   130        ADI   31964.0 . 241     310417.6        9.7 .  39
   150        SBR    4440.0 .  34     233199.0       52.5 .  29
   202        LDL    6320.0 .  48     203268.0       32.2 .  25
   205        CXP     149.0 .   1     109426.1      734.4 .  14
     0 SLDO-TOTAL    8758.0 .  66     101772.2       11.6 .  13
   201       LESI    4609.0 .  35      95615.1       20.7 .  12
   197       GRTI    4275.0 .  32      88531.5       20.7 .  11
   195       EQUI    4053.0 .  31      82744.7       20.4 .  10
   194        CBP     205.0 .   2      53403.5      260.5 .   7
   134        DVI     265.0 .   2      52978.5      199.9 .   7
   204        STL    1294.0 .  10      40603.6       31.4 .   5
   193        RBP     352.0 .   3      30753.8       87.4 .   4
     0 SIND-TOTAL    1671.0 .  13      24594.9       14.7 .   3
   217      SLDL2    1690.0 .  13      19597.0       11.6 .   2
   146        NGR     963.0 .   7      19319.7       20.1 .   2
   236      SLDO5    1511.0 .  11      17582.9       11.6 .   2
   237      SLDO6    1408.0 .  11      16337.2       11.6 .   2
   178        LDA     319.0 .   2      16091.1       50.4 .   2
   232      SLDO1    1279.0 .  10      14861.1       11.6 .   2
   235      SLDO4    1255.0 .   9      14574.5       11.6 .   2
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238        SLDO7    1080.0 .    8      12547.0       11.6 .    2
233        SLDO2    1001.0 .    8      11645.9       11.6 .    1
191          STB    1018.0 .    8      11435.2       11.2 .    1
182          LOD     191.0 .    1      11316.9       59.3 .    1
248        SIND0     973.0 .    7      10880.7       11.2 .    1
142          MOD      52.0 .    0      10394.8      199.9 .    1
190          LDB     483.0 .    4      10055.7       20.8 .    1
132          AND     554.0 .    4       9366.6       16.9 .    1
255        SIND7     432.0 .    3       8489.8       19.7 .    1
196         GEQI     365.0 .    3       7800.5       21.4 .    1
163          IND     223.0 .    2       7184.7       32.2 .    1
239        SLDO8     552.0 .    4       6415.8       11.6 .    1
175      COMPARE      80.0 .    1       5871.0       73.4 .    1
203         NEQI     221.0 .    2       4903.9       22.2 .    1
253        SIND5     224.0 .    2       4398.6       19.6 .    1
234        SLDO3     345.0 .    3       4010.5       11.6 .    1
229       SLDL14     306.0 .    2       3553.4       11.6 .    0
240        SLDO9     287.0 .    2       3325.3       11.6 .    0
181      COMPARE      40.0 .    0       2860.0       71.5 .    0
170          SAS       2.0 .    0       2140.8     1070.4 .    0
141          IOR      81.0 .    1        780.9        9.6 .    0
162          INC      39.0 .    0        704.1       18.1 .    0
252        SIND4      29.0 .    0        571.1       19.7 .    0
154          STO      50.0 .    0        527.0       10.5 .    0
166          LCA      24.0 .    0        499.6       20.8 .    0
241       SLDO10      40.0 .    0        472.0       11.8 .    0
128          ABI      19.0 .    0        431.1       22.7 .    0
139          INN       3.0 .    0        350.7      116.9 .    0
183      COMPARE       1.0 .    0        249.9      249.9 .    0
129          ABR      20.0 .    0        194.0        9.7 .    0
186          LDP       3.0 .    0        189.7       63.2 .    0
184          STR       3.0 .    0        152.7       50.9 .    0
251        SIND3       7.0 .    0        137.3       19.6 .    0
218        SLDL3      10.0 .    0        118.0       11.8 .    0
219        SLDL4      10.0 .    0        116.0       11.6 .    0
220        SLDL5      10.0 .    0        116.0       11.6 .    0
222        SLDL7      10.0 .    0        116.0       11.6 .    0
221        SLDL6      10.0 .    0        115.0       11.5 .    0
250        SIND2       3.0 .    0         58.7       19.6 .    0
254        SIND6       3.0 .    0         58.7       19.6 .    0
199         LDCI       1.0 .    0         20.9       20.9 .    0
147          NOT       2.0 .    0         16.8        8.4 .    0
133          DIF       0.0 .    0          0.0        0.0 .    0
137          FLO       0.0 .    0          0.0        0.0 .    0
140          INT       0.0 .    0          0.0        0.0 .    0
145          NGI       0.0 .    0          0.0        0.0 .    0
148          SRS       0.0 .    0          0.0        0.0 .    0
151          SGS       0.0 .    0          0.0        0.0 .    0
152          SQI       0.0 .    0          0.0        0.0 .    0
153          SQR       0.0 .    0          0.0        0.0 .    0
155          IXS       0.0 .    0          0.0        0.0 .    0
156          UNI       0.0 .    0          0.0        0.0 .    0
157          S2P       0.0 .    0          0.0        0.0 .    0
159         LDCN       0.0 .    0          0.0        0.0 .    0
160          ADJ       0.0 .    0          0.0        0.0 .    0
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168        MOV        0.0  .   0         0.0        0.0  .   0
169        MVB        0.0  .   0         0.0        0.0  .   0
172        XJP        0.0  .   0         0.0        0.0  .   0
174        CIP        0.0  .   0         0.0        0.0  .   0
176    COMPARE        0.0  .   0         0.0        0.0  .   0
177    COMPARE        0.0  .   0         0.0        0.0  .   0
180    COMPARE        0.0  .   0         0.0        0.0  .   0
187        STP        0.0  .   0         0.0        0.0  .   0
192        IXP        0.0  .   0         0.0        0.0  .   0
208        S1P        0.0  .   0         0.0        0.0  .   0
209        IXB        0.0  .   0         0.0        0.0  .   0
210        BYT        0.0  .   0         0.0        0.0  .   0
211        EFJ        0.0  .   0         0.0        0.0  .   0
212        NFJ        0.0  .   0         0.0        0.0  .   0
213        BPT        0.0  .   0         0.0        0.0  .   0
214        XIT        0.0  .   0         0.0        0.0  .   0
215        NOP        0.0  .   0         0.0        0.0  .   0
223      SLDL8        0.0  .   0         0.0        0.0  .   0
224      SLDL9        0.0  .   0         0.0        0.0  .   0
225     SLDL10        0.0  .   0         0.0        0.0  .   0
226     SLDL11        0.0  .   0         0.0        0.0  .   0
227     SLDL12        0.0  .   0         0.0        0.0  .   0
228     SLDL13        0.0  .   0         0.0        0.0  .   0
230     SLDL15        0.0  .   0         0.0        0.0  .   0
231     SLDL16        0.0  .   0         0.0        0.0  .   0
242     SLDO11        0.0  .   0         0.0        0.0  .   0
243     SLDO12        0.0  .   0         0.0        0.0  .   0
244     SLDO13        0.0  .   0         0.0        0.0  .   0
245     SLDO14        0.0  .   0         0.0        0.0  .   0
246     SLDO15        0.0  .   0         0.0        0.0  .   0
247     SLDO16        0.0  .   0         0.0        0.0  .   0
249      SIND1        0.0  .   0         0.0        0.0  .   0

                    1.3E6               8.0E7                .7884
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REPORT3 - 3 SORTS


CNTOVH =  4.4 COREOVHD =  14.7 SLDCIOVHD =  7.4

 OPCODE     MNEM     FREQ    FPERC        MICS     AVEMICS  MPERC

   164        IXA   358455.9 . 684        1.5E7       41.1 . 826
   136        CHK   493869.0 . 943        1.3E7       26.4 . 730
   165        LAO   358387.9 . 684        1.2E7       34.7 . 698
   199       LDCI   496169.9 . 947        1.1E7       21.7 . 603
   161        FJP   272157.0 . 520        6.5E6       23.7 . 362
     0 SLDL-TOTAL   534440.9 .1020        6.2E6       11.6 . 348
     0 SLDO-TOTAL   422487.0 . 807        4.9E6       11.6 . 275
   143        MPI    60077.0 . 115        4.6E6       76.4 . 257
   204        STL   135327.9 . 258        4.3E6       31.4 . 238
   142        MOD    18000.0 .  34        3.6E6      200.0 . 202
   201       LESI   142358.9 . 272        3.2E6       22.2 . 177
   171        SRO    95589.0 . 183        3.1E6       32.4 . 173
     0 SIND-TOTAL   260455.9 . 497        2.9E6       11.3 . 165
   248      SIND0   258751.9 . 494        2.9E6       11.3 . 163
   217      SLDL2   231017.9 . 441        2.7E6       11.6 . 151
   127 SLDC-TOTAL   901206.0 .1721        2.3E6        2.5 . 127
   149        SBI   218633.0 . 417        2.1E6        9.7 . 119
   185        UJP    71133.0 . 136        2.0E6       28.1 . 112
   158        CSP      218.0 .   0        1.9E6     8649.9 . 106
   200       LEQI    66709.0 . 127        1.4E6       20.6 .  77
   236      SLDO5   101971.9 . 195        1.2E6       11.6 .  66
   130        ADI   117672.0 . 225        1.1E6        9.7 .  64
   237      SLDO6    98129.0 . 187        1.1E6       11.6 .  64
   154        STO    99038.0 . 189        1.0E6       10.4 .  58
   218      SLDL3    88764.0 . 169        1.0E6       11.6 .  58
   219      SLDL4    87830.0 . 168        1.0E6       11.6 .  57
   167        LDO    21269.0 .  41        1.0E6       47.3 .  56
   234      SLDO3    85375.0 . 163     993027.4       11.6 .  56
   216      SLDL1    78364.0 . 150     913579.6       11.7 .  51
   134        DVI     4472.0 .   9     894532.7      200.0 .  50
   206        CLP     4502.0 .   9     780707.8      173.4 .  44
   196       GEQI    32156.0 .  61     769051.4       23.9 .  43
   197       GRTI    28978.0 .  55     666229.1       23.0 .  37
   207        CGP     2204.0 .   4     513452.5      233.0 .  29
   239      SLDO8    43454.0 .  83     505301.5       11.6 .  28
   173        RNP     6708.0 .  13     477792.1       71.2 .  27
   242     SLDO11    39805.0 .  76     462160.4       11.6 .  26
   202        LDL     9515.0 .  18     444890.4       46.8 .  25
   221      SLDL6    36289.0 .  69     420515.0       11.6 .  24
   205        CXP       87.0 .   0     285968.2     3287.0 .  16
   238      SLDO7    15818.0 .  30     183752.2       11.6 .  10
   235      SLDO4    14451.0 .  28     167630.8       11.6 .   9
   220      SLDL5    12156.0 .  23     140756.3       11.6 .   8
   241     SLDO10    11997.0 .  23     140066.3       11.7 .   8
   243     SLDO12     7868.0 .  15      91484.2       11.6 .   5
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240       SLDO9    3033.0 .   6      35003.7       11.5 .    2
195        EQUI    1527.0 .   3      31146.3       20.4 .    2
162         INC    1641.0 .   3      29741.9       18.1 .    2
194         CBP     115.0 .   0      28686.5      249.4 .    2
249       SIND1    1199.0 .   2      23607.1       19.7 .    1
193         RBP     207.0 .   0      19396.3       93.7 .    1
182         LOD     280.0 .   1      15490.0       55.3 .    1
175     COMPARE      92.0 .   0      13729.8      149.2 .    1
163         IND     271.0 .   1       8719.9       32.2 .    0
190         LDB     405.0 .   1       8413.5       20.8 .    0
170         SAS      30.0 .   0       6876.0      229.2 .    0
232       SLDO1     344.0 .   1       3998.6       11.6 .    0
178         LDA      72.0 .   0       3640.8       50.6 .    0
203        NEQI     151.0 .   0       3428.9       22.7 .    0
132         AND     201.0 .   0       3414.9       17.0 .    0
252       SIND4     146.0 .   0       2857.4       19.6 .    0
233       SLDO2     241.0 .   0       2793.9       11.6 .    0
255       SIND7     130.0 .   0       2555.0       19.7 .    0
253       SIND5      99.0 .   0       1948.1       19.7 .    0
198         LLA      58.0 .   0       1782.2       30.7 .    0
251       SIND3      84.0 .   0       1646.6       19.6 .    0
183     COMPARE       6.0 .   0       1496.4      249.4 .    0
147         NOT     150.0 .   0       1283.0        8.6 .    0
139         INN      10.0 .   0       1153.0      115.3 .    0
186         LDP      14.0 .   0        943.6       67.4 .    0
141         IOR      92.0 .   0        890.8        9.7 .    0
166         LCA      36.0 .   0        744.4       20.7 .    0
191         STB      62.0 .   0        696.8       11.2 .    0
168         MOV       3.0 .   0        569.7      189.9 .    0
250       SIND2      28.0 .   0        554.2       19.8 .    0
184         STR      10.0 .   0        513.0       51.3 .    0
172         XJP       7.0 .   0        411.3       58.8 .    0
254       SIND6      18.0 .   0        354.2       19.7 .    0
179         LDC       3.0 .   0        281.7       93.9 .    0
159        LDCN      25.0 .   0        225.5        9.0 .    0
213         BPT       3.0 .   0        223.7       74.6 .    0
229      SLDL14      18.0 .   0        211.2       11.7 .    0
222       SLDL7       2.0 .   0         22.8       11.4 .    0
128         ABI       0.0 .   0          0.0        0.0 .    0
129         ABR       0.0 .   0          0.0        0.0 .    0
131         ADR       0.0 .   0          0.0        0.0 .    0
133         DIF       0.0 .   0          0.0        0.0 .    0
135         DVR       0.0 .   0          0.0        0.0 .    0
137         FLO       0.0 .   0          0.0        0.0 .    0
138         FLT       0.0 .   0          0.0        0.0 .    0
140         INT       0.0 .   0          0.0        0.0 .    0
144         MPR       0.0 .   0          0.0        0.0 .    0
145         NGI       0.0 .   0          0.0        0.0 .    0
146         NGR       0.0 .   0          0.0        0.0 .    0
148         SRS       0.0 .   0          0.0        0.0 .    0
150         SBR       0.0 .   0          0.0        0.0 .    0
151         SGS       0.0 .   0          0.0        0.0 .    0
152         SQI       0.0 .   0          0.0        0.0 .    0
153         SQR       0.0 .   0          0.0        0.0 .    0
155         IXS       0.0 .   0          0.0        0.0 .    0
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156        UNI        0.0 .   0          0.0        0.0 .   0
157        S2P        0.0 .   0          0.0        0.0 .   0
160        ADJ        0.0 .   0          0.0        0.0 .   0
169        MVB        0.0 .   0          0.0        0.0 .   0
174        CIP        0.0 .   0          0.0        0.0 .   0
176    COMPARE        0.0 .   0          0.0        0.0 .   0
177    COMPARE        0.0 .   0          0.0        0.0 .   0
180    COMPARE        0.0 .   0          0.0        0.0 .   0
181    COMPARE        0.0 .   0          0.0        0.0 .   0
187        STP        0.0 .   0          0.0        0.0 .   0
188        LDM        0.0 .   0          0.0        0.0 .   0
189        STM        0.0 .   0          0.0        0.0 .   0
192        IXP        0.0 .   0          0.0        0.0 .   0
208        S1P        0.0 .   0          0.0        0.0 .   0
209        IXB        0.0 .   0          0.0        0.0 .   0
210        BYT        0.0 .   0          0.0        0.0 .   0
211        EFJ        0.0 .   0          0.0        0.0 .   0
212        NFJ        0.0 .   0          0.0        0.0 .   0
214        XIT        0.0 .   0          0.0        0.0 .   0
215        NOP        0.0 .   0          0.0        0.0 .   0
223      SLDL8        0.0 .   0          0.0        0.0 .   0
224      SLDL9        0.0 .   0          0.0        0.0 .   0
225     SLDL10        0.0 .   0          0.0        0.0 .   0
226     SLDL11        0.0 .   0          0.0        0.0 .   0
227     SLDL12        0.0 .   0          0.0        0.0 .   0
228     SLDL13        0.0 .   0          0.0        0.0 .   0
230     SLDL15        0.0 .   0          0.0        0.0 .   0
231     SLDL16        0.0 .   0          0.0        0.0 .   0
244     SLDO13        0.0 .   0          0.0        0.0 .   0
245     SLDO14        0.0 .   0          0.0        0.0 .   0
246     SLDO15        0.0 .   0          0.0        0.0 .   0
247     SLDO16        0.0 .   0          0.0        0.0 .   0

                    5.2E6               1.8E8           .6840
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REPORT4 - XREF



CNTOVH =  4.4 COREOVHD =  14.7 SLDCIOVHD =  7.4

 OPCODE      MNEM      FREQ    FPERC          MICS      AVEMICS  MPERC

     0 SLDO-TOTAL  890384.9 .2372          1.0E7         11.6 . 699
   205        CXP   28095.0 .  75          8.4E6        300.4 . 571
   161        FJP  339464.9 . 904          7.9E6         23.2 . 533
   171        SRO  177786.0 . 474          5.6E6         31.4 . 378
   194        CBP   22879.0 .  61          5.5E6        241.7 . 374
   193        RBP   50976.0 . 136          4.8E6         95.1 . 328
   158        CSP   36837.0 .  98          4.5E6        121.4 . 302
   163        IND  125529.0 . 334          4.0E6         32.2 . 273
   238      SLDO7  325100.9 . 866          3.8E6         11.6 . 255
     0 SIND-TOTAL  223230.0 . 595          3.6E6         16.1 . 243
   165        LAO   74501.0 . 198          3.0E6         40.9 . 206
   204        STL   91654.0 . 244          2.9E6         31.4 . 195
   188        LDM   11313.0 .  30          2.8E6        248.6 . 190
   164        IXA   29677.0 .  79          2.6E6         86.2 . 173
   195       EQUI  121750.9 . 324          2.5E6         20.4 . 168
   130        ADI  192529.0 . 513          1.9E6          9.7 . 126
   233      SLDO2  156852.9 . 418          1.8E6         11.6 . 123
   185        UJP   95495.0 . 254          1.8E6         18.4 . 119
   182        LOD   29962.0 .  80          1.6E6         52.1 . 106
   162        INC   83702.0 . 223          1.5E6         18.1 . 102
   197       GRTI   66320.0 . 177          1.5E6         22.6 . 101
   134        DVI    7213.0 .  19          1.4E6        200.0 .  98
   207        CGP    6614.0 .  18          1.4E6        204.9 .  92
   127 SLDC-TOTAL  462056.0 .1231          1.2E6          2.5 .  78
   156        UNI    4000.0 .  11          1.1E6        283.3 .  77
   248      SINDO   94237.0 . 251          1.1E6         11.2 .  72
     0 SLDL-TOTAL   90821.0 . 242          1.1E6         11.6 .  71
   190        LDB   50220.0 . 134          1.0E6         20.8 .  71
   236      SLDO5   88538.0 . 236          1.0E6         11.6 .  69
   199       LDCI   46613.0 . 124          1.0E6         21.6 .  68
   136        CHK   37999.0 . 101       991902.0         26.1 .  67
   235      SLDO4   81056.0 . 216       940653.4         11.6 .  64
   234      SLDO3   77936.0 . 208       904200.3         11.6 .  61
   173        RNP   11089.0 .  30       844203.0         76.1 .  57
   139        INN    7318.0 .  19       839126.2        114.7 .  57
   154        STO   79233.0 . 211       827137.6         10.4 .  56
   167        LDO   17295.0 .  46       821042.5         47.5 .  56
   252      SIND4   40431.0 . 108       796483.9         19.7 .  54
   206        CLP    4473.0 .  12       794997.6        177.7 .  54
   239      SLDO8   60631.0 . 162       703814.9         11.6 .  48
   149        SBI   67276.0 . 179       653349.4          9.7 .  44
   253      SIND5   33120.0 .  88       651970.0         19.7 .  44
   142        MOD    3135.0 .   8       626875.4        200.0 .  42
   198        LLA   20037.0 .  53       613961.3         30.6 .  42
   237      SLDO6   50790.0 . 135       590509.9         11.6 .  40
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232      SLDO1   48903.0 . 130    567656.7     11.6 .  38
249      SIND1   21158.0 .  56    416083.2     19.7 .  28
251      SIND3   20556.0 .  55    404093.4     19.7 .  27
143        MPI    4681.0 .  12    403428.8     86.2 .  27
169        MVB    2498.0 .   7    401980.2    160.9 .  27
181    COMPARE    4278.0 .  11    362915.2     84.8 .  25
200       LEQI   15348.0 .  41    332615.2     21.7 .  22
176    COMPARE    3333.0 .   9    312470.7     93.8 .  21
180    COMPARE    3333.0 .   9    310959.7     93.3 .  21
203       NEQI   13277.0 .  35    296209.3     22.3 .  20
178        LDA    5801.0 .  15    292961.9     50.5 .  20
147        NOT   31854.0 .  85    271295.6      8.5 .  18
225     SLDL10   22623.0 .  60    262261.7     11.6 .  18
132        AND   15399.0 .  41    260773.0     16.9 .  18
191        STB   21128.0 .  56    237637.2     11.2 .  16
224      SLDL9   16619.0 .  44    193135.1     11.6 .  13
250      SIND2    9105.0 .  24    179106.4     19.7 .  12
216      SLDL1   14662.0 .  39    169988.7     11.6 .  11
226     SLDL11   13598.0 .  36    157645.2     11.6 .  11
217      SLDL2   13225.0 .  35    152635.5     11.5 .  10
201       LESI    6034.0 .  16    129402.6     21.4 .   9
175    COMPARE     672.0 .   2    123923.8    184.4 .   8
196       GEQI    4886.0 .  13    103212.4     21.1 .   7
183    COMPARE     694.0 .   2     92705.6    133.6 .   6
141        IOR    9509.0 .  25     91888.1      9.7 .   6
255      SIND7    4528.0 .  12     88988.2     19.7 .   6
172        XJP     947.0 .   3     59466.3     62.8 .   4
229     SLDL14    4656.0 .  12     54090.4     11.6 .   4
218      SLDL3    3203.0 .   9     37203.7     11.6 .   3
223      SLDL8    2088.0 .   6     24173.2     11.6 .   2
166        LCA     844.0 .   2     17494.6     20.7 .   1
168        MOV     109.0 .   0     14767.1    135.5 .   1
128        ABI     468.0 .   1      7994.2     17.1 .   1
184        STR     144.0 .   0      7381.6     51.3 .   0
208        S1P     827.0 .   2      7350.3      8.9 .   0
240      SLDO9     479.0 .   1      5544.1     11.6 .   0
159       LDCN     569.0 .   2      5078.1      8.9 .   0
170        SAS       5.0 .   0      2473.5    494.7 .   0
254      SIND6      95.0 .   0      1859.5     19.6 .   0
222      SLDL7     132.0 .   0      1534.8     11.6 .   0
241     SLDO10      93.0 .   0      1078.7     11.6 .   0
186        LDP      11.0 .   0       749.9     68.2 .   0
179        LDC       2.0 .   0       188.8     94.4 .   0
220      SLDL5      15.0 .   0       175.5     11.7 .   0
202        LDL       2.0 .   0        63.8     31.9 .   0
242     SLDO11       5.0 .   0        57.5     11.5 .   0
129        ABR       0.0 .   0         0.0      0.0 .   0
131        ADR       0.0 .   0         0.0      0.0 .   0
133        DIF       0.0 .   0         0.0      0.0 .   0
135        DVR       0.0 .   0         0.0      0.0 .   0
137        FLO       0.0 .   0         0.0      0.0 .   0
138        FLT       0.0 .   0         0.0      0.0 .   0
140        INT       0.0 .   0         0.0      0.0 .   0
144        MPR       0.0 .   0         0.0      0.0 .   0
145        NGI       0.0 .   0         0.0      0.0 .   0
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146        NGR        0.0  .  0          0.0        0.0  .   0
148        SRS        0.0  .  0          0.0        0.0  .   0
150        SBR        0.0  .  0          0.0        0.0  .   0
151        SGS        0.0  .  0          0.0        0.0  .   0
152        SQI        0.0  .  0          0.0        0.0  .   0
153        SQR        0.0  .  0          0.0        0.0  .   0
155        IXS        0.0  .  0          0.0        0.0  .   0
157        S2P        0.0  .  0          0.0        0.0  .   0
160        ADJ        0.0  .  0          0.0        0.0  .   0
174        CIP        0.0  .  0          0.0        0.0  .   0
177    COMPARE        0.0  .  0          0.0        0.0  .   0
187        STP        0.0  .  0          0.0        0.0  .   0
189        STM        0.0  .  0          0.0        0.0  .   0
192        IXP        0.0  .  0          0.0        0.0  .   0
209        IXB        0.0  .  0          0.0        0.0  .   0
210        BYT        0.0  .  0          0.0        0.0  .   0
211        EFJ        0.0  .  0          0.0        0.0  .   0
212        NFJ        0.0  .  0          0.0        0.0  .   0
213        BPT        0.0  .  0          0.0        0.0  .   0
214        XIT        0.0  .  0          0.0        0.0  .   0
215        NOP        0.0  .  0          0.0        0.0  .   0
219      SLDL4        0.0  .  0          0.0        0.0  .   0
221      SLDL6        0.0  .  0          0.0        0.0  .   0
227     SLDL12        0.0  .  0          0.0        0.0  .   0
228     SLDL13        0.0  .  0          0.0        0.0  .   0
230     SLDL15        0.0  .  0          0.0        0.0  .   0
231     SLDL16        0.0  .  0          0.0        0.0  .   0
243     SLDO12        0.0  .  0          0.0        0.0  .   0
244     SLDO13        0.0  .  0          0.0        0.0  .   0
245     SLDO14        0.0  .  0          0.0        0.0  .   0
246     SLDO15        0.0  .  0          0.0        0.0  .   0
247     SLDO16        0.0  .  0          0.0        0.0  .   0

                    3.8E6               1.5E8           .7508
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REPORTS - BALANCED TREE SEARCH AND INSERTION



CNTOVH =  4.4 COREOVHD =  14.7 SLDCIOVHD =  7.4

 OPCODE      MNEM      FREQ     FPERC         MICS      AVEMICS  MPERC

   207         CGP   36000.0 . 296           8.8E6       245.6 .1738
   161         FJP  149915.0 .1233           4.6E6        30.9 . 909
     0 SLDL-TOTAL  348293.9 .2864           4.0E6        11.6 . 794
     0 SIND-TOTAL  267720.0 .2202           3.6E6        13.4 . 707
   173         RNP   40997.0 . 337           2.9E6        71.1 . 573
   248       SIND0  198205.9 .1630           2.2E6        11.2 . 438
   217       SLDL2  158375.0 .1302           1.8E6        11.6 . 361
   249       SIND1   67145.0 . 552           1.3E6        19.7 . 260
   218       SLDL3  103624.9 . 852           1.2E6        11.6 . 236
   206         CLP    5001.0 .  41           1.1E6       225.9 . 222
   142         MOD    5015.0 .  41           1.0E6       199.9 . 197
   185         UJP   44769.0 . 368        964811.0        21.6 . 190
   201        LESI   40528.0 . 333        927220.1        22.9 . 182
   216       SLDL1   77492.0 . 637        899533.7        11.6 . 177
   195        EQUI   41401.0 . 340        847226.9        20.5 . 167
   162         INC   40337.0 . 332        731277.3        18.1 . 144
   197        GRTI   26754.0 . 220        562622.6        21.0 . 111
   143         MPI    5000.0 .  41        415564.0        83.1 .  82
   158         CSP     578.0 .   5        389415.2       673.7 .  77
   159        LDCN   42006.0 . 345        374864.3         8.9 .  74
   171         SRO   10372.0 .  85        325628.8        31.4 .  64
   165         LAO   10120.0 .  83        310174.9        30.6 .  61
     0 SLDO-TOTAL   26395.0 . 217        306375.5        11.6 .  60
   238       SLDO7   15153.0 . 125        175865.7        11.6 .  35
   154         STO   15103.0 . 124        157885.7        10.5 .  31
   199        LDCI    7184.0 .  59        155645.5        21.7 .  31
   130         ADI   14763.0 . 121        143254.7         9.7 .  28
   200        LEQI    5075.0 .  42        103736.4        20.4 .  20
   172         XJP    1380.0 .  11         86754.0        62.9 .  17
   127 SLDC-TOTAL   26575.0 . 219         67139.0         2.5 .  13
   237       SLDO6    5209.0 .  43         60517.1        11.6 .  12
   239       SLDO8    5048.0 .  42         58525.2        11.6 .  12
   227      SLDL12    5010.0 .  41         58175.0        11.6 .  11
   136         CHK    2174.0 .  18         56753.6        26.1 .  11
   250       SIND2    1680.0 .  14         33065.0        19.7 .   6
   204         STL     926.0 .   8         29064.4        31.4 .   6
   221       SLDL6    2500.0 .  21         28958.0        11.6 .   6
   134         DVI      85.0 .   1         16987.5       199.9 .   3
   205         CXP      35.0 .   0         14119.5       403.4 .   3
   220       SLDL5    1180.0 .  10         13673.0        11.6 .   3
   164         IXA     163.0 .   1          7876.7        48.3 .   2
   194         CBP      25.0 .   0          6459.5       258.4 .   1
   252       SIND4     314.0 .   3          6162.6        19.6 .   1
   251       SIND3     295.0 .   2          5812.5        19.7 .   1
   193         RBP      62.0 .   1          5541.8        89.4 .   1
```

```
236         SLDO5       447.0 .    4        5207.3        11.6 .     1
178           LDA       102.0 .    1        5153.8        50.5 .     1
202           LDL       150.0 .    1        4818.0        32.1 .     1
182           LOD        67.0 .    1        4101.3        61.2 .     1
132           AND       201.0 .    2        3417.9        17.0 .     1
175       COMPARE        21.0 .    0        3077.9       146.6 .     1
163           IND        79.0 .    1        2542.1        32.2 .     0
196          GEQI       117.0 .    1        2470.3        21.1 .     0
233         SLDO2       170.0 .    1        1978.0        11.6 .     0
235         SLDO4       134.0 .    1        1557.6        11.6 .     0
145           NGI       181.0 .    1        1547.9         8.6 .     0
232         SLDO1       114.0 .    1        1324.6        11.6 .     0
234         SLDO3       104.0 .    1        1212.6        11.7 .     0
229        SLDL14       101.0 .    1        1174.9        11.6 .     0
203          NEQI        50.0 .    0        1115.0        22.3 .     0
190           LDB        53.0 .    0        1108.7        20.9 .     0
149           SBI       102.0 .    1         989.8         9.7 .     0
191           STB        79.0 .    1         890.1        11.3 .     0
255         SIND7        43.0 .    0         846.7        19.7 .     0
253         SIND5        34.0 .    0         666.6        19.6 .     0
167           LDO        15.0 .    0         482.5        32.2 .     0
170           SAS         3.0 .    0         390.7       130.2 .     0
198           LLA        10.0 .    0         308.0        30.8 .     0
183       COMPARE         1.0 .    0         250.9       250.9 .     0
147           NOT        23.0 .    0         192.7         8.4 .     0
168           MOV         1.0 .    0         190.9       190.9 .     0
141           IOR        17.0 .    0         165.3         9.7 .     0
186           LDP         2.0 .    0         148.8        74.4 .     0
240         SLDO9        11.0 .    0         129.9        11.8 .     0
226        SLDL11        11.0 .    0         122.9        11.2 .     0
213           BPT         1.0 .    0          89.9        89.9 .     0
254         SIND6         3.0 .    0          59.7        19.9 .     0
242        SLDO11         4.0 .    0          45.6        11.4 .     0
243        SLDO12         1.0 .    0          11.9        11.9 .     0
128           ABI         0.0 .    0           0.0         0.0 .     0
129           ABR         0.0 .    0           0.0         0.0 .     0
131           ADR         0.0 .    0           0.0         0.0 .     0
133           DIF         0.0 .    0           0.0         0.0 .     0
135           DVR         0.0 .    0           0.0         0.0 .     0
137           FLO         0.0 .    0           0.0         0.0 .     0
138           FLT         0.0 .    0           0.0         0.0 .     0
139           INN         0.0 .    0           0.0         0.0 .     0
140           INT         0.0 .    0           0.0         0.0 .     0
144           MPR         0.0 .    0           0.0         0.0 .     0
146           NGR         0.0 .    0           0.0         0.0 .     0
148           SRS         0.0 .    0           0.0         0.0 .     0
150           SBR         0.0 .    0           0.0         0.0 .     0
151           SGS         0.0 .    0           0.0         0.0 .     0
152           SQI         0.0 .    0           0.0         0.0 .     0
153           SQR         0.0 .    0           0.0         0.0 .     0
155           IXS         0.0 .    0           0.0         0.0 .     0
156           UNI         0.0 .    0           0.0         0.0 .     0
157           S2P         0.0 .    0           0.0         0.0 .     0
160           ADJ         0.0 .    0           0.0         0.0 .     0
166           LCA         0.0 .    0           0.0         0.0 .     0
```

```
 169        MVB        0.0 .    0          0.0          0.0 .    0
 174        CIP        0.0 .    0          0.0          0.0 .    0
 176    COMPARE        0.0 .    0          0.0          0.0 .    0
 177    COMPARE        0.0 .    0          0.0          0.0 .    0
 179        LDC        0.0 .    0          0.0          0.0 .    0
 180    COMPARE        0.0 .    0          0.0          0.0 .    0
 181    COMPARE        0.0 .    0          0.0          0.0 .    0
 184        STR        0.0 .    0          0.0          0.0 .    0
 187        STP        0.0 .    0          0.0          0.0 .    0
 188        LDM        0.0 .    0          0.0          0.0 .    0
 189        STM        0.0 .    0          0.0          0.0 .    0
 192        IXP        0.0 .    0          0.0          0.0 .    0
 208        S1P        0.0 .    0          0.0          0.0 .    0
 209        IXB        0.0 .    0          0.0          0.0 .    0
 210        BYT        0.0 .    0          0.0          0.0 .    0
 211        EFJ        0.0 .    0          0.0          0.0 .    0
 212        NFJ        0.0 .    0          0.0          0.0 .    0
 214        XIT        0.0 .    0          0.0          0.0 .    0
 215        NOP        0.0 .    0          0.0          0.0 .    0
 219      SLDL4        0.0 .    0          0.0          0.0 .    0
 222      SLDL7        0.0 .    0          0.0          0.0 .    0
 223      SLDL8        0.0 .    0          0.0          0.0 .    0
 224      SLDL9        0.0 .    0          0.0          0.0 .    0
 225     SLDL10        0.0 .    0          0.0          0.0 .    0
 228     SLDL13        0.0 .    0          0.0          0.0 .    0
 230     SLDL15        0.0 .    0          0.0          0.0 .    0
 231     SLDL16        0.0 .    0          0.0          0.0 .    0
 241     SLDO10        0.0 .    0          0.0          0.0 .    0
 244     SLDO13        0.0 .    0          0.0          0.0 .    0
 245     SLDO14        0.0 .    0          0.0          0.0 .    0
 246     SLDO15        0.0 .    0          0.0          0.0 .    0
 247     SLDO16        0.0 .    0          0.0          0.0 .    0

                     1.2E6                5.1E7             .8084
```

APPENDIX B - Standard Procedure Execution Speeds

REPORT 8 - (five of six) COMPILATIONS

```
                              STANDARD PROCEDURES

PROC       MNEM       FREQ     FPERC          MICS        AVEMICS  MPERC

   7     UWRITE     4442.0  .1511           4.4E7        9810.5 .8330
   6      UREAD      190.0  .   65          4.0E6       20888.3 . 759
   8        IDS     5089.0  .1731           1.9E6         371.5 . 361
   9        TRS     6112.0  .2079           1.4E6         228.1 . 266
  12        SCN     4271.0  .1453        599136.0         140.3 . 115
   3        MVL     3251.0  .1106        512621.0         157.7 .  98
   2        NEW     2221.0  . 755        196114.0          88.3 .  37
  33        MRK     1573.0  . 535         73950.0          47.0 .  14
  34        RLS     1578.0  . 537         67367.0          42.7 .  13
  35        IOR      412.0  . 140         13174.0          32.0 .   3
  10        TIM      150.0  .  51          6852.0          45.7 .   1
  37        POT       76.0  .  26          5309.0          69.9 .   1
  36      UBUSY       21.0  .   7          4653.0         221.6 .   1
   5        XIT       14.0  .   5          1572.0         112.3 .   0
  39     UCLEAR        1.0  .   0           295.0         295.0 .   0
   1        IOC        0.0  .   0             0.0           0.0 .   0
   4        MVR        0.0  .   0             0.0           0.0 .   0
  11        FLC        0.0  .   0             0.0           0.0 .   0
  13   DRAWLINE        0.0  .   0             0.0           0.0 .   0
  14  DRAWBLOCK        0.0  .   0             0.0           0.0 .   0
  15                   0.0  .   0             0.0           0.0 .   0
  16                   0.0  .   0             0.0           0.0 .   0
  17                   0.0  .   0             0.0           0.0 .   0
  18                   0.0  .   0             0.0           0.0 .   0
  19                   0.0  .   0             0.0           0.0 .   0
  20                   0.0  .   0             0.0           0.0 .   0
  21                   0.0  .   0             0.0           0.0 .   0
  22                   0.0  .   0             0.0           0.0 .   0
  23                   0.0  .   0             0.0           0.0 .   0
  24        TRC        0.0  .   0             0.0           0.0 .   0
  25        RND        0.0  .   0             0.0           0.0 .   0
  26     SINCSP        0.0  .   0             0.0           0.0 .   0
  27     COSCSP        0.0  .   0             0.0           0.0 .   0
  28     LOGCSP        0.0  .   0             0.0           0.0 .   0
  29     ATNCSP        0.0  .   0             0.0           0.0 .   0
  30      LNCSP        0.0  .   0             0.0           0.0 .   0
  31     EXPCSP        0.0  .   0             0.0           0.0 .   0
  32     SQTCSP        0.0  .   0             0.0           0.0 .   0
  38      UWAIT        0.0  .   0             0.0           0.0 .   0
  40        HLT        0.0  .   0             0.0           0.0 .   0
  41        MEM        0.0  .   0             0.0           0.0 .   0

                   29401.0                  5.2E7
```

REPORT 9 - WHETSTONE

STANDARD PROCEDURES

```
PROC        MNEM      FREQ     FPERC         MICS      AVEMICS   MPERC

  27      COSCSP    1920.0 .2777          5.6E6       2935.0 .3280
   7      UWRITE     420.0 . 607          4.1E6       9772.7 .2389
  30       LNCSP     930.0 .1345          1.7E6       1834.3 . 993
  29      ATNCSP     640.0 . 926          1.6E6       2540.1 . 946
  31      EXPCSP     930.0 .1345          1.6E6       1678.9 . 909
  26      SINCSP     640.0 . 926          1.3E6       2031.2 . 757
  32      SQTCSP     930.0 .1345          1.1E6       1158.1 . 627
  28      LOGCSP      40.0 .  58        90056.0       2251.4 .  52
  24         TRC     337.0 . 487        65483.0        194.3 .  38
   6       UREAD       2.0 .   3         8632.0       4316.0 .   5
   1         IOC     104.0 . 150         3594.0         34.6 .   2
  36       UBUSY       3.0 .   4          663.0        221.0 .   0
  35         IOR      14.0 .  20          445.0         31.8 .   0
  39      UCLEAR       1.0 .   1          293.0        293.0 .   0
  37         POT       2.0 .   3          139.0         69.5 .   0
   5         XIT       1.0 .   1           80.0         80.0 .   0
  34         RLS       1.0 .   1           42.0         42.0 .   0
   2         NEW       0.0 .   0            0.0          0.0 .   0
   3         MVL       0.0 .   0            0.0          0.0 .   0
   4         MVR       0.0 .   0            0.0          0.0 .   0
   8         IDS       0.0 .   0            0.0          0.0 .   0
   9         TRS       0.0 .   0            0.0          0.0 .   0
  10         TIM       0.0 .   0            0.0          0.0 .   0
  11         FLC       0.0 .   0            0.0          0.0 .   0
  12         SCN       0.0 .   0            0.0          0.0 .   0
  13    DRAWLINE       0.0 .   0            0.0          0.0 .   0
  14   DRAWBLOCK       0.0 .   0            0.0          0.0 .   0
  15                   0.0 .   0            0.0          0.0 .   0
  16                   0.0 .   0            0.0          0.0 .   0
  17                   0.0 .   0            0.0          0.0 .   0
  18                   0.0 .   0            0.0          0.0 .   0
  19                   0.0 .   0            0.0          0.0 .   0
  20                   0.0 .   0            0.0          0.0 .   0
  21                   0.0 .   0            0.0          0.0 .   0
  22                   0.0 .   0            0.0          0.0 .   0
  23                   0.0 .   0            0.0          0.0 .   0
  25         RND       0.0 .   0            0.0          0.0 .   0
  33         MRK       0.0 .   0            0.0          0.0 .   0
  38       UWAIT       0.0 .   0            0.0          0.0 .   0
  40         HLT       0.0 .   0            0.0          0.0 .   0
  41         MEM       0.0 .   0            0.0          0.0 .   0

                    6915.0                1.7E7
```

```
                          REPORT 10 - SORTS

                         STANDARD PROCEDURES

PROC      MNEM     FREQ    FPERC        MICS     AVEMICS  MPERC

   7     UWRITE       66.0 .2946        2.6E6    38801.3 .8133
   6      UREAD       40.0 .1786     579684.0    14492.1 .1841
  36      UBUSY        7.0 . 313       1556.0      222.3 .   5
  35        IOR       46.0 .2054       1466.0       31.9 .   5
   3        MVL       10.0 . 446       1456.0      145.6 .   5
  12        SCN        4.0 . 179       1237.0      309.2 .   4
   1        IOC       30.0 .1339       1039.0       34.6 .   3
  10        TIM       12.0 . 536        551.0       45.9 .   2
   5        XIT        4.0 . 179        488.0      122.0 .   2
   2        NEW        2.0 .  89        177.0       88.5 .   1
  34        RLS        3.0 . 134        129.0       43.0 .   0
   4        MVR        0.0 .   0          0.0        0.0 .   0
   8        IDS        0.0 .   0          0.0        0.0 .   0
   9        TRS        0.0 .   0          0.0        0.0 .   0
  11        FLC        0.0 .   0          0.0        0.0 .   0
  13   DRAWLINE        0.0 .   0          0.0        0.0 .   0
  14  DRAWBLOCK        0.0 .   0          0.0        0.0 .   0
  15                   0.0 .   0          0.0        0.0 .   0
  16                   0.0 .   0          0.0        0.0 .   0
  17                   0.0 .   0          0.0        0.0 .   0
  18                   0.0 .   0          0.0        0.0 .   0
  19                   0.0 .   0          0.0        0.0 .   0
  20                   0.0 .   0          0.0        0.0 .   0
  21                   0.0 .   0          0.0        0.0 .   0
  22                   0.0 .   0          0.0        0.0 .   0
  23                   0.0 .   0          0.0        0.0 .   0
  24        TRC        0.0 .   0          0.0        0.0 .   0
  25        RND        0.0 .   0          0.0        0.0 .   0
  26     SINCSP        0.0 .   0          0.0        0.0 .   0
  27     COSCSP        0.0 .   0          0.0        0.0 .   0
  28     LOGCSP        0.0 .   0          0.0        0.0 .   0
  29     ATNCSP        0.0 .   0          0.0        0.0 .   0
  30      LNCSP        0.0 .   0          0.0        0.0 .   0
  31     EXPCSP        0.0 .   0          0.0        0.0 .   0
  32     SQTCSP        0.0 .   0          0.0        0.0 .   0
  33        MRK        0.0 .   0          0.0        0.0 .   0
  37        POT        0.0 .   0          0.0        0.0 .   0
  38      UWAIT        0.0 .   0          0.0        0.0 .   0
  39     UCLEAR        0.0 .   0          0.0        0.0 .   0
  40        HLT        0.0 .   0          0.0        0.0 .   0
  41        MEM        0.0 .   0          0.0        0.0 .   0

                     224.0              3.1E6
```

REPORT 11 - CROSS-REFERENCER

STANDARD PROCEDURES

```
PROC        MNEM       FREQ FPERC         MICS     AVEMICS MPERC

   7      UWRITE       53.0 .  18        2.0E6     37679.8 .4649
   3         MVL    13447.0 .4467        1.2E6        89.9 .2815
   1         IOC    16358.0 .5435     566195.0        34.6 .1318
   6       UREAD       17.0 .   6     469270.9     27604.2 .1092
  11         FLC       14.0 .   5      38399.0      2742.8 .  89
   2         NEW      141.0 .  47      12463.0        88.4 .  29
  35         IOR       60.0 .  20       1918.0        32.0 .   4
  36       UBUSY        3.0 .   1        667.0       222.3 .   2
  39      UCLEAR        1.0 .   0        294.0       294.0 .   1
  10         TIM        4.0 .   1        184.0        46.0 .   0
   5         XIT        1.0 .   0         81.0        81.0 .   0
  34         RLS        1.0 .   0         43.0        43.0 .   0
   4         MVR        0.0 .   0          0.0         0.0 .   0
   8         IDS        0.0 .   0          0.0         0.0 .   0
   9         TRS        0.0 .   0          0.0         0.0 .   0
  12         SCN        0.0 .   0          0.0         0.0 .   0
  13    DRAWLINE        0.0 .   0          0.0         0.0 .   0
  14   DRAWBLOCK        0.0 .   0          0.0         0.0 .   0
  15                    0.0 .   0          0.0         0.0 .   0
  16                    0.0 .   0          0.0         0.0 .   0
  17                    0.0 .   0          0.0         0.0 .   0
  18                    0.0 .   0          0.0         0.0 .   0
  19                    0.0 .   0          0.0         0.0 .   0
  20                    0.0 .   0          0.0         0.0 .   0
  21                    0.0 .   0          0.0         0.0 .   0
  22                    0.0 .   0          0.0         0.0 .   0
  23                    0.0 .   0          0.0         0.0 .   0
  24         TRC        0.0 .   0          0.0         0.0 .   0
  25         RND        0.0 .   0          0.0         0.0 .   0
  26      SINCSP        0.0 .   0          0.0         0.0 .   0
  27      COSCSP        0.0 .   0          0.0         0.0 .   0
  28      LOGCSP        0.0 .   0          0.0         0.0 .   0
  29      ATNCSP        0.0 .   0          0.0         0.0 .   0
  30       LNCSP        0.0 .   0          0.0         0.0 .   0
  31      EXPCSP        0.0 .   0          0.0         0.0 .   0
  32      SQTCSP        0.0 .   0          0.0         0.0 .   0
  33         MRK        0.0 .   0          0.0         0.0 .   0
  37         POT        0.0 .   0          0.0         0.0 .   0
  38       UWAIT        0.0 .   0          0.0         0.0 .   0
  40         HLT        0.0 .   0          0.0         0.0 .   0
  41         MEM        0.0 .   0          0.0         0.0 .   0

                    30100.0              4.3E6
```

REPORT 12 - BALANCED TREE SEARCH AND INSERTION

STANDARD PROCEDURES

```
PROC       MNEM      FREQ FPERC         MICS      AVEMICS MPERC

   7     UWRITE      90.0 .3543     985042.9     10944.9 .9279
   6      UREAD       2.0 .  79      68063.0     34031.5 . 641
   2        NEW      51.0 .2008       4522.0        88.7 .  43
   1        IOC      89.0 .3504       3082.0        34.6 .  29
  35        IOR      17.0 . 669        547.0        32.2 .   5
  10        TIM       4.0 . 157        184.0        46.0 .   2
   5        XIT       1.0 .  39        136.0       136.0 .   1
   3        MVL       0.0 .   0          0.0         0.0 .   0
   4        MVR       0.0 .   0          0.0         0.0 .   0
   8        IDS       0.0 .   0          0.0         0.0 .   0
   9        TRS       0.0 .   0          0.0         0.0 .   0
  11        FLC       0.0 .   0          0.0         0.0 .   0
  12        SCN       0.0 .   0          0.0         0.0 .   0
  13   DRAWLINE       0.0 .   0          0.0         0.0 .   0
  14  DRAWBLOCK       0.0 .   0          0.0         0.0 .   0
  15                  0.0 .   0          0.0         0.0 .   0
  16                  0.0 .   0          0.0         0.0 .   0
  17                  0.0 .   0          0.0         0.0 .   0
  18                  0.0 .   0          0.0         0.0 .   0
  19                  0.0 .   0          0.0         0.0 .   0
  20                  0.0 .   0          0.0         0.0 .   0
  21                  0.0 .   0          0.0         0.0 .   0
  22                  0.0 .   0          0.0         0.0 .   0
  23                  0.0 .   0          0.0         0.0 .   0
  24        TRC       0.0 .   0          0.0         0.0 .   0
  25        RND       0.0 .   0          0.0         0.0 .   0
  26     SINCSP       0.0 .   0          0.0         0.0 .   0
  27     COSCSP       0.0 .   0          0.0         0.0 .   0
  28     LOGCSP       0.0 .   0          0.0         0.0 .   0
  29     ATNCSP       0.0 .   0          0.0         0.0 .   0
  30      LNCSP       0.0 .   0          0.0         0.0 .   0
  31     EXPCSP       0.0 .   0          0.0         0.0 .   0
  32     SQTCSP       0.0 .   0          0.0         0.0 .   0
  33        MRK       0.0 .   0          0.0         0.0 .   0
  34        RLS       0.0 .   0          0.0         0.0 .   0
  36      UBUSY       0.0 .   0          0.0         0.0 .   0
  37        POT       0.0 .   0          0.0         0.0 .   0
  38      UWAIT       0.0 .   0          0.0         0.0 .   0
  39     UCLEAR       0.0 .   0          0.0         0.0 .   0
  40        HLT       0.0 .   0          0.0         0.0 .   0
  41        MEM       0.0 .   0          0.0         0.0 .   0

                    254.0              1.1E6
```

APPENDIX C - Execution Speeds of Microcoded P-macine Instructions

```
REPORT6 - MICRO CODE TIMES
  ( ALL OF INTERP PAGE EXCEPT DLO,SRO,LLA )


CNTOVH =  4.4 COREOVHD =  14.3 SLDCIOVHD =  7.0

 OPCODE      MNEM      FREQ     FPERC         MICS      AVEMICS  MPERC

   158          CSP   16959.0 .   43         2.9E7      1695.8 .1756
   164          IXA  162162.0 . 412          9.8E6        60.7 . 601
   167          LDO  176259.9 . 448          6.4E6        36.0 . 388
   171          SRO  169114.0 . 429          6.0E6        35.2 . 364
     0 SLDO-TOTAL  436123.9 .1108          5.1E6        11.6 . 309
   174          CIP   25247.0 .   64         4.7E6       188.1 . 290
   136          CHK  211040.9 . 536          4.5E6        21.5 . 277
   189          STM   55505.0 . 141          3.5E6        63.2 . 214
   198          LLA   87744.0 . 223          3.0E6        34.5 . 185
   188          LDM  125024.9 . 318          2.8E6        22.2 . 170
   135          DVR   11403.0 .   29         2.3E6       203.1 . 141
   144          MPR   23206.0 .   59         2.2E6        93.4 . 132
   165          LAO  191024.9 . 485          1.8E6         9.5 . 110
   143          MPI   24391.0 .   62         1.8E6        72.4 . 108
   138          FLT    4908.0 .   12         1.8E6       356.8 . 107
   179          LDC   38609.0 .   98         1.7E6        45.1 . 106
     0 SLDL-TOTAL  149836.0 . 381          1.7E6        11.6 . 106
   127 SLDC-TOTAL  666506.0 .1693          1.7E6         2.5 . 103
   131          ADR   36897.0 .   94         1.7E6        45.5 . 103
   142          MOD    7230.0 .   18         1.4E6       200.1 .   88
   130          ADI  141437.9 . 359          1.4E6         9.7 .   84
     0 SIND-TOTAL  100989.9 . 256          1.3E6        13.3 .   82
   139          INN   12046.0 .   31         1.3E6       108.7 .   80
   195         EQUI   55738.0 . 142          1.1E6        20.4 .   69
   237        SLDO6   97433.0 . 247          1.1E6        11.6 .   69
   173          RNP   46464.0 . 118          1.1E6        24.1 .   68
   236        SLDO5   96410.0 . 245          1.1E6        11.6 .   68
   149          SBI  110345.9 . 280          1.1E6         9.7 .   65
   201         LESI   47625.0 . 121          1.1E6        22.5 .   65
   207          CGP    8997.0 .   23      966098.1       107.4 .   59
   206          CLP   12216.0 .   31      914998.8        74.9 .   56
   248        SINDO   76506.0 . 194      859406.8        11.2 .   52
   205          CXP    1744.0 .    4      855445.1       490.5 .   52
   216        SLDL1   69548.0 . 177      805559.3        11.6 .   49
   161          FJP  209015.9 . 531      768164.7         3.7 .   47
   199         LDCI  154163.0 . 392      726917.7         4.7 .   44
   202          LDL   17276.0 .   44      631890.8        36.6 .   39
   190          LDB   28502.0 .   72      591251.6        20.7 .   36
   156          UNI    6146.0 .   16      572790.8        93.2 .   35
   185          UJP   98776.0 . 251      566054.8         5.7 .   35
   243       SLDO12   48589.0 . 123      563788.7        11.6 .   34
   134          DVI    2710.0 .    7      542046.0       200.0 .   33
   200         LEQI   48304.0 . 123      512577.1        10.6 .   31
   242       SLDO11   43353.0 . 110      502165.8        11.6 .   31
   234        SLDO3   41016.0 . 104      475331.8        11.6 .   29
```

```
154          STO    36921.0 .  94      386235.2        10.5 .  24
235        SLDO4    27603.0 .  70      320140.9        11.6 .  20
204          STL    34163.0 .  87      317227.9         9.3 .  19
163          IND     8023.0 .  20      289053.9        36.0 .  18
244       SLDO13    22396.0 .  57      259828.8        11.6 .  16
217        SLDL2    20744.0 .  53      240578.1        11.6 .  15
150          SBR     4440.0 .  11      233191.9        52.5 .  14
197         GRTI    22395.0 .  57      226315.4        10.1 .  14
218        SLDL3    19253.0 .  49      223201.8        11.6 .  14
193          RBP     2318.0 .   6      209198.4        90.2 .  13
182          LOD     2928.0 .   7      192325.3        65.7 .  12
249        SIND1     9765.0 .  25      191625.4        19.6 .  12
172          XJP    11915.0 .  30      187680.4        15.8 .  11
238        SLDO7    15924.0 .  40      184455.2        11.6 .  11
162          INC     8311.0 .  21      181749.2        21.9 .  11
160          ADJ     5768.0 .  15      161751.4        28.0 .  10
241       SLDO10    13639.0 .  35      157856.7        11.6 .  10
219        SLDL4    12962.0 .  33      150435.5        11.6 .   9
233        SLDO2    12950.0 .  33      150277.9        11.6 .   9
191          STB    11931.0 .  30      134679.2        11.3 .   8
196         GEQI     6162.0 .  16      131946.6        21.4 .   8
159         LDCN    14210.0 .  36      126915.0         8.9 .   8
178          LDA     2111.0 .   5      122921.2        58.2 .   8
203         NEQI    15600.0 .  40      119314.0         7.6 .   7
175      COMPARE      890.0 .   2      115757.0       130.1 .   7
228       SLDL13     9729.0 .  25      112852.6        11.6 .   7
168          MOV     1598.0 .   4      100992.3        63.2 .   6
239        SLDO8     8413.0 .  21       97724.9        11.6 .   6
255        SIND7     3449.0 .   9       67680.7        19.6 .   4
194          CBP      573.0 .   1       63574.9       111.0 .   4
250        SIND2     3113.0 .   8       60999.9        19.6 .   4
220        SLDL5     5212.0 .  13       60447.6        11.6 .   4
169          MVB      447.0 .   1       59181.1       132.4 .   4
147          NOT     6678.0 .  17       57314.4         8.6 .   3
132          AND    11901.0 .  30       56538.3         4.8 .   3
252        SIND4     2579.0 .   7       50709.7        19.7 .   3
232        SLDO1     3751.0 .  10       43552.3        11.6 .   3
240        SLDO9     3660.0 .   9       42255.0        11.5 .   3
253        SIND5     2136.0 .   5       41909.8        19.6 .   3
251        SIND3     2130.0 .   5       41800.0        19.6 .   3
141          IOR     4265.0 .  11       41484.5         9.7 .   3
222        SLDL7     3238.0 .   8       37510.4        11.6 .   2
170          SAS      226.0 .   1       33984.8       150.4 .   2
254        SIND6     1312.0 .   3       25727.6        19.6 .   2
229       SLDL14     1857.0 .   5       21504.1        11.6 .   1
146          NGR      966.0 .   2       19352.8        20.0 .   1
221        SLDL6     1651.0 .   4       19151.3        11.6 .   1
225       SLDL10     1543.0 .   4       17863.9        11.6 .   1
223        SLDL8     1498.0 .   4       17365.4        11.6 .   1
148          SRS       71.0 .   0       16978.3       239.1 .   1
227       SLDL12     1320.0 .   3       15321.0        11.6 .   1
245       SLDO14      987.0 .   3       11426.1        11.6 .   1
166          LCA      443.0 .   1        9227.9        20.8 .   1
226       SLDL11      632.0 .   2        7297.6        11.5 .   0
224        SLDL9      561.0 .   1        6523.3        11.6 .   0
```

```
184        STR       85.0  .   0       5188.5       61.0  .   0
186        LDP       56.0  .   0       3808.8       68.0  .   0
181    COMPARE       40.0  .   0       3351.0       83.8  .   0
128        ABI      248.0  .   1       3070.4       12.4  .   0
183    COMPARE       13.0  .   0       2430.9      187.0  .   0
208        S1P      202.0  .   1       1805.6        8.9  .   0
137        FLO        3.0  .   0       1237.9      412.6  .   0
230     SLDL15       84.0  .   0        966.2       11.5  .   0
187        STP        6.0  .   0        700.8      116.8  .   0
145        NGI       58.0  .   0        491.4        8.5  .   0
133        DIF        5.0  .   0        405.5       81.1  .   0
129        ABR       20.0  .   0        190.0        9.5  .   0
213        BPT        2.0  .   0        159.6       79.8  .   0
231     SLDL16        4.0  .   0         45.2       11.3  .   0
140        INT        0.0  .   0          0.0        0.0  .   0
151        SGS        0.0  .   0          0.0        0.0  .   0
152        SQI        0.0  .   0          0.0        0.0  .   0
153        SQR        0.0  .   0          0.0        0.0  .   0
155        IXS        0.0  .   0          0.0        0.0  .   0
157        S2P        0.0  .   0          0.0        0.0  .   0
176    COMPARE        0.0  .   0          0.0        0.0  .   0
177    COMPARE        0.0  .   0          0.0        0.0  .   0
180    COMPARE        0.0  .   0          0.0        0.0  .   0
192        IXP        0.0  .   0          0.0        0.0  .   0
209        IXB        0.0  .   0          0.0        0.0  .   0
210        BYT        0.0  .   0          0.0        0.0  .   0
211        EFJ        0.0  .   0          0.0        0.0  .   0
212        NFJ        0.0  .   0          0.0        0.0  .   0
214        XIT        0.0  .   0          0.0        0.0  .   0
215        NOP        0.0  .   0          0.0        0.0  .   0
246     SLDO15        0.0  .   0          0.0        0.0  .   0
247     SLDO16        0.0  .   0          0.0        0.0  .   0

                     3.9E6               1.6E8           .7356
```

```
REPORT7 - MACRO CODE TIMES
          : FOR COMPARISON TO REPORT6 - MICRO CODE RESULTS



CNTOVH =  4.4 COREOVHD =  14.7 SLDCIOVHD =  7.4


 OPCODE      MNEM      FREQ     FPERC        MICS      AVEMICS  MPERC

   158        CSP   16966.0 .  43         2.9E7     1696.0 .1448
   174        CIP   25247.0 .  64         1.4E7      541.7 . 688
   164        IXA  162309.0 . 412         8.6E6       53.1 . 434
   165        LAO  191067.0 . 485         7.3E6       38.1 . 367
   188        LDM  125024.9 . 317         7.0E6       56.0 . 352
   167        LDO  176367.9 . 448         5.7E6       32.2 . 286
   136        CHK  211040.9 . 536         5.5E6       26.1 . 278
   171        SRO  169254.9 . 430         5.3E6       31.4 . 268
     0 SLDO-TOTAL  436732.0 .1108         5.1E6       11.6 . 255
   161        FJP  209183.0 . 531         5.0E6       24.1 . 254
   189        STM   55505.0 . 141         3.5E6       62.5 . 175
   173        RNP   46467.0 . 118         3.4E6       73.7 . 172
   199       LDCI  154163.0 . 391         3.3E6       21.6 . 167
   198        LLA   87743.0 . 223         2.7E6       30.7 . 136
   207        CGP    8997.0 .  23         2.4E6      270.9 . 123
   185        UJP   98837.0 . 251         2.4E6       24.2 . 120
   135        DVR   11403.0 .  29         2.3E6      203.1 . 117
   206        CLP   12219.0 .  31         2.3E6      188.6 . 116
   144        MPR   23206.0 .  59         2.2E6       93.4 . 109
   138        FLT    4908.0 .  12         1.8E6      362.1 .  89
   143        MPI   24392.0 .  62         1.8E6       72.4 .  89
   179        LDC   38609.0 .  98         1.7E6       45.1 .  88
     0 SLDL-TOTAL  149822.9 . 380         1.7E6       11.6 .  87
   131        ADR   36897.0 .  94         1.7E6       45.5 .  85
   127 SLDC-TOTAL  666739.9 .1692         1.7E6        2.5 .  84
   142        MOD    7230.0 .  18         1.4E6      200.1 .  73
   139        INN   12046.0 .  31         1.4E6      114.0 .  69
   130        ADI  141510.0 . 359         1.4E6        9.7 .  69
     0 SIND-TOTAL  101182.9 . 257         1.3E6       13.3 .  68
   195       EQUI   55845.0 . 142         1.1E6       20.4 .  57
   237      SLDO6   97534.0 . 248         1.1E6       11.6 .  57
   236      SLDO5   96573.0 . 245         1.1E6       11.6 .  56
   204        STL   34185.0 .  87         1.1E6       31.4 .  54
   149        SBI  110356.9 . 280         1.1E6        9.7 .  54
   201       LESI   47624.0 . 121         1.1E6       22.5 .  54
   200       LEQI   48406.0 . 123         1.0E6       20.7 .  50
   205        CXP    1745.0 .   4      987217.5      565.7 .  50
   248      SINDO   76596.0 . 194      857994.3       11.2 .  43
   216      SLDL1   69550.0 . 177      806297.9       11.6 .  41
   172        XJP   11915.0 .  30      748505.4       62.8 .  38
   202        LDL   17279.0 .  44      611751.1       35.4 .  31
   190        LDB   28540.0 .  72      593236.0       20.8 .  30
   156        UNI    6146.0 .  16      572874.4       93.2 .  29
   243     SLDO12   48591.0 . 123      563571.9       11.6 .  28
   134        DVI    2711.0 .   7      542241.9      200.0 .  27
```

```
197        GRTI    22407.0 .  57      510504.2        22.8 .  26
242      SLDO11    43359.0 . 110      501786.0        11.6 .  25
234       SLDO3    41050.0 . 104      475709.0        11.6 .  24
154         STO    36935.0 .  94      386092.5        10.5 .  19
203        NEQI    15605.0 .  40      330146.5        21.2 .  17
235       SLDO4    27750.0 .  70      321652.0        11.6 .  16
163         IND     8096.0 .  21      260871.3        32.2 .  13
244      SLDO13    22396.0 .  57      259886.4        11.6 .  13
217       SLDL2    20746.0 .  53      240604.4        11.6 .  12
150         SBR     4440.0 .  11      233369.9        52.6 .  12
218       SLDL3    19246.0 .  49      223190.4        11.6 .  11
193         RBP     2325.0 .   6      208606.5        89.7 .  11
132         AND    12020.0 .  31      203733.9        16.9 .  10
182         LOD     2933.0 .   7      197788.7        67.4 .  10
249       SIND1     9853.0 .  25      193704.7        19.7 .  10
238       SLDO7    15946.0 .  40      184057.3        11.5 .   9
160         ADJ     5768.0 .  15      161958.2        28.1 .   8
241      SLDO10    13654.0 .  35      158534.6        11.6 .   8
162         INC     8345.0 .  21      151015.4        18.1 .   8
233       SLDO2    12962.0 .  33      150499.7        11.6 .   8
219       SLDL4    12963.0 .  33      150276.7        11.6 .   8
194         CBP      579.0 .   1      148917.1       257.2 .   7
191         STB    11931.0 .  30      134391.8        11.3 .   7
196        GEQI     6171.0 .  16      132308.9        21.4 .   7
159        LDCN    14213.0 .  36      126919.7         8.9 .   6
168         MOV     1587.0 .   4      117090.2        73.8 .   6
175     COMPARE      912.0 .   2      116056.7       127.3 .   6
228      SLDL13     9729.0 .  25      112763.0        11.6 .   6
178         LDA     2123.0 .   5      107661.7        50.7 .   5
239       SLDO8     8531.0 .  22       99178.9        11.6 .   5
255       SIND7     3450.0 .   9       67815.0        19.7 .   3
250       SIND2     3114.0 .   8       61070.6        19.6 .   3
220       SLDL5     5209.0 .  13       60270.1        11.6 .   3
169         MVB      447.0 .   1       59878.3       134.0 .   3
147         NOT     6745.0 .  17       57608.5         8.5 .   3
252       SIND4     2587.0 .   7       50876.3        19.7 .   3
232       SLDO1     3740.0 .   9       43342.0        11.6 .   2
240       SLDO9     3659.0 .   9       42285.1        11.6 .   2
253       SIND5     2138.0 .   5       42014.2        19.7 .   2
251       SIND3     2130.0 .   5       41919.0        19.7 .   2
141         IOR     4276.0 .  11       41478.4         9.7 .   2
170         SAS      228.0 .   1       38903.2       170.6 .   2
222       SLDL7     3238.0 .   8       37506.2        11.6 .   2
254       SIND6     1315.0 .   3       25817.5        19.6 .   1
229      SLDL14     1857.0 .   5       21504.3        11.6 .   1
146         NGR      966.0 .   2       19396.4        20.1 .   1
221       SLDL6     1643.0 .   4       19053.7        11.6 .   1
225      SLDL10     1543.0 .   4       17887.7        11.6 .   1
223       SLDL8     1498.0 .   4       17376.2        11.6 .   1
148         SRS       71.0 .   0       17363.9       244.6 .   1
227      SLDL12     1320.0 .   3       15305.0        11.6 .   1
245      SLDO14      987.0 .   3       11448.3        11.6 .   1
166         LCA      444.0 .   1        9230.6        20.8 .   0
226      SLDL11      632.0 .   2        7338.8        11.6 .   0
224       SLDL9      561.0 .   1        6512.9        11.6 .   0
```

```
 184        STR      85.0 .   0      4817.5      56.7 .   0
 186        LDP      60.0 .   0      4082.0      68.0 .   0
 183    COMPARE      13.0 .   0      3344.7     257.3 .   0
 128        ABI     248.0 .   1      3064.2      12.4 .   0
 181    COMPARE      40.0 .   0      2857.0      71.4 .   0
 208        S1P     202.0 .   1      1794.8       8.9 .   0
 137        FLO       3.0 .   0      1251.7     417.2 .   0
 230     SLDL15      84.0 .   0       973.6      11.6 .   0
 187        STP       6.0 .   0       729.4     121.6 .   0
 145        NGI      58.0 .   0       497.2       8.6 .   0
 133        DIF       5.0 .   0       406.5      81.3 .   0
 129        ABR      20.0 .   0       196.0       9.8 .   0
 213        BPT       2.0 .   0       165.8      82.9 .   0
 231     SLDL16       4.0 .   0        46.6      11.7 .   0
 140        INT       0.0 .   0         0.0       0.0 .   0
 151        SGS       0.0 .   0         0.0       0.0 .   0
 152        SQI       0.0 .   0         0.0       0.0 .   0
 153        SQR       0.0 .   0         0.0       0.0 .   0
 155        IXS       0.0 .   0         0.0       0.0 .   0
 157        S2P       0.0 .   0         0.0       0.0 .   0
 176    COMPARE       0.0 .   0         0.0       0.0 .   0
 177    COMPARE       0.0 .   0         0.0       0.0 .   0
 180    COMPARE       0.0 .   0         0.0       0.0 .   0
 192        IXP       0.0 .   0         0.0       0.0 .   0
 209        IXB       0.0 .   0         0.0       0.0 .   0
 210        BYT       0.0 .   0         0.0       0.0 .   0
 211        EFJ       0.0 .   0         0.0       0.0 .   0
 212        NFJ       0.0 .   0         0.0       0.0 .   0
 214        XIT       0.0 .   0         0.0       0.0 .   0
 215        NOP       0.0 .   0         0.0       0.0 .   0
 246     SLDO15       0.0 .   0         0.0       0.0 .   0
 247     SLDO16       0.0 .   0         0.0       0.0 .   0

                    3.9E6                 2.0E8           .7739
```

APPENDIX D - Prosram Execution Speeds

REPORT A - COMPILATIONS

		ANY 11		LSI-11	
program	lines	secs	lines/min	secs	lines/min
TRAC.MAIN	1276	86	895	84	907
ADJSTATS	296	36	495	35	505
WHETSTONE	252	27	561	26	573
CALC	434	40	659	39	666
XREF	779	44	1073	43	1092
RT11TOEDIT	304	27	687	26	689

		LSI/EIS/FIS		LSI/EIS/FIS/MIC	
program	lines	secs	lines/min	secs	lines/min
TRAC.MAIN	1276	84	909	51	1495
ADJSTATS	296	35	507	19	915
WHETSTONE	252	26	576	15	980
CALC	434	39	668	22	1184
XREF	779	43	1090	26	1831
RT11TOEDIT	304	26	692	15	1227

REPORT B - WHETSTONE

WEIGHT = 10
EXECUTION TIME IN SECONDS

module	ANY 11	LSI-11	LSI/EIS/FIS	LSI/EIS/FIS/MIC
1. SIMPLE IDENTIFIERS	0	0	0	0
2. ARRAY ELEMENTS	3	2	1	1
3. ARRAY AS PARAMETER	20	16	8	6
4. CONDITIONAL JUMPS	4	4	4	2
5. (OMITTED)				
6. INTEGER ARITHMETIC	15	9	9	6
7. TRIG FUNCTIONS	49	49	10	10
8. PROCEDURE CALLS	75	74	29	16
9. ARRAY REFERENCES	28	20	20	11
10. INTEGER ARITHMETIC	0	0	0	0
11. STANDARD FUNCTIONS	26	26	5	5
	220	200	86	57

REPORT C - SORTS

EXECUTION TIME IN SECONDS

algorithm	LSI-11	LSI/EIS/FIS	LSI/EIS/FIS/MIC
QUICKSORT(recursive)	51	51	28
QUICKSORT(nonrecursive)	57	57	31
HEAPSORT	99	99	56

REPORT D - CROSS-REFERENCER AND BALANCED TREE SEARCH AND INSERTION

EXECUTION TIME IN SECONDS

program	LSI-11	LSI/EIS/FIS	LSI/EIS/FIS/MIC
CROSS-REFERENCER			
with full listing	349	335	227
without listing	-	215	146
BALANCED TREE SEARCH AND INSERTION	62	62	34

APPENDIX E - Report Generators

```
PROGRAM STATS;


TYPE ENTRY = RECORD
              MICS : REAL;
              FREQ : REAL
             END;

VAR T : ARRAY[1..132] OF ENTRY;
    I,J : INTEGER;
    TOTALMPC : INTEGER;
    FREQTOTAL, MICSTOTAL : REAL;
    M : ARRAY[1..132] OF STRING[11];

    CNTOVHD,COREOVHD,SLDCIOVHD,X : REAL;
    REPORT : STRING;
    CONFIGURATION, TITLE1, TITLE2 : STRING;
     RPT : TEXT;
    OP : ARRAY[1..132] OF INTEGER;

PROCEDURE INITVARIABLES;
BEGIN

  WRITE('CNTOVHD := ');
  READLN(CNTOVHD);
  WRITE('COREOVHD := ');
  READLN(COREOVHD);
  WRITE('SLDCIOVHD := ');
  READLN(SLDCIOVHD);
  WRITE('OUTPUT FILE NAME := ');
  READLN(REPORT);

  WRITE('TITLE1 := ');
  READLN(TITLE1);
  WRITE('TITLE2 := ');
  READLN(TITLE2);
  WRITE('CONFIGURATION := ');
  READLN(CONFIGURATION);

END;



PROCEDURE XCHG;
VAR TM : STRING[10];
    TOP : INTEGER;
    TENTRY : ENTRY;

BEGIN
  TM := M[J];
  TOP := OP[J];
  TENTRY := T[J];

  M[J] := M[J+1];
  OP[J] := OP[J+1];
  T[J] := T[J+1];

  M[J+1] := TM;
  OP[J+1] := TOP;
  T[J+1] := TENTRY;

END;

PROCEDURE PRINT;
VAR I : INTEGER;
    FPC, MPC : INTEGER;
    AMIC : REAL;

BEGIN
  REWRITE(RPT,REPORT);
  WRITELN(RPT,TITLE1);
  WRITELN(RPT,TITLE2);
  WRITELN(RPT);
  WRITELN(RPT,CONFIGURATION);
  WRITELN(RPT);
  WRITE(RPT,'CNTOVH = ',CNTOVHD,' COREOVHD = ',COREOVHD);
  WRITELN(RPT,' SLDCIOVHD = ',SLDCIOVHD);
  WRITELN(RPT);
  WRITELN(RPT);
  WRITE(RPT,' OPCODE     MNEM     FREQ    FPERC');
  WRITELN(RPT,'        MICS     AVEMICS  MPERC');
  WRITELN(RPT);

  FOR I := 1 TO 132 DO
    BEGIN
      FPC := ROUND((T[I].FREQ/FREQTOTAL) * 10000);
      MPC := ROUND((T[I].MICS/MICSTOTAL) * 10000);
      TOTALMPC := TOTALMPC + MPC;

      IF T[I].FREQ = 0 THEN
        AMIC := 0
      ELSE
        AMIC := T[I].MICS/T[I].FREQ;

      WRITE(RPT,OP[I] : 6,M[I] : 11,T[I].FREQ : 11 : 1,' .',FPC : 4);
      WRITELN(RPT,T[I].MICS : 13 : 1,AMIC : 11 : 1,' .',MPC : 4);
    END;

  WRITELN(RPT);
  WRITE(RPT,'                   ',FREQTOTAL : 9 : 1);
  WRITELN(RPT,'       ',MICSTOTAL : 13 : 1,'          .',TOTALMPC : 4);
END;

PROCEDURE INITM1;

BEGIN
  M[1] := 'SLDC-TOTAL';
  M[2] := 'ABI';
  M[3] := 'ABR';
```

```
   M[4] := 'ADI';
   M[5] := 'ADR';
   M[6] := 'AND';
   M[7] := 'DIF';
   M[8] := 'DVI';
   M[9] := 'DVR';
   M[10] := 'CHK';
   M[11] := 'FLO';
   M[12] := 'FLT';
   M[13] := 'INN';
   M[14] := 'INT';
   M[15] := 'IOR';
   M[16] := 'MOD';
   M[17] := 'MPI';
   M[18] := 'MPR';
   M[19] := 'NGI';
   M[20] := 'NGR';
   M[21] := 'NOT';
   M[22] := 'SRS';
   M[23] := 'SBI';
   M[24] := 'SBR';
   M[25] := 'SGS';
   M[26] := 'SQI';
   M[27] := 'SQR';
   M[28] := 'STO';
   M[29] := 'IXS';
   M[30] := 'UNI';
   M[31] := 'S2P';
   M[32] := 'CSP';
   M[33] := 'LDCN';
   M[34] := 'ADJ';
   M[35] := 'FJP';
   M[36] := 'INC';
   M[37] := 'IND';
   M[38] := 'IXA';
   M[39] := 'LAO';
   M[40] := 'LCA';
   M[41] := 'LDO';
   M[42] := 'MOV';
   M[43] := 'MVB';
   M[44] := 'SAS';
   M[45] := 'SRO';
   M[46] := 'XJP';
   M[47] := 'RNP';
   M[48] := 'CIP';
   M[49] := 'COMPARE';

END;


PROCEDURE INITM2;

BEGIN
   M[50] := 'COMPARE';
   M[51] := 'COMPARE';
   M[52] := 'LDA';
   M[53] := 'LDC';
   M[54] := 'COMPARE';
   M[55] := 'COMPARE';
   M[56] := 'LOD';
   M[57] := 'COMPARE';
   M[58] := 'STR';
   M[59] := 'UJP';
   M[60] := 'LDP';
   M[61] := 'STP';
   M[62] := 'LDM';
   M[63] := 'STM';
   M[64] := 'LDB';
   M[65] := 'STB';
   M[66] := 'IXP';
   M[67] := 'RBP';
   M[68] := 'CBP';
   M[69] := 'EQUI';
   M[70] := 'GEQI';
   M[71] := 'GRTI';
   M[72] := 'LLA';
   M[73] := 'LDCI';
   M[74] := 'LEQI';
   M[75] := 'LESI';
   M[76] := 'LDL';
   M[77] := 'NEQI';
   M[78] := 'STL';
   M[79] := 'CXP';
   M[80] := 'CLP';
   M[81] := 'CGP';
   M[82] := 'S1P';
   M[83] := 'IXB';
   M[84] := 'BYT';
   M[85] := 'EFJ';
   M[86] := 'NFJ';
   M[87] := 'BPT';
   M[88] := 'XIT';
   M[89] := 'NOP';
   M[90] := 'SLDL1';
   M[91] := 'SLDL2';
   M[92] := 'SLDL3';
   M[93] := 'SLDL4';
   M[94] := 'SLDL5';
   M[95] := 'SLDL6';
   M[96] := 'SLDL7';
   M[97] := 'SLDL8';
   M[98] := 'SLDL9';
   M[99] := 'SLDL10';

END;


PROCEDURE INITM3;

BEGIN
```

```
   M[100] := 'SLDL11';
   M[101] := 'SLDL12';
   M[102] := 'SLDL13';
   M[103] := 'SLDL14';
   M[104] := 'SLDL15';
   M[105] := 'SLDL16';
   M[106] := 'SLDO1';
   M[107] := 'SLDO2';
   M[108] := 'SLDO3';
   M[109] := 'SLDO4';
   M[110] := 'SLDO5';
   M[111] := 'SLDO6';
   M[112] := 'SLDO7';
   M[113] := 'SLDO8';
   M[114] := 'SLDO9';
   M[115] := 'SLDO10';
   M[116] := 'SLDO11';
   M[117] := 'SLDO12';
   M[118] := 'SLDO13';
   M[119] := 'SLDO14';
   M[120] := 'SLDO15';
   M[121] := 'SLDO16';
   M[122] := 'SIND0';
   M[123] := 'SIND1';
   M[124] := 'SIND2';
   M[125] := 'SIND3';
   M[126] := 'SIND4';
   M[127] := 'SIND5';
   M[128] := 'SIND6';
   M[129] := 'SIND7';
   M[130] := 'SLDL-TOTAL';
   M[131] := 'SLDO-TOTAL';
   M[132] := 'SIND-TOTAL';

END;



BEGIN
   WRITE('INPUT WHAT BLOCK NUMBER? >');
   READLN(I);

   UNITREAD(5,T,1032,I,0);

   IF IORESULT <> 0 THEN
     BEGIN
       WRITELN('IO ERROR - FATAL');
       EXIT(STATS)
     END;

   INITVARIABLES;

   TOTALMPC := 0;
   FREQTOTAL := 0;
   MICSTOTAL := 0;
```

```
FOR I := 1 TO 129 DO
  T[I].MICS := T[I].MICS - (T[I].FREQ * CNTOVHD);

FOR I := 1 TO 129 DO
  BEGIN
    FREQTOTAL := FREQTOTAL + T[I].FREQ;
    MICSTOTAL := MICSTOTAL + T[I].MICS
  END;


FOR I := 2 TO 129 DO
  T[I].MICS := T[I].MICS - (T[I].FREQ * COREOVHD);

T[1].MICS := T[1].MICS - (T[1].FREQ * SLDCIOVHD);

FOR I := 130 TO 132 DO
  BEGIN
    T[I].FREQ := 0;
    T[I].MICS := 0;
  END;

FOR I := 90 TO 105 DO
  BEGIN
    T[130].FREQ := T[130].FREQ + T[I].FREQ;
    T[130].MICS := T[130].MICS + T[I].MICS
  END;


FOR I := 106 TO 121 DO
  BEGIN
    T[131].FREQ := T[131].FREQ + T[I].FREQ;
    T[131].MICS := T[131].MICS + T[I].MICS;
  END;

FOR I := 122 TO 129 DO
  BEGIN
    T[132].FREQ := T[132].FREQ + T[I].FREQ;
    T[132].MICS := T[132].MICS + T[I].MICS;
  END;

INITM1;
INITM2;
INITM3;

FOR I := 1 TO 129 DO OP[I] := I + 126;

FOR I := 130 TO 132 DO OP[I] := 0;


WRITELN;
WRITELN('.....SORTING');
WRITELN;
```

```
  FOR I := 1 TO 131 DO
    FOR J := 1 TO 132 - I DO
      IF T[J].MICS < T[J+1].MICS THEN XCHG;
  PRINT;
  CLOSE(RPT,LOCK);

END.
```

```
PROGRAM CSPSTATS;

TYPE ENTRY = RECORD
              MICS : REAL;
              FREQ : REAL
             END;

VAR T : ARRAY[1..41] OF ENTRY;
    I,J : INTEGER;
    FREQTOTAL, MICSTOTAL : REAL;
    M : ARRAY[1..41] OF STRING[11];
    OP : ARRAY[1..41] OF INTEGER;
    RPTNAME : STRING;
    REPT : TEXT;


PROCEDURE XCHG;
VAR TM : STRING[10];
    TOP : INTEGER;
    TENTRY : ENTRY;

BEGIN
  TM := M[J];
  TOP := OP[J];
  TENTRY := T[J];

  M[J] := M[J+1];
  OP[J] := OP[J+1];
  T[J] := T[J+1];

  M[J+1] := TM;
  OP[J+1] := TOP;
  T[J+1] := TENTRY;

END;

PROCEDURE PRINT;
VAR I : INTEGER;
    FPC, MPC : INTEGER;
    AMIC : REAL;

BEGIN
  WRITELN(REPT);
  WRITELN(REPT,'               STANDARD PROCEDURES');
  WRITELN(REPT);
WRITE(REPT,'  PROC      MNEM     FREQ    FPERC');
  WRITELN(REPT,'       MICS     AVEMICS  MPERC');
  WRITELN(REPT);

  FOR I := 1 TO 41 DO
    BEGIN

      IF (FREQTOTAL = 0) OR (MICSTOTAL = 0) THEN
        BEGIN
```

```
          WRITELN('A TOTAL IS ZERO');
          EXIT(CSPSTATS);
        END;
      FPC := ROUND((T[I].FREQ/FREQTOTAL) * 10000);
      MPC := ROUND((T[I].MICS/MICSTOTAL) * 10000);

      IF T[I].FREQ = 0 THEN
        AMIC := 0
      ELSE
        AMIC := T[I].MICS/T[I].FREQ;

      WRITE(REPT,OP[I] : 6,M[I] : 11,T[I].FREQ : 11 : 1,' .',FPC : 4);
      WRITELN(REPT,T[I].MICS : 13 : 1,AMIC : 11 : 1,' .',MPC : 4);
    END;

  WRITELN(REPT);
  WRITE(REPT,'                  ',FREQTOTAL : 9 : 1);
  WRITELN(REPT,'       ',MICSTOTAL : 13 : 1);
 END;

PROCEDURE INITM1;

BEGIN

  FOR I := 1 TO 41 DO M[I] := ' ';

  M[1] := 'IOC';
  M[2] := 'NEW';
  M[3] := 'MVL';
  M[4] := 'MVR';
  M[5] := 'XIT';
  M[6] := 'UREAD';
  M[7] := 'UWRITE';
  M[8] := 'IDS';
  M[9] := 'TRS';
  M[10] := 'TIM';
  M[11] := 'FLC';
  M[12] := 'SCN';
  M[13] := 'DRAWLINE';
  M[14] := 'DRAWBLOCK';

  M[24] := 'TRC';
  M[25] := 'RND';
  M[26] := 'SINCSP';
  M[27] := 'COSCSP';
  M[28] := 'LOGCSP';
  M[29] := 'ATNCSP';
  M[30] := 'LNCSP';
  M[31] := 'EXPCSP';
  M[32] := 'SQTCSP';
  M[33] := 'MRK';
  M[34] := 'RLS';
  M[35] := 'IOR';
  M[36] := 'UBUSY';
  M[37] := 'POT';
  M[38] := 'UWAIT';
  M[39] := 'UCLEAR';
  M[40] := 'HLT';
  M[41] := 'MEM';
END;




BEGIN
  WRITE('INPUT WHAT BLOCK NUMBER? >');
  READLN(I);

  UNITREAD(5,T,500,I,0);

  IF IORESULT <> 0 THEN
    BEGIN
      WRITELN('IORESULT = ',IORESULT);
      EXIT(CSPSTATS);
    END;

  FREQTOTAL := 0;
  MICSTOTAL := 0;


  FOR I := 1 TO 41 DO
    BEGIN
      FREQTOTAL := FREQTOTAL + T[I].FREQ;
      MICSTOTAL := MICSTOTAL + T[I].MICS
    END;

  FOR I := 1 TO 41 DO OP[I] := I;

  INITM1;

  WRITELN;
  WRITELN('.....SORTING');
  WRITELN;

  FOR I := 1 TO 41 DO
    FOR J := 1 TO 41 - I DO
      IF T[J].MICS < T[J+1].MICS THEN XCHG;
  WRITE('OUTPUT FILE NAME := ');
  READLN(RPTNAME);
  REWRITE(REPT,RPTNAME);
  PRINT;
  CLOSE(REPT,LOCK);

END.
```

APPENDIX F - Pascal Test Prosrams

```
(*WHETSTONE BENCHMARK - - DIRECT TRANSLITERATION FROM:
    "A SYNTHETIC BENCKMARK"  BY H. J. CURNOW & B. A. WICHMANN
    'THE COMPUTER JOURNAL' VOL 19, NO. *)

(* transliteration done by Roger Peterson,
   I/O modifications done by Gordon Smith *)


(*$G+*)   (* TURN ON 'GOTO' -- SORRY ABOUT THAT!! *)

PROGRAM WHETSTONE;

CONST T=0.499975;
      T1=0.50025;
      T2=2.0;

TYPE ARGARRAY = ARRAY[1..4] OF REAL;

VAR E1 : ARRAY[1..4] OF REAL;
    X,Y,Z,X1,X2,X3,X4 : REAL;
    MODULE,I,J,K,L,N1,N2,N3,N4,N5,N6,N7,N8,N9,N10,N11 : INTEGER;
    HT,LT1,LT2,TT,WKT  : INTEGER;  (* TIMING VARIABLES *)

PROCEDURE PA(VAR E:ARGARRAY);

LABEL 1;
VAR J : INTEGER;

BEGIN
   J:=0;

1:
   E[1]:=(E[1]+E[2]+E[3]-E[4])*T;
   E[2]:=(E[1]+E[2]-E[3]+E[4])*T;
   E[3]:=(E[1]-E[2]+E[3]+E[4])*T;
   E[4]:=(-E[1]+E[2]+E[3]+E[4])/T2;
   J:=J+1;
   IF J<6 THEN
    GOTO 1
END;  (* PROCEDURE PA*)


PROCEDURE P0;

BEGIN
   E1[J]:=E1[K];
   E1[K]:=E1[L];
   E1[L]:=E1[J]
END;   (* PROCEDURE P0 *)

PROCEDURE P3(X,Y:REAL;VAR Z:REAL);

BEGIN
   X:=T*(X+Y);
   Y:=T*(X+Y);
   Z:=(X+Y)/T2
END;  (* PROCEDURE P3 *)

PROCEDURE MODULE1; (* MODULE 1: SIMPLE IDENTIFIERS *)

BEGIN
  X1:=1.0;
  X2:=-1.0; X3:=-1.0; X4:=-1.0;

  FOR I:=1 TO N1 DO
  BEGIN
    X1:=(X1+X2+X3-X4)*T;
    X2:=(X1+X2-X3+X4)*T;
    X3:=(X1-X2+X3+X4)*T;
    X4:=(-X1+X2+X3+X4)*T
  END;

END; (* MODULE 1 *)

PROCEDURE MODULE2; (* MODULE 2: ARRAY ELEMENTS *)

BEGIN
E1[1]:=1.0;
E1[2]:=-1.0; E1[3]:=-1.0; E1[4]:=-1.0;

FOR I:=1 TO N2 DO
  BEGIN
  E1[1]:=(E1[1]+E1[2]+E1[3]-E1[4])*T;
  E1[2]:=(E1[1]+E1[2]-E1[3]+E1[4])*T;
  E1[3]:=(E1[1]-E1[2]+E1[3]+E1[4])*T;
  E1[4]:=(-E1[1]+E1[2]+E1[3]+E1[4])*T
  END;
END;  (* MODULE 2 *)

PROCEDURE MODULE4; (* MODULE 4: CONDITIONAL JUMPS *)

BEGIN
J:=1;
FOR I:=1 TO N4 DO
  BEGIN
    IF J=1 THEN
      J:=2
    ELSE
      J:=3;
    IF J>1 THEN
      J:=0
    ELSE
      J:=1;
    IF J<1 THEN
      J:=1
    ELSE
      J:=0
  END;
END; (* MODULE 4 *)
```

```
PROCEDURE MODULE6; (* INTEGER ARITHMETIC *)

BEGIN
  J:=1;
  K:=2;
  L:=3;

  FOR I:= 1 TO N6 DO
  BEGIN
    J:=J*(K-J)*(L-K);
    K:=L*K-(L-J)*K;
    L:=(L-K)*K+J;
    E1[L-1]:=J+K+L;
    E1[K-1]:=J*K*L
  END;
END; (* MODULE 6 *)

PROCEDURE MODULE7; (* MODULE 7: TRIG FUNCTIONS *)

BEGIN
X:=0.5; Y:=0.5;
FOR I:=1 TO N7 DO
  BEGIN
    X:=T*ATAN(T2*SIN(X)*COS(X)/(COS(X+Y)+COS(X-Y)-1.0));
    Y:=T*ATAN(T2*SIN(Y)*COS(Y)/(COS(X+Y)+COS(X-Y)-1.0))
  END;
END; (* MODULE 7 *)

PROCEDURE MODULE8; (* MODULE 8: PROCEDURE CALLS *)

BEGIN
  X:=1.0; Y:=1.0; Z:=1.0;

  FOR I:=1 TO N8 DO
    P3(X,Y,Z)
END; (* MODULE 8 *)

PROCEDURE MODULE10; (* MODULE 10: INTEGER ARTIHMETIC *)

BEGIN
  J:=2;
  K:=3;
  FOR I:=1 TO N10 DO
    BEGIN
    J:=J+K;
    K:=J+K;
    J:=K-J;
    K:=K-J-J
  END;
END; (* MODULE 10 *)

PROCEDURE MODULE11; (* MODULE 11: STANDARD FUNCTIONS *)

BEGIN
  X:=0.75;
  FOR I:=1 TO N11 DO
    X:=SQRT(EXP(LN(X)/T1));
END; (* MODULE 11 *)

PROCEDURE POUT(VAR N,J,K:INTEGER; VAR X1,X2,X3,X4:REAL);

BEGIN
  TIME(HT,LT2);
  WRITE('MODULE ',MODULE:2,N:5,J:5,K:5);
  WRITELN(X1:12:3,X2:12:3,X3:12:3,X4:12:3);
  WKT := ((LT2 - LT1) + 30) DIV 60;
  TT := TT + WKT;
  WRITELN(WKT,' SECS');
  TIME(HT,LT1);
END;   (* PROCEDURE POUT *)

BEGIN  (* START WHETSTONE *)

(* READ VALUE OF I, CONTROLLING TOTAL WEIGHT: IF I=10,
    THE TOTAL WEIGHT IS ONE MILLION WHETSTONE INSTRUCTIONS *);

  WRITELN;
  WRITE ('WEIGHTING FACTOR I = '); READLN(I);
  WRITELN;
  N1:=0;
  N2:=12*I;
  N3:=14*I;
  N4:=345*I;
  N5:=0;
  N6:=210*I;
  N7:=32*I;
  N8:=899*I;
  N9:=616*I;
  N10:=0;
  N11:=93*I;

  TT:= 0;
  TIME(HT,LT1);

(* MODULAR PROGRAMMING IS USED TO REDUCE THE LENGTH OF MAIN CODE *)

MODULE1; (* SIMPLE IDENTIFIERS *)
MODULE:=1;
POUT(N1,N1,N1,X1,X2,X3,X4);

MODULE2; (* ARRAY ELEMENTS *)
MODULE:=2;
POUT(N2,N3,N2,E1[1],E1[2],E1[3],E1[4]);

(* MODULE 3: ARRAY AS A PARAMETER *)

FOR I:= 1 TO N3 DO

  PA(E1);
```

```
MODULE:=3;
POUT(N3,N2,N2,E1[1],E1[2],E1[3],E1[4]);

(* END OF MODULE 3 *)

MODULE4; (* CONDITIONAL JUMPS *)
MODULE:=4;
POUT(N4,J,J,X1,X2,X3,X4);

WRITELN('MODULE  5 OMITTED ');
MODULE6; (* INTEGER ARITHMETIC *)
MODULE:=6;
POUT(N6,J,K,E1[1],E1[2],E1[3],E1[4]);

MODULE7; (* TRIG FUNCTIONS *)
MODULE:=7;
POUT(N7,J,K,X,X,Y,Y);

MODULE8; (* PROCEDURE CALLS *)
MODULE:=8;
POUT(N8,J,K,X,Y,Z,Z);

(* MODULE 9: ARRAY REFERENCES *)

  J:=1;
  K:=2;
  L:=3;
  E1[1]:=1.0;
  E1[2]:=2.0;
  E1[3]:=3.0;

  FOR I:=1 TO N9 DO P0;

MODULE:=9;
POUT(N9,J,K,E1[1],E1[2],E1[3],E1[4]);

MODULE10; (* INTEGER ARITHMETIC *)
MODULE:=10;
POUT(N10,J,K,X1,X2,X3,X4);

MODULE11; (* STANDARD FUNCTIONS *)
MODULE:=11;
POUT(N11,J,K,X,X,X,X);

WRITELN(TT,' TOTAL SECS');
WRITELN('END OF WHETSTONE')
END. (* END WHETSTONE *)
```

```
PROGRAM BTSI;  (* BALANCED TREE SEARCH AND INSERTION *)

TYPE
   BALANCE = -1..1;
   REF = ^NODE;
   NODE = RECORD
           KEY,COUNT : INTEGER;
           BAL : BALANCE;
           LEFT,RIGHT : REF
         END;

VAR
   HT,LT1,LT2 : INTEGER;
   I,J,X : INTEGER;
   P : REF;
   H : BOOLEAN;

PROCEDURE SEARCH(X: INTEGER;VAR P: REF;VAR H: BOOLEAN);

VAR P1,P2: REF;

BEGIN
  IF P = NIL THEN
    BEGIN
      NEW(P);
      H := TRUE;
      WITH P^ DO
        BEGIN
          KEY := X;
          COUNT := 1;
          LEFT := NIL;
          RIGHT := NIL;
          BAL := 0
        END
    END
  ELSE
  IF X < P^.KEY THEN
    BEGIN
      SEARCH(X,P^.LEFT,H);
      IF H THEN
        CASE P^.BAL OF
          1: BEGIN
               P^.BAL := 0;
               H := FALSE
             END;
          0: P^.BAL := -1;
         -1: BEGIN (*REBALANCE*)
               P1 := P^.LEFT;
               IF P1^.BAL = -1 THEN
                 BEGIN
                   P^.LEFT := P1^.RIGHT;
                   P1^.RIGHT := P;
                   P^.BAL := 0;
                   P := P1
               END
             ELSE
               BEGIN
                 P2 := P1^.RIGHT;
                 P1^.RIGHT := P2^.LEFT;
                 P2^.LEFT := P1;
                 P^.LEFT := P2^.RIGHT;
                 P2^.RIGHT := P;
                 IF P2^.BAL = -1 THEN P^.BAL := +1 ELSE P^.BAL := 0;
                 IF P2^.BAL = 1 THEN P1^.BAL := -1 ELSE P1^.BAL := 0;
                 P := P2
               END;
             P^.BAL := 0;
             H := FALSE
           END
         END
  END
  ELSE
IF X > P^.KEY THEN
  BEGIN
    SEARCH(X,P^.RIGHT,H);
    IF H THEN (*RIGHT BRANCH HAS GROWN HIGHER*)
      CASE P^.BAL OF
        -1: BEGIN
              P^.BAL := 0;
              H := FALSE
            END;
         0: P^.BAL := +1;
        +1: BEGIN
              P1 := P^.RIGHT;
              IF P1^.BAL = +1 THEN
                BEGIN (*SINGLE RR ROTATION*)
                  P^.RIGHT := P1^.LEFT;
                  P1^.LEFT := P;
                  P^.BAL := 0;
                  P := P1
                END
              ELSE
                BEGIN
                  P2 := P1^.LEFT;
                  P1^.LEFT := P2^.RIGHT;
                  P2^.RIGHT := P1;
                  P^.RIGHT := P2^.LEFT;
                  P2^.LEFT := P;
                  IF P2^.BAL = +1 THEN P^.BAL := -1 ELSE P^.BAL := 0;
                  IF P2^.BAL = -1 THEN P1^.BAL := 1 ELSE P1^.BAL := 0;
                      P := P2
                END;
                P^.BAL := 0;
                H := FALSE
            END
         END
END
ELSE
  BEGIN
```

```
      P^.COUNT := P^.COUNT + 1;
      H := FALSE
    END
END;


PROCEDURE PRINT(P: REF);
BEGIN
  IF P <> NIL THEN
    WITH P^ DO
      BEGIN
        WRITELN(KEY,' ',COUNT,' ',BAL);
        PRINT(LEFT);
        PRINT(RIGHT)
      END
END;



BEGIN
  TIME(HT,LT1);

  P := NIL;
  H := FALSE;

  FOR I := 0 TO 9 DO
    FOR J := 0 TO 999 DO
      BEGIN
        X := ((((J * 17) + (I * 513)) MOD 117) MOD 51);
        SEARCH(X,P,H)
      END;

  TIME(HT,LT2);

  PRINT(P);

  WRITELN(((LT2 - LT1) + 30) DIV 60,' SECONDS');
END.
```

```
PROGRAM RQUICKSORT;
  TYPE  INDEX = 0..2999;

  VAR A : ARRAY[0..2999] OF INTEGER;
      C : CHAR;
      HT,LT1,LT2 : INTEGER;

  PROCEDURE SORT(L,R : INDEX);
  VAR I,J : INDEX;
      X,W : INTEGER;
  BEGIN
    I := L;
    J := R;
    X := A[(L+R) DIV 2];
    REPEAT
      WHILE A[I] < X DO I := I + 1;
      WHILE X < A[J] DO J := J - 1;
      IF I <= J THEN
        BEGIN
          W := A[I];
          A[I] := A[J];
          A[J] := W;
          I := I + 1;
          J := J - 1
        END
    UNTIL I > J;
    IF L < J THEN SORT(L,J);
    IF I < R THEN SORT(I,R);
  END;

BEGIN
  FOR LT1 := 0 TO 9 DO
    FOR LT2 := 0 TO 299 DO
      BEGIN
        HT := (LT2 * 10) + LT1;
        A[HT] := ((((LT2 * 17) + (LT1 * 513)) MOD 117) MOD 51);
      END;

  WRITE('PRINT INPUT? >');
  READLN(C);
  IF C = 'Y' THEN
  FOR LT2 := 0 TO 299 DO
    BEGIN
      WRITELN;
      FOR LT1 := 0 TO 9 DO WRITE(A[(LT2 * 10) + LT1],' ');
    END;

  TIME(HT,LT1);
  SORT(0,2999);
  TIME(HT,LT2);
  HT := ((LT2 - LT1) + 30) DIV 60;


  WRITE('PRINT OUTPUT? >');
  READLN(C);
  IF C = 'Y' THEN
  FOR LT2 := 0 TO 299 DO
    BEGIN
      WRITELN;
      FOR LT1 := 0 TO 9 DO WRITE(A[(LT2 * 10) + LT1],' ');
    END;

  WRITELN;
  WRITELN(HT,' SECONDS');
END.
```

```
(*$L+*)

PROGRAM QUICKSORT;
CONST M = 100;
TYPE INDEX = 0..2999;
VAR I,J,L,R : INDEX;
    X,W,HT,LT1,LT2 : INTEGER;
    S : 0..M;
    STACK : ARRAY[1..M] OF RECORD
                             L,R : INDEX
                           END;
    A : ARRAY[0..2999] OF INTEGER;
    C : CHAR;


BEGIN
  FOR LT1 := 0 TO 9 DO
    FOR LT2 := 0 TO 299 DO
      BEGIN
        HT := (LT2 * 10) + LT1;
        A[HT] := ((((LT2 * 17) + (LT1 * 513)) MOD 117) MOD 51);
      END;

  WRITE('PRINT INPUT? >');
  READLN(C);
  IF C = 'Y' THEN
  FOR LT2 := 0 TO 299 DO
    BEGIN
      WRITELN;
      FOR LT1 := 0 TO 9 DO WRITE(A[(LT2 * 10) + LT1],' ')
    END;

  TIME(HT,LT1);

  S := 1;
  STACK[1].L := 1;
  STACK[1].R := 2999;
  REPEAT
    L := STACK[S].L;
    R := STACK[S].R;
    S := S - 1;
    REPEAT
      I := L;
      J := R;
      X := A[(L + R) DIV 2];
      REPEAT
        WHILE A[I] < X DO I := I + 1;
        WHILE X < A[J] DO J := J - 1;
        IF I <= J THEN
          BEGIN
            W := A[I];
            A[I] := A[J];
            A[J] := W;
            I := I + 1;
            J := J - 1;
          END
       UNTIL I > J;
       IF I < R THEN
         BEGIN
           S := S + 1;
           STACK[S].L := I;
           STACK[S].R := R
         END;
       R := J
    UNTIL L >= R
  UNTIL S = 0;

  TIME(HT,LT2);
  HT := ((LT2 - LT1) + 30) DIV 60;

  WRITE('PRINT OUTPUT? >');
  READLN(C);
  IF C = 'Y' THEN
  FOR LT2 := 0 TO 299 DO
    BEGIN
      WRITELN;
      FOR LT1 := 0 TO 9 DO WRITE(A[(LT2 * 10) + LT1],' ');
    END;

  WRITELN;
  WRITELN(HT,' SECONDS')
END.
```

```
(*$L+,G+*)

PROGRAM HEAPSORT;
TYPE INDEX = 1..3000;
VAR L,R : INDEX;
    X,HT,LT1,LT2 : INTEGER;
    C : CHAR;
    A : ARRAY[1..3000] OF INTEGER;

  PROCEDURE SIFT;
  LABEL 13;
  VAR I : INDEX;
      J : INTEGER;
  BEGIN
    I := L;
    J := 2*I;
    X := A[I];
    WHILE J <= R DO
      BEGIN
        IF J < R THEN
          IF A[J] < A[J + 1] THEN J := J + 1;
        IF X >= A[J] THEN GOTO 13;
        A[I] := A[J];
        I := J;
        J := 2 * I
      END;
  13: A[I] := X
  END;


BEGIN
  FOR LT1 := 0 TO 9 DO
    FOR LT2 := 0 TO 299 DO
      BEGIN
        HT := (LT2 * 10) + LT1;
        A[HT + 1] := ((((LT2 * 17) + (LT1 * 513)) MOD 117) MOD 51);
      END;

  WRITE('PRINT INPUT? >');
  READLN(C);
  IF C = 'Y' THEN
  FOR LT2 := 0 TO 299 DO
    BEGIN
      WRITELN;
      FOR LT1 := 0 TO 9 DO WRITE(A[(LT2 * 10) + LT1 + 1],' ')
    END;

  TIME(HT,LT1);


  L := (3000 DIV 2) + 1;
  R := 3000;
  WHILE L > 1 DO
    BEGIN
```

```
      L := L - 1;
      SIFT
    END;
  WHILE R > 1 DO
    BEGIN
      X := A[1];
      A[1] := A[R];
      A[R] := X;
      R := R - 1;
      SIFT
    END;


  TIME(HT,LT2);
  HT := ((LT2 - LT1) + 30) DIV 60;

  WRITE('PRINT OUTPUT? >');
  READLN(C);
  IF C = 'Y' THEN
  FOR LT2 := 0 TO 299 DO
    BEGIN
      WRITELN;
      FOR LT1 := 0 TO 9 DO WRITE(A[(LT2 * 10) + LT1 + 1],' ');
    END;

  WRITELN;
  WRITELN(HT,' SECONDS')

END.
```

APPENDIX G - Microcode Used for Timins

```
; CNTER.MIC


;***********************
; MICRO CODE LOCATIONS

;***********************

; MACRO MEMORY LOCATIONS

LLASTMP = 16
HLASTMP = 1

LJTAB = 20
HJTAB = 1

LSEG = 22
HSEG = 1


;***********************

; MARK STACK OFFSET VARIABLES

MSSTAT = 0
MSDYN = 2
MSIPC = 10
MSSEG = 6
MSJTAB = 4
MSSP = 12
MSBASE = -2
MSDLTA = 12




        LOC     3000
        JMP     0,TROFF
        JMP     DECODE
ERROR:  JMP     0,TROFF
        JMP     CLKOPS

INTRUP: JZBF    REREAD
        LGL     RPSWL
        MI      GH,GL
        JMP     0


        JMP     OPBIG           ;OP CODE 76770
        JMP     OPBIG           ;        76771
        JMP     OPBIG           ;        76702

        JMP     3500            ;        76773
        JMP     3504            ;        76774
        JMP     0,TROFF        ;        76775
        JMP     0,TROFF        ;        76776
        JMP     0,TROFF        ;        76777


REREAD: LL      7,PCH,RSVC
        LL      120,PCL

DECODE:  CL      175,RIRL
         JZBF    ERROR
         CL      304,RIRH
         JZBT    CLKOFF

         AL      10,RIRH
         JC8F    ERROR
         MI      RPSWL,RIRH      ; INDEX JUMP TABLE ABOVE
         JMP     3010


SLDCI:  AL      376,SPL
        CDB     SPH
        W       SPH,SPL
        OW      RPSWL,GL

EXIT:  NOP
       NOP
       NOP
       JMP     CLKOFF

NEXT:   LGL     RIRH
        RIW1    GH,GL
         LGL     RPSWL
         LL      377,GH
         LL      6,RSRCL

        IBF     2,GL

        LL      7,RBAH
        LL      116,RBAL
        W       RBAH,RBAL
        OW      RPSWL,GL

        JNF     SLDCI

        SLB     GL,GL

        R       RSRCL,GL
         LL      1,RSRCL
         LL      2,RBAH
         LL      3,RBAL

        IW      0,RDST
        AL      10,RDSTH
        JC8F    MACRO
        MI      RDSTH,RDSTL
        JMP     0

MACRO:  AL      -10,RDSTH,RSVC
        MW      RDST,PC


; COMMON PROCEDURES SECTION


OPBIG:  JMP     BIG2,LRR
        NOP     RSVC
GETBIG:   LL      0,RIRH
BIG2:   LL      4,RDSTL

        LGL     RDSTL
        RIW1    GH,GL
         LGL     RIRH
         LL      0,GH
        IB      2,GL
        JNBF    ISMALL

        LGL     RDSTL
        RIW1    GH,GL
         LGL     RIRH
         MB      GL,GH
         NL      177,GH
        IB      2,GL

ISMALL: LL      4,RIRH
        RFS


SUB:    RIW2    SPH,SP
        IW      0,RIR

        R       SPH,SP
        IW      0,RDST

        SWF     RIR,RDST
        RFS


PSHFLS: LL      0,RSRCL
PSHTRU: W       SPH,SPL
        OW      RPSWL,RSRCL
        JMP     EXIT


EQUI:   JMP     SUB,LRR
        JZT     PSHTRU
        JMP     PSHFLS

NEQI:   JMP     SUB,LRR
        JZF     PSHTRU
        JMP     PSHFLS

LEQI:   JMP     SUB,LRR
        JZT     PSHTRU
        CCF     RBAL
        NL      12,RBAL
        JZBT    PSHFLS
        OCB     RBAL,RBAL
        JZBT    PSHFLS
        JMP     PSHTRU

GRTI:   JMP     SUB,LRR
        JZT     PSHFLS
        CCF     RBAL
        NL      12,RBAL
        JZBT    PSHTRU
        OCB     RBAL,RBAL
        JZBT    PSHTRU
        JMP     PSHFLS


        LOC 3250    ; MACRO 3230 <- 177250

STL:    JMP     GETBIG,LRR

        SLW     G,RDST
        AL      12,RDSTL
        CIB     RDSTH

        RIW2    SPH,SPL
         LGL     RIRL
         AW      G,RDST
        IW      0,RSRC

        W       RDSTH,RDSTL
        OW      RSRCH,RSRCL

        JMP     EXIT

        LOC

CLKOPS: CL      173,RIRL
        JZBF    ERROR
        LL      175,RIRL

        CL      304,RIRH
        JZBT    NEXT
        CL      314,RIRH
        JZBF    ERROR

CLKON:  LL      361,RDSTH
        LL      20,RDSTL
        LL      17,RSRCL

        W       RDSTH,RDSTL
        OW      RPSWL,RSRCL

        JMP     NEXT

CLKOFF: LL      361,RDSTH
        LL      20,RDSTL
        LL      2,PCL
        LL      7,PCH

        W       RDSTH,RDSTL
        OW      PCL,PCH,RSVC

        LL      122,PCL

        .END
```

```
#CNTINT.MIC


;***********************

; MACRO MEMORY LOCATIONS

LLASTMP = 16
HLASTMP = 1

LJTAB = 20
HJTAB = 1

LSEG = 22
HSEG = 1


;***********************

; MARK STACK OFFSET VARIABLES

MSSTAT = 0
MSDYN = 2
MSIPC = 10
MSSEG = 6
MSJTAB = 4
MSSP = 12
MSBASE = -2
MSDLTA = 12

;***************************

; JTAB OFFSETS

ENTRIC = -2
DATASZ = -10
PARMSZ = -6


;--------------------------------------
;          CORE SECTION


        LOC 3000

        JMP     0,TROFF                   ; OPCODES 220-227, RESERVED BY DEC.
        JMP     DECODE                    ; OPCODES 76000-76777, TOP 64 ARE OURS.
ERROR:  JMP     0,TROFF                   ; MICRO POWER UP.
        JMP     CLKOPS

        LOC 3004                          ; MICROINTERRUPT ABORT ENTRY POINT.
```

```
REREAD: AL      -2,PCL,RSVC         ; RETURN TO MACRO TO SERVICE INTERRUPT.
        CDB     PCH                 ; DECREMENT PC SO SAME OPCODE WILL BE
                                    ; READ AGAIN.

DECODE; CL      175,RIRL            ; CHECK OPCODE TO MAKE SURE ITS LEGIT.
        JZBF    ERROR               ; NOTE, HIGH ORDER BYTE OF OP IS IN
                                    ; RIRL AND LOW BYTE IS IN RIRH.
        CL      304,RIRH            ; QUICK CHECK FOR INTERPRETER FETCH OP
        JZBT    CLKOFF

        AL      20,RIRH             ; CHECK OPCODES FOR RANGE 76760-76777
        JC8F    ERROR
        MI      RPSWL,RIRH          ; USE LOWER 4 BITS OF OPCODE TO INDEX
        JMP     3760                ; MICRO JUMP TABLE.

        LOC 3760                  ; MICRO JUMP TABLE
        JMP     DECMOV              ; OP CODE 76760
        JMP     DECMOV              ;         76771
        JMP     DECMOV              ;         76762
        JMP     0,TROFF             ;         76763
        JMP     CLP                 ;         76764
        JMP     CIP                 ;         76765
        JMP     0,TROFF             ;         76766
        JMP     0,TROFF             ;         76767
        JMP     INCMOV              ;         76770
        JMP     INCMOV              ;         76771
        JMP     INCMOV              ;         76772
        JMP     0,TROFF             ;         76773
        JMP     OPBIG               ;         76774
        JMP     0,TROFF             ;         76775
        JMP     CHK                 ;         76776
        JMP     LKLST               ;         76777

        LOC


SLDCI:  ; SHORT LOAD CONSTANT INTEGER
        AL      -2,SPL              ; PUSH OPCODE ONTO STACK
        CDB     SPH
        W       SPH,SPL             ; ( MOV   R0,-(SP) )
        OW      RPSWL,RDSTL

CINTRP: ; CHECK FOR INTERRUPTS AND THEN FALL INTO INTERPRETER FETCH.
        SI      I6
        LL      4,RIRH,RSVC
        RI      I6
        JMP     CLKOFF

IFETCH: ; INTERPRETER FETCH
        ; THIS IS SIMILAR TO THE BACK ROUTINE IN MACROCODE.
        ; DIFFERENCES ARE:
        ;       1. XFRTBL CONTAINS BOTH MICRO AND MACRO ADDRESSES.
        ;          MICRO ADDRESSES HAVE HIGH ORDER 5 BITS SET TO 1S.
        ;       2. REGISTER 0 IS NOT LOADED WITH THE OPCODE.
        ;
        ; INTERNAL REGISTERS ARE INITIALIZED DURING THE COURSE OF
        ; IFETCH AND CINTRP TO THESE VALUES:
        ;        RSRCL = 1
        ;        RBAH = 2
        ;        RBAL = 3
        ;        RIRH = 4
        ;        RIRL = 5

        LGL     RIRH
        RIW1    GH,GL               ; READ OPCODE
         LL      5,RIRL
         LL      6,RSRCL            ; TEMPORARY - WHEN XFRTBL IS MOVED TO
                                    ; ADDRESS 400 CHANGE TO LL  1,RSRCL.
        IBF      2,RDSTL

        LL      7,RBAH
        LL      116,RBAL
        W       RBAH,RBAL
        OW      RPSWL,RDSTL

        JNF    SLDCI

        SLB     RDSTL,RDSTL

        R       RSRCL,RDSTL         ; ACCESS XFRTBL.
         LL      1,RSRCL            ; TEMPORARY - SEE NOTE ABOVE
         LL      2,RBAH
         LL      3,RBAL
        IW      O,RDST

        AL      10,RDSTH            ; SEE IF ITS MICRO OR MACRO ADDRESS.
        JC8F    MACRO

        MI      RDSTH,RDSTL         ; JUMP TO MICRO ROUTINE.
        JMP     O

MACRO:  AL      -10,RDSTH,RSVC      ; BACK TO MACRO.
        MW      RDST,PC


; --------------------------------------------
;            P-MACINE OP CODES



CLKOPS: CL      173,RIRL
        JZBF    ERROR
        LL      175,RIRL

        CL      304,RIRH
        JZBT    IFETCH
        CL      314,RIRH
        JZBF    ERROR
```

```
CLKON:  LL      361,RDSTH
        LL      20,RDSTL
        LL      17,RSRCL

        W       RDSTH,RDSTL
        OW      RPSWL,RSRCL

        JMP     IFETCH

CLKOFF: LL      361,RDSTH
        LL      20,RDSTL
        LL      2,PCL
        LL      7,PCH

        W       RDSTH,RDSTL
        OW      PCL,PCH,RSVC

        LL      122,PCL



;*****


        AL      MSDLTA,RDSTL
        CIB     RDSTH

        LGL     RIRL
        AW      G,RDST

        SW      RBAH,SP
        W       SPH,SPL
        OW      RDSTH,RDSTL

        JMP     CINTRP

;*****

LAO:    ; LOAD GLOBAL ADDRESS
        JMP     PRCBIG,LRR
        SLW     G,RDST

        AL      MSDLTA,RDSTL
        CIB     RDSTH

        LGL     RBAL
        AW      G,RDST

        SW      RBAH,SP


        W       SPH,SPL
        OW      RDSTH,RDSTL
        JMP     CINTRP

;*****

AND:    ; AND
        RIW2    SPH,SPL
        IW      0,RDST

        R       SPH,SPL
        IW      4,RSRC

        NW      RSRC,RDST

        OW      RDSTH,RDSTL

        JMP     CINTRP


;*****

LDCI:   ; LOAD CONSTANT WORD
        LGL     RIRH
        RIW1    GH,GL
        IB      2,RDSTL

        RIW1    GH,GL
         SW      RBAH,SP
        IB      2,RDSTH

        W       SPH,SPL
        OW      RDSTH,RDSTL

        JMP     CINTRP



;****

FJP:    ; FALSE JUMP   (NOTE, REQUIRES UJP BE PRESENT)
        RIW2    SPH,SPL
        LGL     RIRH
        IBF     1,RSRCL
        SRBF    RSRCL,RSRCL
        JCF     UJPSKP
        ICW1    G,G
        JMP     CINTRP

;****

UJP:    ; UNCONDITIONAL JUMP
        LGL     RIRH
UJPSKP: RIW1    GH,GL
        IBF     2,RSRCH
        JNBT    LONG
        AW      RSRCH,G
        JMP     CINTRP
LONG:   LL      1,RDSTH
        LL      20,RDSTL
        R        RDSTH,RDSTL
        IW      0,G
        AW      RSRCH,G
        R       GH,GL
        IW      0,RSRC
        SW      RSRC,G
        JMP     CINTRP

SUB:    ; COMMON PROCEDURE USED BY COMPARISONS
        RIW2    SPH,SP
        IW      0,RIR

        R       SPH,SP
        IW      0,RDST

        SWF     RIR,RDST
        RFS

;****
EQUI:   ; INTEGER EQUAL COMPARE
        JMP     SUB,LRR
        JZT     PSHTRU

PSHFLS: LL      0,RSRCL
PSHTRU: W       SPH,SPL
        OW      RPSWL,RSRCL
        JMP     CINTRP



;****
NEQI:   ; INTEGER NOT EQUAL COMPARE
        JMP     SUB,LRR
        JZF     PSHTRU
        JMP     PSHFLS

;****
LEQI:   ; INTEGER LESS THAN OR EQUAL COMPARE
        JMP     SUB,LRR
        JZT     PSHTRU
        CCF     RBAL
        NL      12,RBAL
        JZBT    PSHFLS
        OCB     RBAL,RBAL
        JZBT    PSHFLS
        JMP     PSHTRU

;****
GRTI:   ; INTEGER GREATER THAN COMPARE
        JMP     SUB,LRR
        JZT     PSHFLS
        CCF     RBAL
        NL      12,RBAL
        JZBT    PSHTRU
        OCB     RBAL,RBAL
        JZBT    PSHTRU
        JMP     PSHFLS



;****
STL:    ; STORE LOCAL
        JMP     PRCBIG,LRR

        SLW     G,RDST
        AL      12,RDSTL
        CIB     RDSTH

        RIW2    SPH,SPL
         LGL     RIRL
         AW      G,RDST
        IW      0,RSRC

        W       RDSTH,RDSTL
        OW      RSRCH,RSRCL

        JMP     CINTRP




;****
XJP:    ; CASE TABLE
        RIW2    SPH,SPL
         LGL     RIRH
         ICW1    G,G
        IW      0,RDST

        NL      376,GL
        RIW2    GH,GL
        IW      0,RSRC

        RIW2    GH,GL
         CWF     RSRC,RDST
         CCF     RIRL
        IW      0,RBA

        NL      12,RIRL
        JZBT     CONT1
        OCB     RIRL,RIRL
        JZBF    XJPEXIT

CONT1:  CWF     RDST,RBA
        CCF     RIRL
        NL      12,RIRL
        JZBT    CONT2
        OCB     RIRL,RIRL
        JZBF    XJPEXIT

CONT2:  ICW2    G,G

        SW      RSRC,RDST
        SLW     RDST,RDST

        AW      RDST,G

        R       GH,GL
        IW      0,RDST

        SW      RDST,G

XJPEXIT: JMP    CINTRP




;****
LDM:    ; LOAD MULTIPLE
        R       SPH,SPL
         LGL     RIRH
         MW      SP,RDST
        IW      0,RSRC

        R       GH,GL
         DW1     G,G
         LL      0,RBAH
        IB      2,RBAL
        JZBT    LDMEXIT

        SW      RBAL,RDST
        SW      RBAL,RDST
        ICW2    RDST,RDST

        MW      RDST,RBA

LDMLOP: SI      I6
        LL      1,RIRH,RSVC
        RI      I6

        RIW2    RSRCH,RSRCL
         CWF     RDST,SP
        IW      0,RIR

        WIW2    RDSTH,RDSTL
        OW      RIRH,RIRL

        JZF     LDMLOP

        MW      RBA,SP
LDMEXIT: ICW2    G,G
```

```
        JMP     CINTRP


;****

RNP:    ; RETURN FROM NORMAL PROCEDURE
        LGL     RIRL
        MW      G,RSRC
        AL      MSSP,RSRCL
        CIB     RSRCH

        R       RSRCH,RSRCL
         LGL     RPSWL
        IW      0,G

        LGL     RIRH
        R       GH,GL
         DW1     G,G
         LL      0,RBAH
        IB      2,RBAL
        JZBT    DOPROC

        AW      RBA,RSRC
        AW      RBA,RSRC

        LGL     RPSWL
        LL      2,RBAH

RNPLOP: R       RSRCH,RSRCL
         SW      RBAH,RSRC
         SW      RBAH,G
        IW      0,RDST

        W       GH,GL
        OW      RDSTH,RDSTL

        DB1     RBAL,RBAL
        JZBF    RNPLOP


DOPROC: LGL     RIRL

        SI      I6
        MW      G,RSRC,RSVC
        RI      I6

        ICW2    RSRC,RSRC

        RIW2    RSRCH,RSRCL     ; LASTMP
         LL      LLASTMP,RDSTL
         LL      HLASTMP,RDSTH
        IW      0,G

        WIW2    RDSTH,RDSTL     ; LASTMP
        OW      GH,GL
        RIW2    RSRCH,RSRCL     ; JTAB
         LGL     RPSWL
        IW      0,RBA

        WIW2    RDSTH,RDSTL     ; JTAB
        OW      RBAH,RBAL

        RIW2    RSRCH,RSRCL     ; SEG
         MW      G,SP
        IW      0,RBA

        WIW2    RDSTH,RDSTL     ; SEG
        OW      RBAH,RBAL

        R       RSRCH,RSRCL     ; IPC
         LGL     RIRH
        IW      0,G

        JMP     CINTRP



;--------------------------------------------
;            COMMON PROCEDURES SECTION
; THE FOLLOWING ARE COMMON PROCEDURES THAT CAN BE USED BY
; ANY P-MACHINE OPCODE.



; GETBIG - PERFORMS THE SAME FUNCTION AS THE GETBIG MACRO EXCEPT
;          THE VALUE RETURNED IS ALWAYS IN REGISTER 0.

;          ASSUMES RIRH CONTAINS A 4.

OPBIG:  ; ENTRY POINT FOR GETBIG OPCODE - FROM MACRO CODE.
        JMP     PRCBIG,LRR
        NOP     RSVC

PRCBIG: ; ENTRY POINT FOR GETBIG PROCEDURE - CALLED FROM MICROCODE.
        LGL     RIRH
        RIW1    GH,GL
         LGL     RPSWL
         LL      0,GH
        IB      2,GL
        JNBF    ISMALL

        LGL     RIRH
        RIW1    GH,GL
         LGL     RPSWL
         MB      GL,GH
         NL      177,GH
        IB      2,GL

ISMALL: RFS



INCMOV: ; OPCODE 76770-76772
        ; PERFORMS THE OPERATION
        ;    1$:  MOV (RB)+,(RC)+
        ;         SOB RA,1$
        ; RA IS THE LOW ORDER DIGIT OF THE OPCDOE AND RB AND RC
        ; ARE THE LOW ORDER 3 BITS OF THE LOW AND HIGH ORDER BYTES
        ; RESPECTIVILY OF THE WORD FOLLOWING THE OPCODE.  NOTE,
        ; RA CAN ONLY BE REGISTERS 0,1, OR 2 AND THE REGESTER SHOULD
        ; CONTAIN A NUMBER > 0 TO OPERATE AS PROBABLY INTENDED
        ; (I.E. IT WILL BEHAVE LIKE A SOB)

        R       PCH,PCL
        IW      0,RBA

ILOOP:  SI      I6
        LGL     RBAL,RSVC
        RI      I6

        RIW2    GH,GL
         LGL     RIRH
         DW1F    G,G
        IW      0,RDST

        LGL     RBAH
        WIW2    GH,GL
        OW      RDSTH,RDSTL

        JZF     ILOOP

        ICW2    PC,PC,RSVC    ; *** NOTE RSVC HERE


LKLST:  ; OP CODE 76777
        ; PERFORMS THE FUNCTION
        ;   1$:  MOV  @R1,R1
        ;        SOB  R0,1$
        ; THE INITIAL ADDRESS MUST BE IN REGISTER 1 AND THE COUNT
        ; IN REGISTER 0.  THE COUNT MUST BE IN THE RANGE 1..127 TO
        ; WORK PROPERLY.

        LL      1,RSRCL

LLOOP:  SI      I6
        LGL     RSRCL,RSVC
        RI      I6

        R       GH,GL
         LGL     RPSWL
         DB1F     GL,GL
         LGL      RSRCL
        IW       O,G

        JZF     LLOOP

        NOP      RSVC
        NOP      ; *** TEMPORARY



DECMOV: ; OPCODE 76760-76762
        ; PERFORMS THE OPERATION:
        ;   $1:   MOV   -(RB),-(RC)
        ;         SOB   RA,1$
        ; RA IS THE LOW ORDER DIGIT OF THE OPCODE AND RB AND RC ARE
        ; THE LOW ORDER 3 BITS OF THE LOW AND HIGH ORDER BYTES
        ; RESPECTIVELY OF THE WORD FOLLOWING THE OPCODE.  NOTE, RA
        ; CAN ONLY BE REGISTERS 0,1 OR 2 AND THE REGISTER SHOULD
        ; CONTAIN A NUMBER > 0 (I.E. IT WILL BEHAVE LIKE A SOB)

        R       PCH,PCL
        IW      O,RBA
        LL      2,RSRCH

DLOOP:  SI      I6
        LGL     RBAL,RSVC
        RI      I6

        SW      RSRCH,G
        R       GH,GL
         LGL     RIRH
         DW1F    G,G
        IW      O,RDST

        LGL     RBAH
        SW      RSRCH,G
        W       GH,GL
        OW      RDSTH,RDSTL

        JZF     DLOOP

        ICW2    PC,PC,RSVC
        NOP      ;****TEMPORARY - FIND NON JUMP



;--------------------------------------
;            MACRO P-MACHINE OPS
; THIS SECTION CONTAINS THOSE P-MACHINE OPS THAT HAVE THEIR OWN
; OPCODE I.E. THEIR MICRO ADDRESS IS NOT OBTAINED FROM THE XFRTBL.
```

```
CHK:    ; CHECK AGAINST SUBRANGE BOUNDS
        ;OP CODE 76776
        ;MACRO CODE SHOULD LOOK LIKE:
        ;   .WORD 76776
        ;   .WORD 76704
        ;   TRAP INVNDX

        RIW2    SPH,SPL      ; GET MAXIMUM RANGE
         ICW2    PC,PC       ; THIS INSURES THAT BOTH THE INVNDX
                             ; AND NORMAL CINTRP EXIT ROUTINES WORK RIGHT
        IW      0,RSRC


        RIW2    SPH,SPL      ; GET MINIMUM RANGE
        IW      0,RDST

        R       SPH,SPL      ; GET SCALAR
        IW      0,RIR

        CWF     RIR,RSRC     ; CHECK MAXIMUM RANGE
        JMP     LSSTHN,LRR

        CWF     RDST,RIR     ; CHECK MINIMUM RANGE
        JMP     LSSTHN,LRR
        JMP     CINTRP

RTRN:   RFS

LSSTHN: CCF     RBAL         ; IF LESS THAN  -> RETURN
        NL      12,RBAL      ; TO MACRO CODE FOR TRAP
        JZBT    RTRN
        OCB     RBAL,RBAL
        JZBT    RTRN
        NOP     RSVC         ; RANGE ERROR  *** NOTE RSVC



CIP:    ; OPCODE 76765
        ; CALL INTERMEDIATE PROC - SEARCH FOR PARENT

        LL      1,RIRH     ;(DELETE THIS ONCE REAL OP CODE IS IN USE)
        LGL     RIRH

        R       GH,GL      ; GET LEX LEVEL OF PROCEDURE BEING CALLED
         LGL     RIRL
        IB      0,RBAH

        JZBT    QUIT       ; IF ZERO OR -1 RETURN TO MACRO CODE FOR
        JNBF    CONT       ; JUMP TO THE LAST PART OF CBP

QUIT:   ICW2    PC,PC,RSVC
CONT:   MW      G,RDST
```

```
LOOP:   AL      4,RDSTL   ; SEARCH DOWN DYNAMIC LINK FOR PARENT
        CIB     RDSTH

        R       RDSTH,RDSTL ; GET JTAB FROM MSCW
        IW      0,RSRC

        SI      I6
        LL      2,RIRH,RSVC   ; CHECK FOR INTERRUPTS
        RI      I6

        R       RSRCH,RSRCL   ; GET LEX LEVEL OF THE PROCEDURE
         SW      RIRH,RDST
        IB      0,RBAL

        CB      RBAH,RBAL     ; COMPARE LEX LEVELS
        JNBT    GOTIT       ; IF ITS LOWER WE'VE FOUND THE PARENT

        R       RDSTH,RDSTL  ; IF NOT LINK DOWN TO NEXT PROCEDURE
        IW      0,RDST       ; ON THE DYNAMIC STACK

        JMP     LOOP         ; KEEP LOOKING FOR PARENT

GOTIT:  SW      RIRH,RDST
        R       RDSTH,RDSTL
        IW      0,RSRC       ; PUT LEX LINK ON THE STACK

        W       GH,GL,RSVC
        OW      RSRCH,RSRCL




;****
CLPERR: NOP     RSVC            ; STACK OVERFLW  - RETURN TO MACRO

CLP:    ; CALL LOCAL PROCEDURE
        LL      LSEG,RDSTL
        LL      HSEG,RDSTH
        LGL     RPSWL
        R       RDSTH,RDSTL
         MW      SP,G           ; MOV  SP,R0
         LL      2,RBAH
         LGL     RBAH           ; USES R2 INSTEAD OF OLDSEG
        IW      0,G             ; MOV SEQ,OLDSEG

        LGL     RIRH
        R       GH,GL
         LL      1,RSRCL
         LGL     RSRCL          ; GETBYTE R1
         LL      0,GH
        IB      2,GL

        SLW     G,G             ; ASL R1
```

```
TCW     G,G            ; NEG R1

LL      LSEG,RDSTL
LL      HSEG,RDSTH

R       RDSTH,RDSTL
IW      0,RDST

AW      RDST,G         ; ADD SEG,R1

R       GH,GL
 LL      377,RDSTH
 LL      DATASZ,RDSTL
IW      0,RSRC
SW      RSRC,G       ; SUB @R1,R1


AW      G,RDST
R       RDSTH,RDSTL
 LL      50,RBAL     ; SUB DATASZ(R1),SP
 MW      SP,RDST
IW      0,RSRC

SI      I6
SW      RSRC,RDST
RI      I6

R       RPSWL,RBAL
 LGL     RIRL
IW      0,RSRC
CW      RDST,RSRC     ; CMP SP,NP

JZBT    CLPERR        ; BLOS CLPERR
JC8T    CLPERR

AL      -14,RDSTL     ; REVERSE PUSH ORDER
CDB     RDSTH
MW      RDST,RIR

WIW2    RDSTH,RDSTL
OW      GH,GL         ; MOV MP,-(SP)

LL      LJTAB,RSRCL

WIW2    RDSTH,RDSTL
OW      GH,GL           ; MOV MP,-(SP)

LL      HJTAB,RSRCH

R       RSRCH,RSRCL
 LGL     RBAH
 LL      1,RSRCL
IW      0,RBA

WIW2    RDSTH,RDSTL    ; MOV JTAB,-(SP)
```

```
        OW      RBAH,RBAL

        LL      4,RSRCH
        WIW2    RDSTH,RDSTL    ; MOV OLDSEG,-(SP)
        OW      GH,GL          ;   (R2 USED INSTEAD OF OLDSEG)

        LGL     RSRCH
        ICW1    G,RBA
        W       RDSTH,RDSTL    ; MOV  IPC,-(SP)
        OW      RBAH,RBAL

        LGL     RSRCL

        SI      I6
        MW      G,RDST
        RI      I6

        AL      PARMSZ,RDSTL
        CDB     RDSTH

        R       RDSTH,RDSTL
         LGL     RPSWL         ; MOV PARMSZ(R1),IPC
        IW      O,RDST         ;   (IPC NOT USED)

        JZBT    CLPFIN         ; BEG 2$


        SRW     RDSTH,RDSTH    ; ASR IPC

        MW      RIR,RSRC        ; MOV SP,MP  (MP NOT USED)

        AL      MSDLTA+2,RSRCL
        CIB     RSRCH          ; ADD #MSDLTA+2,MP

CLPLOP: RIW2    GH,GL
         DW1F    RDST,RDST
        IW      O,RBA

        SI      I6
        LCF     O,RPSWL    ; SET Z FLAG TO FALSE
        RI      I6

        WIW2    RSRCH,RSRCL
        OW      RBAH,RBAL

        JZF     CLPLOP


CLPFIN: MW      RIR,SP
        LL      5,RIRL
        LL      4,RIRH

        LGL     RIRL
        MW      SP,G           ; MOV SP,MP
```

```
LL      LLASTMP,RDSTL
LL      HLASTMP,RDSTH

WIW2    RDSTH,RDSTL    ; MOV MP,LASTMP
OW      GH,GL

MW      G,RSRC
AL      MSSP,RSRCL
CIB     RSRCH          ; MOV R0,MSSP(MP)
LGL     RPSWL
W       RSRCH,RSRCL
OW      GH,GL

LL      1,RSRCL
LGL     RSRCL

W       RDSTH,RDSTL    ; MOV R1,JTAB
OW      GH,GL

MW      G,RDST         ; MOV R1,IPC
AL      ENTRIC,RDSTL
CDB     RDSTH          ; ADD #ENTRIC,IPC

R       RDSTH,RDSTL
 LGL     RIRH
 MW      RDST,G
IW      0,RDST

SW      RDST,G,RSVC         ; SUB @IPC,IPC
ICW2    PC,PC               ; SKIP OVER STACK OVERFLW ERROR BR

,END
```

APPENDIX H - MACRO-11 Code Used for timins

```
; P-code Timer


; ***** INSERT INTO MAINOP AT BOTTOM OF  TRANSFER TABLE


        .ENDR
        .IRP    N,<1,2,3,4,5,6,7,10,11,12,13,14,15,16,17,20>
        .WORD   SLDOS+<6*<N-1>>
        .ENDR
        .IRP    N,<0,1,2,3,4,5,6,7>
        .WORD   SINDS+<10*N>
        .ENDR
        .NLIST  ME


        .BLKW   3*<MAXUNT+1>    ; UNIT TABLE IN IOTRAP

;----------------------------------------------

INDEX:  .WORD 0
        .WORD 75704     ; GO HERE TO RESTART OPS THAT ARE INTERRUPTED

ENTRY:  .WORD 75714     ; MAIN ENTRY POINT / CHANGE TO NOP TO START COUNT

        MOV     INDEX,R0

        TSTB    R0
        BPL     DOSLDCI
        BICB    #200,R0

        ASL     R0
        ASL     R0
        ASL     R0      ; CHANGE INDEX FROM OP CODE (LEFT SHIFTED
        ADD     #OPCNTS,R0   ; SHIFTED ONE) TO ACTUAL INDEX FOR OPCNTS

UPDATE: ADD     #4,R0
        MOV     (R0)+,WD1
        MOV     (R0),WD2     ; COUNT NUMBER OF TIMES EXECUTED
        MOV     #ADDER,R1
        FADD    R1
        MOV     WD2,(R0)
        MOV     WD1,-(R0)

        TSTB    CSR
        BMI     OVRFLW       ; TEST FOR ERROR CONDITIONS
        TST     BPR
        BEQ     ZTIME


        MOV     -(R0),-(SP)
        MOV     -(R0),-(SP)
        MOV     BPR,-(SP)
        MOV     IPC,FPIPC

        TST     (SP)
        BMI     NTIME

W:      MOV     #X,IPC






        JMP     @(R4)+          ; COUNT NUMBER OF MICROSECONDS
X:      .WORD $IR,Y
Y:      MOV     LASTMP,MP
        MOV     #BACK,BK
        MOV     STKBAS,BASE
        MOV     FPIPC,IPC

        FADD    SP

        MOV     (SP)+,(R0)+
        MOV     (SP)+,(R0)

SKIP:   .WORD   75714            ; START TIMER AND EXECUTE OP

OVRFLW: HALT
        .WORD   75714
NTIME:  BIC     #100000,(SP)
        ADD     #1,(SP)
        BMI     NERROR
        MOV     #A,IPC
        JMP     @(R4)+
A:      .WORD  $IR,B
B:      FADD    SP

        MOV     #77777,-(SP)
        JMP     W

NERROR: HALT
        .WORD   75714
ZTIME:  HALT
        .WORD   75714

DOSLDCI: MOV    #OP127,R0
         JMP    UPDATE

; OUTPUT ROUTINE TO BLOCK 40 OF BLANK FLOPPY ON #5
        MOV     #5,-(SP)
        MOV     #OP127,-(SP)
        MOV     #2010,-(SP)
        MOV     #40,-(SP)
        CLR     -(SP)
        JSR     R1,SYIORQ
        .WORD 0

        HALT

; REINITIALIZE OPCNTS TABLES AND RESET COUNTER MACRO ROUTINE
        MOV     #OP127,TABLOC
        MOV     #1004,TABCNT
INIT:   CLR     @TABLOC
        ADD     #2,TABLOC
        DEC     TABCNT
        BNE     INIT
        HALT
TABLOC: .WORD
TABCNT: .WORD

OP127:  .FLT2   0,0




OPCNTS: .REPT 200
        .FLT2 0,0
        .ENDM

ADDER:  .FLT2 1
WD1:    .WORD 0
WD2:    .WORD 0

CSR = 170420
BPR = 170422
;---------------------------------------------------------

CMPTBL: .WORD   0
        .WORD   REALCMP
        .WORD   STRGCMP
        .WORD   BOOLCMP
        .WORD   POWRCMP
```

```
; Standard Procedure Timer

; ******** INSERT INTO MAINOP



;;;;;;;;;;;;;;;;;;;;;;;
; MAIN INTERPRETER LOOP
; GO HERE FOR OPCODE
; FETCH SEQUENCE
;;;;;;;;;;;;;;;;;;;;;;;;

SLDCI:  MOV     R0,-(SP)        ; PUSH THE LIT VALUE AND FALL INTO NEXT OP
BACK:  MOV     #1007,170420     ; STOP REAL TIME CLOCK
        CMP     #1,BPRSW
        BEQ     SKIPIT
        MOV     #1,BPRSW
        MOV     170422,SAVEBPR
SKIPIT: GETNEXT                 ; GET NEXT INSTRUCTION BYTE
        BPL     SLDCI           ; IF POSITIVE THEN A SHORT LDCI
        ASL     R0              ; DOUBLE FOR WORD INDEXING
        MOV     XFRTBL(R0),PC   ; TRANSFER CONTROL TO PROPER OP

ABI:    ; INTEGER ABSOLUTE VALUE
        TST     @SP
        BPL     1$





; ***** INSERT INTO PROCOP


        MOV     LASTMP,MP       ; RESTORE OLD MP VALUE
2$:     MOV     MP,R1           ; NOW RESTORE STATE FROM MSCW
        TST     (R1)+           ; CHUCK STAT LINK
        MOV     (R1)+,MP        ; DYNAMIC LINK
        MOV     (R1)+,JTAB
        MOV     (R1)+,SEG
        MOV     (R1)+,IPC
        MOV     MP,LASTMP
        MOV     R0,SP           ; NOW BACK IN STATE AT CALL TIME
        MORE

CSP:    ; CALL STANDARD PROCEDURE

;---------------------
        JMP     SKPCNT
        MOV     OLDRO,R1
        ADD     #10,R1
        MOV     -(R1),-(SP)         ; COUNT EXECUTIONS
        MOV     -(R1),-(SP)







        MOV     AONE+2,-(SP)
        MOV     AONE,-(SP)
        FADD    SP
        MOV     (SP)+,(R1)+
        MOV     (SP)+,(R1)


        TSTB    CSR
        BMI     OVRFLW              ; CHECK FOR TIMING ERRORS
        TST     SAVEBPR
        BEQ     ZTIME

        MOV     OLDRO,R1
        ADD     #4,R1
        MOV     -(R1),-(SP)
        MOV     -(R1),-(SP)         ; COUNT MICROSECONDS
        MOV     SAVEBPR,-(SP)
        MOV     RO,SAVERO
        MOV     IPC,SAVER4

        TST     (SP)                ; CHECK FOR NEGATIVE TIMES
        BMI     NTIME

C:      MOV     #D,IPC
        JMP     @(R4)+
D:      .WORD  $IR,E
E:      MOV     LASTMP,MP
        MOV     OLDRO,R1
        MOV     SAVERO,RO
        MOV     #BACK,BK
        MOV     STKBAS,BASE
        MOV     SAVER4,IPC
        FADD    SP
        MOV     (SP)+,(R1)+
        MOV     (SP)+,(R1)

SKPCNT: GETNEXT
        ASL     RO
        MOV     RO,OLDRO
        ASL     OLDRO
        ASL     OLDRO
        ADD     #CSPCNTS,OLDRO
        MOV     #0,BPRSW
        MOV     #ON,CSR           ; TURN TIMER ON
        MOV     CSPTBL(R0),PC


SAVEBPR: .WORD 0
BPRSW:  .WORD 1

OVRFLW: HALT
ZTIME:  HALT
NTIME:  BIC     #100000,(SP)
        MOV     #DX,IPC
        JMP     @(R4)+
DX:     .WORD  $IR,EX
EX:     FADD    SP
        MOV     #77777,-(SP)
        JMP     C









OLDRO:  .WORD   0
SAVERO: .WORD  0
CSPCNTS: .REPT 50
         .FLT2 0,0
         .ENDM

AONE:   .FLT2 1
SAVER4: .WORD 0

ON = 17
CSR = 170420
BPR = 170422

; OUTPUT ROUTINE TO BLOCK 40 OF BLANK FLOPY ON #5
        MOV     #5,-(SP)
        MOV     #CSPCNTS,-(SP)
        MOV     #500,-(SP)
        MOV     #40,-(SP)
        CLR     -(SP)
        JSR     R1,SYIORQ
        .WORD 0

        HALT

;--------------------------------------

IOC:    ; IO CHECK
        TST     @#IORSLT
        BEQ     1$
```

APPENDIX I - Microcode Listing

```
; INTERP.MIC        FINAL MICROCODE LISTING


;***********************

; MACRO MEMORY LOCATIONS

LLASTMP = 16
HLASTMP = 1

LJTAB = 20
HJTAB = 1

LSEG = 22
HSEG = 1


;***********************

; MARK STACK OFFSET VARIABLES

MSSTAT = 0
MSDYN = 2
MSIPC = 10
MSSEG = 6
MSJTAB = 4
MSSP = 12
MSBASE = -2
MSDLTA = 12

;***************************

; JTAB OFFSETS

ENTRIC = -2
DATASZ = -10
PARMSZ = -6


;-------------------------------------
;          CORE SECTION


        LOC 3000

        JMP     0,TROFF                 ; OPCODES 220-227, RESERVED BY DEC.
        JMP     DECODE                  ; OPCODES 76000-76777, TOP 64 ARE OURS.
        JMP     0,TROFF                 ; MICRO POWER UP.
ERROR:  JMP     0,TROFF                 ; OP CODES 75040-75777, RESERVED BY DEC.

        LOC 3004                        ; MICROINTERRUPT ABORT ENTRY POINT.
REREAD: AL      -2,PCL,RSVC             ; RETURN TO MACRO TO SERVICE INTERRUPT.
        CDB     PCH                     ; DECREMENT PC SO SAME OPCODE WILL BE
                                        ; READ AGAIN.
```

```
DECODE: CL      175,RIRL            ; CHECK OPCODE TO MAKE SURE ITS LEGIT.
        JZBF    ERROR               ; NOTE, HIGH ORDER BYTE OF OP IS IN
                                    ; RIRL AND LOW BYTE IS IN RIRH.
        CL      304,RIRH            ; QUICK CHECK FOR INTERPRETER FETCH OF
        JZBT    IFETCH              ; 76704 FOR EXTRA SPEED.
        AL      20,RIRH             ; CHECK OPCODES FOR RANGE 76760-76777
        JC8F    ERROR
        MI      RPSWL,RIRH          ; USE LOWER 4 BITS OF OPCODE TO INDEX
        JMP     3760                ; MICRO JUMP TABLE.

        LOC 3760                   ; MICRO JUMP TABLE
        JMP     DECMOV              ; OP CODE 76760
        JMP     DECMOV              ;         76771
        JMP     DECMOV              ;         76762
        JMP     0,TROFF             ;         76763
        JMP     CLP                 ;         76764
        JMP     CIP                 ;         76765
        JMP     0,TROFF             ;         76766
        JMP     0,TROFF             ;         76767
        JMP     INCMOV              ;         76770
        JMP     INCMOV              ;         76771
        JMP     INCMOV              ;         76772
        JMP     0,TROFF             ;         76773
        JMP     OPBIG               ;         76774
        JMP     0,TROFF             ;         76775
        JMP     CHK                 ;         76776
        JMP     LKLST               ;         76777

        LOC


SLDCI:  ; SHORT LOAD CONSTANT INTEGER
        AL      -2,SPL              ; PUSH OPCODE ONTO STACK
        CDB     SPH
        W       SPH,SPL             ; ( MOV   R0,-(SP) )
        OW      RPSWL,RDSTL

CINTRP: ; CHECK FOR INTERRUPTS AND THEN FALL INTO INTERPRETER FETCH.
        SI      I6
        LL      4,RIRH,RSVC
        RI      I6

IFETCH: ; INTERPRETER FETCH
        ; THIS IS SIMILAR TO THE BACK ROUTINE IN MACROCODE.
        ; DIFFERENCES ARE:
        ;     1. XFRTBL CONTAINS BOTH MICRO AND MACRO ADDRESSES.
        ;        MICRO ADDRESSES HAVE HIGH ORDER 5 BITS SET TO 1S.
        ;     2. REGISTER 0 IS NOT LOADED WITH THE OPCODE.
        ;
        ; INTERNAL REGISTERS ARE INITIALIZED DURING THE COURSE OF
        ; IFETCH AND CINTRP TO THESE VALUES:
        ;        RSRCL = 1
        ;        RBAH = 2
        ;        RBAL = 3
        ;        RIRH = 4
        ;        RIRL = 5

        LGL     RIRH
        RIW1    GH,GL               ; READ OPCODE
         LL      5,RIRL
         LL      6,RSRCL            ; TEMPORARY - WHEN XFRTBL IS MOVED TO
                                    ; ADDRESS 400 CHANGE TO LL  1,RSRCL.
        IB      2,RDSTL

        JNBF    SLDCI

        SLB     RDSTL,RDSTL

        R       RSRCL,RDSTL         ; ACCESS XFRTBL.
         LL      1,RSRCL            ; TEMPORARY - SEE NOTE ABOVE
         LL      2,RBAH
         LL      3,RBAL
        IW      0,RDST

        AL      10,RDSTH            ; SEE IF ITS MICRO OR MACRO ADDRESS.
        JC8F    MACRO

        MI      RDSTH,RDSTL         ; JUMP TO MICRO ROUTINE.
        JMP     0

MACRO:  AL      -10,RDSTH,RSVC      ; BACK TO MACRO.
        MW      RDST,PC


;---------------------------------------------------
;            P-MACINE OP CODES



LDO:    ; LOAD GLOBAL WORD
        JMP     PRCBIG,LRR
        SLW     G,RDST
        AL      MSDLTA,RDSTL
        CIB     RDSTH

        LGL     RBAL
        AW      G,RDST

        R       RDSTH,RDSTL
         SW      RBAH,SP
        IW      0,RDST

        W       SPH,SPL
        OW      RDSTH,RDSTL

        JMP     CINTRP
```

```
;*****

SRO:    ; STORE GLOBAL WORD
        JMP     PRCBIG,LRR
        SLW     G,RDST

        RIW2    SPH,SPL
         AL      MSDLTA,RDSTL
         CIB     RDSTH
         LGL     RBAL
        IW      0,RSRC
        AW      G,RDST

        W       RDSTH,RDSTL
        OW      RSRCH,RSRCL

        JMP     CINTRP


;*****

LLA:    ; LOAD LOCAL ADDRESS
        JMP     PRCBIG,LRR
        SLW     G,RDST

        AL      MSDLTA,RDSTL
        CIB     RDSTH

        LGL     RIRL
        AW      G,RDST

        SW      RBAH,SP
        W       SPH,SPL
        OW      RDSTH,RDSTL

        JMP     CINTRP

;*****

LAO:    ; LOAD GLOBAL ADDRESS
        JMP     PRCBIG,LRR
        SLW     G,RDST

        AL      MSDLTA,RDSTL
        CIB     RDSTH

        LGL     RBAL
        AW      G,RDST

        SW      RBAH,SP


        W       SPH,SPL
        OW      RDSTH,RDSTL

        JMP     CINTRP

;*****

AND:    ; AND
        RIW2    SPH,SPL
        IW      0,RDST

        R       SPH,SPL
        IW      4,RSRC

        NW      RSRC,RDST

        OW      RDSTH,RDSTL

        JMP     CINTRP


;*****

LDCI:   ; LOAD CONSTANT WORD
        LGL     RIRH
        RIW1    GH,GL
        IB      2,RDSTL

        RIW1    GH,GL
         SW      RBAH,SP
        IB      2,RDSTH

        W       SPH,SPL
        OW      RDSTH,RDSTL

        JMP     CINTRP


;****

FJP:    ; FALSE JUMP   (NOTE, REQUIRES UJP BE PRESENT)
        RIW2    SPH,SPL
        LGL     RIRH
        IBF     1,RSRCL
        SRBF    RSRCL,RSRCL
        JCF     UJPSKP
        ICW1    G,G
        JMP     CINTRP

;****

UJP:    ; UNCONDITIONAL JUMP
        LGL     RIRH
UJPSKP: RIW1    GH,GL
        IBF     2,RSRCH
        JNBT    LONG
        AW      RSRCH,G
        JMP     CINTRP
LONG:   LL      1,RDSTH
        LL      20,RDSTL
        R        RDSTH,RDSTL
        IW      0,G
        AW      RSRCH,G
        R       GH,GL
        IW      0,RSRC
        SW      RSRC,G
        JMP     CINTRP

SUB:    ; COMMON PROCEDURE USED BY COMPARISONS
        RIW2    SPH,SP
        IW      0,RIR

        R       SPH,SP
        IW      0,RDST

        SWF     RIR,RDST
        RFS

;****
EQUI:   ; INTEGER EQUAL COMPARE
        JMP     SUB,LRR
        JZT     PSHTRU

PSHFLS: LL      0,RSRCL
PSHTRU: W       SPH,SPL
        OW      RPSWL,RSRCL
        JMP     CINTRP



;****
NEQI:   ; INTEGER NOT EQUAL COMPARE
        JMP     SUB,LRR
        JZF     PSHTRU
        JMP     PSHFLS

;****
LEQI:   ; INTEGER LESS THAN OR EQUAL COMPARE
        JMP     SUB,LRR
        JZT     PSHTRU
        CCF     RBAL
        NL      12,RBAL
        JZBT    PSHFLS
        OCB     RBAL,RBAL
        JZBT    PSHFLS
        JMP     PSHTRU

;****
GRTI:   ; INTEGER GREATER THAN COMPARE
        JMP     SUB,LRR
        JZT     PSHFLS
        CCF     RBAL
        NL      12,RBAL
        JZBT    PSHTRU
        OCB     RBAL,RBAL
        JZBT    PSHTRU
        JMP     PSHFLS



;****
STL:    ; STORE LOCAL
        JMP     PRCBIG,LRR

        SLW     G,RDST
        AL      12,RDSTL
        CIB     RDSTH

        RIW2    SPH,SPL
         LGL     RIRL
         AW      G,RDST
        IW      0,RSRC

        W       RDSTH,RDSTL
        OW      RSRCH,RSRCL

        JMP     CINTRP




;****
XJP:    ; CASE TABLE
        RIW2    SPH,SPL
         LGL     RIRH
         ICW1    G,G
        IW      0,RDST

        NL      376,GL
        RIW2    GH,GL
        IW      0,RSRC

        RIW2    GH,GL
         CWF     RSRC,RDST
         CCF     RIRL
        IW      0,RBA

        NL      12,RIRL
        JZBT     CONT1
        OCB     RIRL,RIRL
        JZBF    XJPEXIT

CONT1:  CWF     RDST,RBA
        CCF     RIRL
        NL      12,RIRL
        JZBT    CONT2
        OCB     RIRL,RIRL
        JZBF    XJPEXIT

CONT2:  ICW2    G,G

        SW      RSRC,RDST
        SLW     RDST,RDST

        AW      RDST,G

        R       GH,GL
        IW      0,RDST

        SW      RDST,G

XJPEXIT: JMP    CINTRP




;****
LDM:    ; LOAD MULTIPLE
        R       SPH,SPL
         LGL     RIRH
         MW      SP,RDST
        IW      0,RSRC

        R       GH,GL
         DW1     G,G
         LL      0,RBAH
        IB      2,RBAL
        JZBT    LDMEXIT

        SW      RBAL,RDST
        SW      RBAL,RDST
        ICW2    RDST,RDST

        MW      RDST,RBA

LDMLOP: SI      I6
        LL      1,RIRH,RSVC
        RI      I6

        RIW2    RSRCH,RSRCL
         CWF     RDST,SP
        IW      0,RIR

        WIW2    RDSTH,RDSTL
        OW      RIRH,RIRL

        JZF     LDMLOP

        MW      RBA,SP
```

```
LDMEXIT: ICW2     G,G
        JMP     CINTRP


;****

RNP:    ; RETURN FROM NORMAL PROCEDURE
        LGL     RIRL
        MW      G,RSRC
        AL      MSSP,RSRCL
        CIB     RSRCH

        R       RSRCH,RSRCL
         LGL     RPSWL
        IW      0,G

        LGL     RIRH
        R       GH,GL
         DW1     G,G
         LL      0,RBAH
        IB      2,RBAL
        JZBT    DOPROC

        AW      RBA,RSRC
        AW      RBA,RSRC

        LGL     RPSWL
        LL      2,RBAH

RNPLOP: R       RSRCH,RSRCL
         SW      RBAH,RSRC
         SW      RBAH,G
        IW      0,RDST

        W       GH,GL
        OW      RDSTH,RDSTL

        DB1     RBAL,RBAL
        JZBF    RNPLOP


DOPROC: LGL     RIRL

        SI      I6
        MW      G,RSRC,RSVC
        RI      I6

        ICW2    RSRC,RSRC

        RIW2    RSRCH,RSRCL     ; LASTMP
         LL      LLASTMP,RDSTL
         LL      HLASTMP,RDSTH
        IW      0,G

        WIW2    RDSTH,RDSTL     ; LASTMP
        OW      GH,GL

        RIW2    RSRCH,RSRCL     ; JTAB
         LGL     RPSWL
        IW      O,RBA

        WIW2    RDSTH,RDSTL     ; JTAB
        OW      RBAH,RBAL

        RIW2    RSRCH,RSRCL     ; SEG
         MW      G,SP
        IW      O,RBA

        WIW2    RDSTH,RDSTL     ; SEG
        OW      RBAH,RBAL

        R       RSRCH,RSRCL     ; IPC
         LGL     RIRH
        IW      O,G

        JMP     CINTRP




;-----------------------------------------------------
;            COMMON PROCEDURES SECTION
; THE FOLLOWING ARE COMMON PROCEDURES THAT CAN BE USED BY
; ANY P-MACHINE OPCODE.




; GETBIG - PERFORMS THE SAME FUNCTION AS THE GETBIG MACRO EXCEPT
;          THE VALUE RETURNED IS ALWAYS IN REGISTER O.

;          ASSUMES RIRH CONTAINS A 4.

OPBIG:  ; ENTRY POINT FOR GETBIG OPCODE - FROM MACRO CODE.
        JMP     PRCBIG,LRR
        NOP     RSVC

PRCBIG: ; ENTRY POINT FOR GETBIG PROCEDURE - CALLED FROM MICROCODE.
        LGL     RIRH
        RIW1    GH,GL
         LGL     RPSWL
         LL      O,GH
        IB      2,GL
        JNBF    ISMALL

        LGL     RIRH
        RIW1    GH,GL
         LGL     RPSWL
         MB      GL,GH
         NL      177,GH
        IB      2,GL

ISMALL: RFS



INCMOV: ; OPCODE 76770-76772
        ; PERFORMS THE OPERATION
        ;     1$:  MOV (RB)+,(RC)+
        ;          SOB RA,1$
        ; RA IS THE LOW ORDER DIGIT OF THE OPCDOE AND RB AND RC
        ; ARE THE LOW ORDER 3 BITS OF THE LOW AND HIGH ORDER BYTES
        ; RESPECTIVILY OF THE WORD FOLLOWING THE OPCODE.  NOTE,
        ; RA CAN ONLY BE REGISTERS 0,1, OR 2 AND THE REGESTER SHOULD
        ; CONTAIN A NUMBER > 0 TO OPERATE AS PROBABLY INTENDED
        ; (I.E. IT WILL BEHAVE LIKE A SOB)

        R       PCH,PCL
        IW      0,RBA

ILOOP:  SI      I6
        LGL     RBAL,RSVC
        RI      I6

        RIW2    GH,GL
         LGL     RIRH
         DW1F    G,G
        IW      0,RDST

        LGL     RBAH
        WIW2    GH,GL
        OW      RDSTH,RDSTL

        JZF     ILOOP

        ICW2    PC,PC,RSVC     ; *** NOTE RSVC HERE


LKLST:  ; OP CODE 76777
        ; PERFORMS THE FUNCTION
        ;    1$:  MOV  @R1,R1
        ;          SOB  R0,1$
        ; THE INITIAL ADDRESS MUST BE IN REGISTER 1 AND THE COUNT
        ; IN REGISTER 0.  THE COUNT MUST BE IN THE RANGE 1..127 TO
        ; WORK PROPERLY.

        LL      1,RSRCL

LLOOP:  SI      I6
        LGL     RSRCL,RSVC
        RI      I6

        R       GH,GL
```

```
         LGL     RPSWL
         DB1F    GL,GL
         LGL     RSRCL
        IW      0,G

        JZF    LLOOP

        NOP     RSVC
        NOP     ; *** TEMPORARY



DECMOV: ; OPCODE 76760-76762
        ; PERFORMS THE OPERATION:
        ;   $1:   MOV   -(RB),-(RC)
        ;         SOB   RA,1$
        ; RA IS THE LOW ORDER DIGIT OF THE OPCODE AND RB AND RC ARE
        ; THE LOW ORDER 3 BITS OF THE LOW AND HIGH ORDER BYTES
        ; RESPECTIVELY OF THE WORD FOLLOWING THE OPCODE.  NOTE, RA
        ; CAN ONLY BE REGISTERS 0,1 OR 2 AND THE REGISTER SHOULD
        ; CONTAIN A NUMBER > 0 (I.E. IT WILL BEHAVE LIKE A SOB)

        R       PCH,PCL
        IW      0,RBA
        LL      2,RSRCH

DLOOP:  SI      I6
        LGL     RBAL,RSVC
        RI      I6

        SW      RSRCH,G
        R       GH,GL
         LGL     RIRH
         DW1F    G,G
        IW      0,RDST

        LGL     RBAH
        SW      RSRCH,G
        W       GH,GL
        OW      RDSTH,RDSTL

        JZF     DLOOP

        ICW2    PC,PC,RSVC
        NOP      ;****TEMPORARY - FIND NON JUMP



;---------------------------------------------------
;            MACRO P-MACHINE OPS
; THIS SECTION CONTAINS THOSE P-MACHINE OPS THAT HAVE THEIR OWN
; OPCODE I.E. THEIR MICRO ADDRESS IS NOT OBTAINED FROM THE XFRTBL.
```

```
CHK:    ; CHECK AGAINST SUBRANGE BOUNDS
        ;OP CODE 76776
        ;MACRO CODE SHOULD LOOK LIKE:
        ;   .WORD 76776
        ;   .WORD 76704
        ;   TRAP INVNDX

        RIW2    SPH,SPL     ; GET MAXIMUM RANGE
         ICW2    PC,PC      ; THIS INSURES THAT BOTH THE INVNDX
                            ; AND NORMAL CINTRP EXIT ROUTINES WORK RIGHT
        IW      O,RSRC


        RIW2    SPH,SPL     ; GET MINIMUM RANGE
        IW      O,RDST

        R       SPH,SPL     ; GET SCALAR
        IW      O,RIR

        CWF     RIR,RSRC    ; CHECK MAXIMUM RANGE
        JMP     LSSTHN,LRR

        CWF     RDST,RIR    ; CHECK MINIMUM RANGE
        JMP     LSSTHN,LRR
        JMP     CINTRP

RTRN:   RFS

LSSTHN: CCF     RBAL        ; IF LESS THAN  -> RETURN
        NL      12,RBAL     ; TO MACRO CODE FOR TRAP
        JZBT    RTRN
        OCB     RBAL,RBAL
        JZBT    RTRN
        NOP     RSVC        ; RANGE ERROR  *** NOTE RSVC



CIP:    ; OPCODE 76765
        ; CALL INTERMEDIATE PROC - SEARCH FOR PARENT

        LL      1,RIRH    ;(DELETE THIS ONCE REAL OP CODE IS IN USE)
        LGL     RIRH

        R       GH,GL     ; GET LEX LEVEL OF PROCEDURE BEING CALLED
         LGL     RIRL
        IB      O,RBAH

        JZBT    QUIT      ; IF ZERO OR -1 RETURN TO MACRO CODE FOR
        JNBF    CONT      ; JUMP TO THE LAST PART OF CBP

QUIT:   ICW2    PC,PC,RSVC
CONT:   MW      G,RDST
```

```
LOOP:   AL      4,RDSTL   ; SEARCH DOWN DYNAMIC LINK FOR PARENT
        CIB     RDSTH

        R       RDSTH,RDSTL ; GET JTAB FROM MSCW
        IW      0,RSRC

        SI      I6
        LL      2,RIRH,RSVC    ; CHECK FOR INTERRUPTS
        RI      I6

        R       RSRCH,RSRCL    ; GET LEX LEVEL OF THE PROCEDURE
         SW      RIRH,RDST
        IB      0,RBAL

        CB      RBAH,RBAL      ; COMPARE LEX LEVELS
        JNBT    GOTIT       ; IF ITS LOWER WE'VE FOUND THE PARENT

        R       RDSTH,RDSTL  ; IF NOT LINK DOWN TO NEXT PROCEDURE
        IW      0,RDST       ; ON THE DYNAMIC STACK

        JMP     LOOP         ; KEEP LOOKING FOR PARENT

GOTIT:  SW      RIRH,RDST
        R       RDSTH,RDSTL
        IW      0,RSRC       ; PUT LEX LINK ON THE STACK

        W       GH,GL,RSVC
        OW      RSRCH,RSRCL




;****
CLPERR: NOP     RSVC            ; STACK OVERFLW  - RETURN TO MACRO

CLP:    ; CALL LOCAL PROCEDURE
        LL      LSEG,RDSTL
        LL      HSEG,RDSTH
        LGL     RPSWL
        R       RDSTH,RDSTL
         MW      SP,G           ; MOV  SP,R0
         LL      2,RBAH
         LGL     RBAH           ; USES R2 INSTEAD OF OLDSEG
        IW      0,G             ; MOV SEQ,OLDSEG

        LGL     RIRH
        R       GH,GL
         LL      1,RSRCL
         LGL     RSRCL          ; GETBYTE R1
         LL      0,GH
        IB      2,GL
```

```
SLW     G,G                    ; ASL R1
TCW     G,G                    ; NEG R1

LL      LSEG,RDSTL
LL      HSEG,RDSTH

R       RDSTH,RDSTL
IW      0,RDST

AW      RDST,G                 ; ADD SEG,R1

R       GH,GL
 LL      377,RDSTH
 LL      DATASZ,RDSTL
IW      0,RSRC
SW      RSRC,G               ; SUB @R1,R1


AW      G,RDST
R       RDSTH,RDSTL
 LL      50,RBAL             ; SUB DATASZ(R1),SP
 MW      SP,RDST
IW      0,RSRC

SI      I6
SW      RSRC,RDST
RI      I6

R       RPSWL,RBAL
 LGL     RIRL
IW      0,RSRC
CW      RDST,RSRC             ; CMP SP,NP

JZBT    CLPERR                ; BLOS CLPERR
JC8T    CLPERR

AL      -14,RDSTL             ; REVERSE PUSH ORDER
CDB     RDSTH
MW      RDST,RIR

WIW2    RDSTH,RDSTL
OW      GH,GL                 ; MOV MP,-(SP)

LL      LJTAB,RSRCL

WIW2    RDSTH,RDSTL
OW      GH,GL                   ; MOV MP,-(SP)

LL      HJTAB,RSRCH

R       RSRCH,RSRCL
 LGL     RBAH
 LL      1,RSRCL
IW      0,RBA
```

```
        WIW2    RDSTH,RDSTL    ; MOV JTAB,-(SP)
        OW      RBAH,RBAL

        LL      4,RSRCH
        WIW2    RDSTH,RDSTL    ; MOV OLDSEG,-(SP)
        OW      GH,GL          ;   (R2 USED INSTEAD OF OLDSEG)

        LGL     RSRCH
        ICW1    G,RBA
        W       RDSTH,RDSTL    ; MOV  IPC,-(SP)
        OW      RBAH,RBAL

        LGL     RSRCL

        SI      I6
        MW      G,RDST
        RI      I6

        AL      PARMSZ,RDSTL
        CDB     RDSTH

        R       RDSTH,RDSTL
         LGL     RPSWL         ; MOV PARMSZ(R1),IPC
        IW      0,RDST         ;   (IPC NOT USED)

        JZBT    CLPFIN         ; BEG 2$


        SRW     RDSTH,RDSTH    ; ASR IPC

        MW      RIR,RSRC        ; MOV SP,MP  (MP NOT USED)

        AL      MSDLTA+2,RSRCL
        CIB     RSRCH          ; ADD #MSDLTA+2,MP

CLPLOP: RIW2    GH,GL
         DW1F    RDST,RDST
        IW      0,RBA

        SI      I6
        LCF     0,RPSWL     ; SET Z FLAG TO FALSE
        RI      I6

        WIW2    RSRCH,RSRCL
        OW      RBAH,RBAL

        JZF     CLPLOP


CLPFIN: MW      RIR,SP
        LL      5,RIRL
        LL      4,RIRH

        LGL     RIRL
        MW      SP,G           ; MOV SP,MP
```

```
LL      LLASTMP,RDSTL
LL      HLASTMP,RDSTH

WIW2    RDSTH,RDSTL    ; MOV MP,LASTMP
OW      GH,GL

MW      G,RSRC
AL      MSSP,RSRCL
CIB     RSRCH          ; MOV R0,MSSP(MP)
LGL     RPSWL
W       RSRCH,RSRCL
OW      GH,GL

LL      1,RSRCL
LGL     RSRCL

W       RDSTH,RDSTL    ; MOV R1,JTAB
OW      GH,GL

MW      G,RDST         ; MOV R1,IPC
AL      ENTRIC,RDSTL
CDB     RDSTH          ; ADD #ENTRIC,IPC

R       RDSTH,RDSTL
 LGL     RIRH
 MW      RDST,G
IW      0,RDST

SW      RDST,G,RSVC         ; SUB @IPC,IPC
ICW2    PC,PC               ; SKIP OVER STACK OVERFLW ERROR BR

.END
```

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