**Comparison of the AMDAHL 470V/6
and the
IBM 370/195 Using Benchmarks**

by

**D. R. Snider, J. L. Midlock, A. R. Hinds,
and D. E. Engert**

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**Prepared for the U. S. ENERGY RESEARCH
AND DEVELOPMENT ADMINISTRATION
under Contract W-31-109-Eng-38**

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ANL-76-50

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Applied Mathematics Division

March 1976

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ABSTRACT

Six groups of jobs were run on the IBM 370/195 at the Applied Mathematics Division (AMD) of Argonne National Laboratory using the current production versions of OS/MVT 21.7 and ASP 3.1. The same jobs were then run on an AMDAHL 470V/6 at the AMDAHL manufacturing facilities in Sunnyvale, California using the identical operating systems. Performance of the two machines are compared.

Differences in the configurations were minimized. The memory size on each machine was the same, all software which had an impact on run times was the same, and the I/O configurations were as similar as possible. This allowed the comparison to be based on the relative performance of the two CPUs.

As part of the studies preliminary to the acquisition of the IBM 195 in 1972, two of the groups of jobs had been run on a CDC 7600 by CDC personnel in Arden Hills, Minnesota, on an IBM 360/195 by IBM personnel in Poughkeepsie, New York, and on the AMD 360/50/75 production system in June, 1971.

I. INTRODUCTION

Benchmarks have been widely used in computer acquisition studies. When installed equipment cannot handle projected (or current) workload requirements, the cost/effectiveness of newer and more powerful computers is often evaluated by running selected parts of the workload on demonstration models of the new machines. At Argonne, an ambitious benchmark study was conducted in 1971.¹ The benchmark library from that study consists of two parts:

- a) 28 applications problems representative of, and essential to, the Laboratory's research programs and development projects current in 1971, and
- b) a model jobstream simulating the Central Computing Facility 1971 daytime workload.

AMD is now planning for a computer acquisition. The existing benchmark library was brought up to date, and four new groups of jobs were added to represent the somewhat different workload and research programs current at the Laboratory in 1975. The original jobstream and applications code collections were augmented by a modified model jobstream, a set of current user application codes, a set of small program kernels (drawn mostly from large production codes but including some written specifically for the benchmark), and the Naval Research Laboratory benchmark kernel collection. These six groups were run on the IBM 370/195 at Argonne using the current production versions of OS/360 21.7 and ASP 3.1, and then on a 470V/6 at AMDAHL headquarters (using the same operating systems).

This report describes that experiment in measuring the relative performance of the two CPUs and summarizes the significance of the results obtained. We attempted an objective experiment within the resources available to the project: three man-months were required for planning and execution and many times more could easily have been used.

¹M. K. Butler and Alan Hirsch, Use of the Argonne Benchmark Collection To Measure Computer System Performance, ANL 8127 (September, 1974).

II. DESIGN OF THE EXPERIMENT

The two major goals of the experiment were:

1. to see if the AMDAHL 470V/6 would run our heavily modified operating systems and jobs with reliability, accuracy, and ease; and
2. to see how fast the 470V/6 is compared to our IBM 370/195.

To accomplish these goals, several procedures were implemented.

First, our production version of OS/360 MVT 21.7 was slightly modified to run on the 470V/6. The Unit Control Blocks (UCBs) in the Input/Output Supervisor (IEAQFXOO) were reassembled to include the devices in the AMDAHL configuration. In addition, the nucleus initialization program (IEAANIPO) was reassembled with modifications supplied by AMDAHL for Recovery Management initialization. AMDAHL modules were copied in for Channel Check Handler, Machine Check Handler, and System Environment Recording; and several modules containing references to the AMDAHL modules were reassembled to point to these modules. It turned out that the changes for Recovery Management were not necessary for the benchmark since we decided to run in "hard stop" to avoid the performance degradation associated with trying to recover from hardware errors.

Second, the ASP initialization deck was modified to match the different hardware configuration on the 470V/6 and a similar stripped-down configuration on our 195. No changes were made to our production version of ASP; it ran on the 470V/6 just as it runs on the 370/195.

Finally, the benchmark library used in 1971 was reactivated and four new parts added to it.

All six parts of the benchmark were run on both machines by the authors. For the two model jobstreams, all of the jobs were read into the ASP queue; then the SLACMON software monitor was started and the jobs were allowed to run. The Argonne SHIFTL (i.e., the prime shift on weekdays) scheduling parameters were used. These parameters cause four initiators to be started in the top 800K of core memory for EXPRESS class jobs and six initiators to be started in 2200K of core for the bigger jobs. Both machines had four megabytes of memory. The rest of the memory was used for ASP and OS. Only one printer was used for the benchmarks (that was all the 470V/6 had), and only the SYMSG files were printed. The printer was active while the streams were run. The time to run a stream was defined as the time from when jobs were allowed to start running until the last job completed.

As soon as the last job ended, SLACMON was stopped. When the SYMSG files were completed, ASP was terminated to get the CPU time used for the run as measured by SMF. The SLACMON outputs were later compared to check for any significant differences in the utilization of the I/O equipment and for overall CPU utilization of the runs.

The application codes, user codes, and specially tuned code kernels were all run together. The important statistic for each of these jobs was the CPU time required on the different machines. The elapsed time required to run each group of jobs was not measured because the additional comparisons of the I/O speeds of the machines were not considered to be worth the time and effort of running the jobs as separate streams.

A. The Model Jobstream

Basically, the Model Jobstream used in this benchmark is identical to that described in Refs. 1 and 2, with the following modifications:

- a) In the original jobstream, several of the jobs were executed several times. Since ASP does not permit concurrent execution of jobs with the same jobname, all jobs in the jobstream were assigned unique jobnames. In the reports, all jobnames were mapped back to their original names.
- b) The AMDAHL hardware configuration did not support 2314 disk drives or 2321 datacells. All jobs requiring these devices were modified to use 3330 disks.
- c) All jobs which depended heavily on operator involvement for mounting tapes were modified to use an online, permanently resident 3330 disk pack. This eliminated the variability inherent in tape mounting.
- d) Several jobs produced more than 50,000 lines of data. Because of our local restriction of a maximum of 50,000 lines of printed data, these jobs had their output directed to tape.
- e) Several of the utility jobs depend upon another job for their successful execution. Where such dependencies exist, the series of jobs was put into an ASP Dependent Job Control (DJC) network to ensure serialized execution.

²M. K. Butler, Alan R. Hirsch, Sue Katilavas, and M. R. Kraimer, The Argonne Benchmark Problem Collection, Technical Memorandum 213, Argonne National Laboratory (June, 1971).

- f) The CLASS Parameter on the JOB cards was changed to better represent the I/O and/or CPU boundness of the jobs.

The Model Jobstream consists of 60 unique jobs (see Refs. 1 and 2): 37 are typical of the jobs submitted by our users, and 23 are exercises of the commonly used system utility functions. Several of the jobs were run several times, making the total number of jobs in the Model Jobstream run 105.

B. Modified Model Jobstream

To place a heavier CPU load on the benchmark machines, the Model Jobstream was augmented by the inclusion of additional CPU bound jobs. These additional jobs were of two types:

- a) selected CPU bound jobs already existing in the Model Jobstream; and
- b) several new jobs (NATRAN, EMATMUL, and DMATMUL described in Appendices C and D).

These jobs contained the same modifications described for the Model Jobstream. The number of jobs in the Modified Model Jobstream totaled 117.

C. Applications Problems

One of the groups of jobs used in this benchmark is a subset of the applications problems documented in TM 213. These application problems are, for the most part, written in FORTRAN. The assembly language routines perform well-defined mathematical, character, or bit manipulation, or system-dependent functions. A single PL/I program is included. Only minimal JCL changes were made to the subset of jobs used in this benchmark. Those jobs from the applications problems which were not included in this benchmark would have required major JCL changes and/or re-programming to be executable; time constraints precluded this.

It was not realized until the data were analyzed at ANL that job SUMX had failed to execute properly because of a lack of scratch space in the LINKEDIT step. This job is included in the report, but it is not counted in the "TOTAL" lines.

For ease in reference and comparison, the jobnames in this subset of applications problems are identical to those described in ANL-8127 and TM-213.

D. Current User Production Codes

The original benchmark application code collection, assembled in 1971, was restricted to those applications then implemented on

the IBM 360/75 using models appropriate to the scale of computing power available on that machine. To represent the current Laboratory computing workload more accurately, particularly as it has been influenced by the increase in computing power available on the 370/195, a selection of heavily used, large-scale production codes was added to the benchmark. These codes represent new or extended applications with the 195, and most of them have undergone some tuning to optimize their performance on the current machine.

The user codes selected include representatives from quantum chemistry (BISONINT, OVCBENCH), nuclear reactor design and engineering (DIFIDADJ, DIFIDMOD, DIFIDRL), reactor fuel management (BIGREBUS, REBUSTST), and fast reactor transient and accident analysis (FX2DEMO, NATRAN, SASBENCH). The codes are dominated by double precision floating point arithmetic, with NATRAN being the only single precision representative. Most of the codes make use of loop mode and the overlap of floating point arithmetic on the 370/195. All are coded in FORTRAN, compiled on the H compiler at optimization level 2, with the exception of SASBENCH, which is compiled with the G compiler. Further information about the codes can be found in the appendices.

The user codes were executed on the 370/195 using the full production I/O device configuration during normal production time. Since this I/O environment differed substantially from that under which the codes were run on the AMDAHL machine, only the CPU times can be usefully compared. Even the CPU times, it should be realized, are subject to some uncertainties owing to the manner in which OS MVT charges CPU time while it is processing interrupts.

E. Special Program Kernels

To update the benchmark collection further, a group of program kernels, most of them highly tuned for the 370/195, was extracted from major user production codes or specially written for the benchmark. Use of small kernels rather than entire production codes allowed us to compare performance of code sequences that were easily characterized, whose behavior was well understood on the 195, and which were representative of whole classes of applications programs. Most of the kernels represent time-limiting paths in large codes and thereby reflect the common code tuning efforts which have been undertaken at Argonne.

The kernels selected include tuned paths from the reactor codes SYN3D (DMATMUL, MINVERT) and VIM Monte Carlo Code (MORETEST), the molecular dynamics models of A. Rahman (FSQRT), and the STATOS graphics package (BITSET). As with the user production code collection, the kernels are primarily FORTRAN H (OPT = 2), dominated by double precision floating point arithmetic, although some single precision floating point representatives are included (EMATMUL,

FORTLIBE). Two assembly language kernels are included which perform no floating point arithmetic--a bit manipulation program (BITSET) and a binary table search routine (MORETEST). Most of the kernels take advantage of loop mode on the 370/195, and most achieve significant overlap of floating point addition with floating point multiplication or division.

The jobs DMALMUL/EMATMUL and FORTLIBD/FORTLIBE require special mention. DMATMUL/EMATMUL consist of five separate matrix multiplication algorithms, each invoked for square matrices of ten different dimensions. FORTLIBD/FORTLIBE consist of five separate FORTRAN library routines, each invoked for a set of random arguments. The results section reports total times for these jobs as well as individual times for each matrix multiplication algorithm, each matrix dimension, and each FORTRAN library function.

For the program kernels, only the CPU times are significant, owing to the differing I/O configurations under which they are executed on the 370/195 and AMDAHL 470V/6. The cautions stated for the user production codes are also appropriate here. Further description of these benchmark kernels can be found in Appendix D.

F. Naval Research Laboratory Benchmark Kernels

Included in the benchmark were six jobs that were taken from the Naval Research Laboratory benchmark collection. These jobs invoke specially written kernels abstracted from major codes essential to the research programs at NRL, and formed the basis of their recent computer evaluation and acquisition. These kernels were included in the ANL benchmark because of the applicability of their numerical methods to the solution of large classes of scientific problems. The availability of timings for these problems on a variety of machines was considered an additional advantage. Specifically these kernels have been run on the fastest computers now available.

The kernels are compiled under FORTRAN H (OPT = 2) and include a finite fast Fourier transform (NRLICH01), a particle push algorithm (NRLICH02), a Runge-Kutta O.D.E. solver (NRLICH04), a two-dimensional mode coupling problem (NRLICH05), a fluid dynamics algorithm (NRLICH06), and a general matrix and vector arithmetic exerciser (NRLICH07). Except for the last, all the kernels use single precision floating point, with NRLICH07 using single and double precision equally. NRLICH01, NRLICH06, and NRLICH07 take advantage of loop mode, and floating point overlap is probable in most of the examples. NRLICH02, NRLICH04, and NRLICH05 have a high proportion of fixed point addressing and loop management instructions.

For the NRL kernels, only the CPU times can be compared, due to differing I/O device configurations under which they were executed on the 370/195 and AMDAHL 470V/6. Again the cautions stated for the user production codes should be noted. Further description of these benchmark kernels can be found in the Appendix E.

III. RESULTS

A. Jobstream Summary

Tables 1 and 2 summarize the relative performance of the AMDAHL 470V/6 and the IBM 370/195 for the Model and Modified Model Jobstreams. Jobstream elapsed times were measured from the start of the first job to the completion of the last job on MAIN using time-stamped console messages. Total job CPU time and ASP CPU time were obtained from SMF, WAIT time from local accounting modifications, and percent CPU utilization from the SLACMON software monitor.

More detailed results are given in the following sections and in Appendix F.

Table 1

Model Jobstream Summary

	<u>AMDAHL 470V/6</u>	<u>IBM 370/195</u>	<u>AMDAHL/IBM</u>
Elapsed time (min:sec)	27:27	30:02	0.914
Total Job CPU time (min:sec)	18:12.07	16:46.22	1.085
Total Job WAIT time (min:sec)	40:50.62	49:03.19	0.833
ASP CPU time (min:sec)	1:41.55	1:55.09	0.882
Total CPU time (min:sec)	20:58	20:22	1.029
CPU utilization	76.36%	67.79%	1.128

Table 2

Modified Model Jobstream Summary

	<u>AMDAHL 470V/6</u>	<u>IBM 370/195</u>	<u>AMDAHL/IBM</u>
Elapsed time (min:sec)	45:02	39:44	1.133
Total Job CPU time (min:sec)	39:35.43	33:15.79	1.190
Total Job WAIT time (min:sec)	50:36.86	50:20.54	1.005
ASP CPU time (min:sec)	1:56.05	2:15.58	0.856
Total CPU time (min:sec)	42:21	36:44	1.153
CPU utilization	94.03%	92.47%	1.017

B. The Model Jobstream

The Model Jobstream consists of 60 unique jobs, some of which were repeated to yield a total of 105 jobs comprising 318 separate job steps. These steps include 52 Assemblies, 17 FORTRAN G compilations, 23 FORTRAN H (OPT=0), compilations, 37 Link Edits, 58 IBM Utility executions, 8 PL/1 compilations, and 123 "GO" steps. This jobstream was assembled in 1971 to represent the daytime workload on the production 360/75; currently, it more closely resembles the 370/195 EXPRESS class workload.

Table 1 shows the stream to be I/O bound on both machines - more so on the 195. Despite requiring more CPU time than the 195, the 470 completed the jobstream in 9 percent less elapsed time. The lower CPU times for ASP on the 470 suggest that its superior elapsed time is partially attributable to faster provision of system services to the jobstream.

The relative performance of the two machines varies across the jobstream. The ratio of job CPU time used on the 470 to CPU time used on the 195 ranges from .692 to 2.366, with a mean of .963 if each unique job is counted once. Weighting each job by the number of times it occurs in the jobstream shifts the mean to .945 and gives 1.085 for the ratio of total job CPU times. Figures 1 and 2 summarize the relative performance distribution in histogram format.

Table 3 compares the performance of the two machines on different classes of programs, revealing the strengths and weaknesses of each. The AMDAHL 470V/6 excels in executing the language translators and service programs - the compilers, linkage editor, and utilities - as well as the shorter user programs (LOAD&GO). The 370/195 dominates only in the execution of the longer user GO steps, which, however, account for nearly 70% of the stream CPU time. Thus, it appears that the 470 is superior at executing codes dominated by logical, shifting, comparison, and branching instructions while the 195 excels with codes dominated by arithmetic - particularly floating point. This is consistent with the published instruction times for the two machines.^{3,4}

³IBM System/360 and System/370 Model 195 Functional Characteristics, Form GA22-6943, IBM Corporation, New York.

⁴Amdahl 470V/6 Machine Reference, Amdahl Corporation, Sunnyvale, California.

<u>MIDPOINT</u>	<u>COUNT</u>	
.70	1	X
.80	17	XXXXXXXXXXXXXXXXXXXX
.90	15	XXXXXXXXXXXXXXXXXXXX
1.00	17	XXXXXXXXXXXXXXXXXXXX
1.10	7	XXXXXXX
1.20	0	
1.30	0	
1.40	0	
1.50	1	X
1.60	0	
1.70	1	X
....	0	
2.30	1	X

Total of 60 Unique Jobs

Mean Ratio of Job CPU Times = .963
 Total Job CPU Time on 470V/6 = 978.02 sec.
 Total Job CPU Time on 370/195 = 886.23 sec.
 Ratio of Total Job CPU Times = 1.104

Figure 1. Distribution of CPU Time Ratios for Model Jobstream - Each Unique Job Counted Only Once.

<u>MIDPOINT</u>	<u>COUNT</u>	
.70	1	X
.80	29	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.90	32	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
1.00	31	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
1.10	9	XXXXXXXXXX
1.20	0	
1.30	0	
1.40	0	
1.50	1	X
1.60	0	
1.70	1	X
....	0	
2.30	1	X

Total of 105 Jobs

Mean Ratio of Job CPU Times = .945
 Total Job CPU Time on 470V/6 = 1092.07 sec.
 Total Job CPU Time on 370/195 = 1006.22 sec.
 Ratio of Total job CPU Times = 1.085

Figure 2. Distribution of CPU Time Ratios for Model Jobstream - All Jobs in Jobstream Included.

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AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP TIMES WEIGHTED BY THE NUMBER OF TIMES EACH STEP WAS RUN

STEPNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
ASM	52	0.26	5.21	52	0.29	6.52	0.900	0.800
EDT	37	0.30	10.33	37	0.36	9.11	0.840	1.134
FTG	17	1.51	2.02	17	1.95	2.33	0.773	0.863
FTH	23	4.20	13.91	23	5.02	10.24	0.836	1.359
GO	89	8.39	3.80	89	6.71	6.91	1.251	0.549
IEBUTIL	33	0.21	9.34	33	0.22	11.03	0.966	0.847
IEHUTIL	25	0.22	9.06	25	0.23	6.50	0.960	1.395
LOAD&GO	34	4.94	14.44	34	5.77	22.54	0.857	0.641
PL1	8	2.20	9.88	8	2.85	10.49	0.773	0.942

SUMMARY OF STEP MEANS (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT	CPU	WAIT
ASM	5	0.47	8.15	5	0.52	12.48	0.896	0.730
EDT	21	0.31	9.90	21	0.36	9.01	0.863	1.199
FTG	10	2.20	2.19	10	2.85	2.64	0.770	0.916
FTH	23	4.20	13.91	23	5.02	10.24	0.840	1.417
GO	21	12.36	4.76	21	9.46	9.23	1.387	1.357
IEBUTIL	16	0.23	11.48	16	0.24	11.82	0.949	1.205
IEHUTIL	9	0.26	11.28	9	0.27	8.20	0.944	1.441
LOAD&GO	14	5.86	16.82	14	6.86	26.60	0.910	1.046
PL1	3	4.04	13.73	3	5.35	16.74	0.791	1.026

Table 3. Summary of Results for Model Jobstream -
Performance Ratios by Program Type.

C. The Modified Model Jobstream

The Modified Model Jobstream consists of the Model Jobstream augmented by additional CPU bound jobs to more closely represent the current daytime computing workload of the production 370/195. A total of 117 jobs, of which 64 are unique, contribute 362 job steps to this stream.

Table 2 shows the modified stream to be CPU bound on both machines, with CPU utilizations exceeding 90 percent. The extra CPU load has extended the 470 stream time nearly twice as much as the 195 stream time, overwhelming the small advantage the 470 had on the Model Jobstream.

The ratio of job CPU time used on the 470 to CPU time used on the 195 ranges from .692 to 2.673 with a mean of 1.007 if each job is counted once. Weighting each job by the number of times it occurs in the jobstream shifts the mean to 1.004 and gives 1.190 for the ratio of the total job CPU times. Figures 3 and 4 present the relative performance distributions in histogram format.

Table 4 updates the comparisons in Table 3 for the inclusion of the additional CPU bound jobs.

<u>MIDPOINT</u>	<u>COUNT</u>	
.70	2	XX
.80	17	XXXXXXXXXXXXXXXXXXXXX
.90	15	XXXXXXXXXXXXXXXXXXXXX
1.00	17	XXXXXXXXXXXXXXXXXXXXX
1.10	8	XXXXXXXXXX
1.20	0	
1.30	0	
1.40	0	
1.50	1	X
1.60	1	X
1.70	1	X
1.80	0	
1.90	0	
2.00	0	
2.10	0	
2.20	0	
2.30	1	X
2.40	0	
2.50	0	
2.60	1	X

Total of 64 Unique Jobs

Mean Ratio of Job CPU Times = 1.007
 Total Job CPU Time on 470V/6 = 1638.80
 Total Job CPU Time on 370/195 = 1385.00
 Ratio of Total Job CPU Times = 1.183

Figure 3. Distribution of CPU Time Ratios for Modified Model Jobstream - Each Unique Job Counted Only Once.

<u>MIDPOINT</u>	<u>COUNT</u>	
.70	2	XX
.80	29	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.90	32	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
1.00	35	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
1.10	10	XXXXXXXXXX
1.20	0	
1.30	0	
1.40	0	
1.50	1	X
1.60	1	X
1.70	5	XXXXX
1.80	0	
1.90	0	
2.00	0	
2.10	0	
2.20	0	
2.30	1	X
2.40	0	
2.50	0	
2.60	1	X

Total of 117 Jobs

Mean Ratio of Job CPU Times = 1.004
 Total Job CPU Time on 470V/6 = 2375.43
 Total Job CPU Time on 370/195 = 1995.79
 Ratio of Total Job CPU Times = 1.190

Figure 4. Distribution of CPU Time Ratios for Modified Model Jobstream - All Jobs in Jobstream Included.

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AMDAHL 470V/6 VS. IBM 370/195
MODIFIED MODEL JOBSTREAM

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP TIMES WEIGHTED BY THE NUMBER OF TIMES EACH STEP WAS RUN

STEPNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
ASM	52	0.27	4.15	52	0.29	4.74	0.920	0.875
EDT	45	0.30	9.40	45	0.37	8.91	0.808	1.055
FTG	17	1.49	1.92	17	1.90	1.81	0.782	1.057
FTH	35	3.85	12.01	35	4.61	9.41	0.834	1.277
GO	109	12.21	5.77	109	9.43	6.35	1.295	0.908
IEBUTIL	33	0.22	8.75	33	0.22	11.05	0.978	0.792
IEHUTIL	25	0.22	8.89	25	0.23	6.14	0.939	1.448
LOAD&GO	38	21.76	19.54	38	18.59	19.21	1.170	1.017
PL1	8	2.22	7.85	8	2.85	9.05	0.777	0.867

SUMMARY OF STEP MEANS (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT	CPU	WAIT
ASM	5	0.47	7.53	5	0.52	8.51	0.909	0.876
EDT	21	0.30	9.49	21	0.37	8.77	0.836	1.110
FTG	10	2.16	1.82	10	2.76	1.74	0.779	1.173
FTH	27	3.89	11.23	27	4.67	8.81	0.839	1.392
GO	21	12.18	9.01	21	9.09	10.11	1.422	1.066
IEBUTIL	16	0.25	9.39	16	0.26	11.88	0.982	1.217
IEHUTIL	9	0.26	10.76	9	0.27	7.72	0.928	1.447
LOAD&GO	18	41.11	20.42	18	33.67	20.10	1.046	0.889
PL1	3	4.08	9.70	3	5.32	12.82	0.789	0.879

Table 4. Summary of Results for Modified Model Jobstream - Performance Ratios by Program Type.

D. Applications Problems

Tables 5 and 6 summarize the performance of the Applications Problems collection on the benchmark machines. Note particularly the differences in relative performance of the single and double precision problems. Average GØ step execution times are recorded, with each job counting once in the tabulated totals and means regardless of how often it was included in the problem collection.

Complete results for the Applications Problems are in Appendix F.

E. Current User Production Codes and Special Kernels

Table 7 summarizes the performance of the User Code and Special Kernel GØ steps on the benchmark machines. Average execution times are recorded, with each job contributing once to the tabulated totals and means. Complete results are in Appendix F.

F. Naval Research Laboratory Benchmark Kernels

Table 8 summarizes the performance of the N.R.L. Benchmark Kernel GØ steps on the benchmark machines. Complete results are in Appendix F.

G. Summary of Performance Ratios

Table 9 summarizes the CPU performance of the benchmark machines for the major categories of work comprising this study. Data for ASP, the language translators and service programs were obtained by combining the Model and Modified Model Jobstream results with the exception of FORTRAN H OPT=2 data that was obtained from the Applications Problems, Special Kernel, and N.R.L. Benchmark Kernel collections. The tabulated mean cpu time ratios were obtained by averaging the job performance ratios in each grouping, counting each unique job once regardless of how often it was included in the benchmark.

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
APPLICATIONS PROBLEMS

25

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = LOAD&GO									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

ANLTRIM	1	125.36	9.22	1	95.97	12.27	1.306	0.751	
DOT2	1	322.36	41.89	1	372.95	51.08	0.864	0.820	
DROPLET	1	488.00	1.94	1	281.29	3.06	1.735	0.634	
EIGEN	1	21.48	2.87	1	12.33	3.87	1.742	0.742	
EROS	1	134.63	83.14	1	145.51	89.77	0.925	0.926	
HEPCVT	1	61.64	10.64	1	74.68	12.21	0.825	0.871	
KTTFLCK	1	67.29	1.48	1	68.53	1.60	0.982	0.925	
LIFE1A	1	149.42	7.21	1	126.06	10.00	1.185	0.721	
MATRIX	3	68.02	3.04	3	36.27	1.92	1.875	1.583	
MONTE	1	204.29	1.82	1	162.42	2.22	1.258	0.820	
MULTC	1	90.23	2.56	1	68.69	18.69	1.314	0.137	
NVERTEX	3	85.58	3.40	3	92.88	21.28	0.921	0.160	
OWL	1	113.75	3.05	1	123.64	4.99	0.920	0.611	
REXCO	1	178.25	3.08	1	133.82	3.76	1.332	0.819	
SDIAG	1	33.30	6.41	1	13.32	1.44	2.500	4.451	

TOTAL	15	2143.60	181.75	15	1808.36	238.16	1.185	0.763	
MEAN	15	142.91	12.12	15	120.56	15.88	1.312	0.998	

STEP = EDT&GO									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

LINDA	1	225.98	102.50	1	276.35	91.07	0.818	1.126	
SUMX	1	0.44	4.39*	1	72.57	31.80			

TOTAL	1	225.98	102.50	1	276.35	91.07	0.818	1.126	
MEAN	1	225.98	102.50	1	276.35	91.07	0.818	1.126	

Table 5. Summary of Results for Applications Problems.

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
DOUBLE PRECISION APPLICATIONS PROBLEMS

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = LOAD&GO									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

ANLTRIM	1	125.36	9.22	1	95.97	12.27	1.306	0.751	
DROPLET	1	488.00	1.94	1	281.29	3.06	1.735	0.634	
EIGEN	1	21.48	2.87	1	12.33	3.87	1.742	0.742	
LIFE1A	1	149.42	7.21	1	126.06	10.00	1.185	0.721	
MATRIX	3	68.02	3.04	3	36.27	1.92	1.875	1.583	
MONTE	1	204.29	1.82	1	162.42	2.22	1.258	0.820	
MULTC	1	90.23	2.56	1	68.69	18.69	1.314	0.137	
REXCO	1	178.25	3.08	1	133.82	3.76	1.332	0.819	
SDIAG	1	33.30	6.41	1	13.32	1.44	2.500	4.451	

TOTAL	9	1358.35	38.15	9	930.17	57.23	1.460	0.667	
MEAN	9	150.93	4.24	9	103.35	6.36	1.583	1.184	

SINGLE PRECISION APPLICATIONS PROBLEMS

STEP = EDT&GO									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
LINDA	1	225.98	102.50	1	276.35	91.07	0.818	1.126	
TOTAL	1	225.98	102.50	1	276.35	91.07	0.818	1.126	
MEAN	1	225.98	102.50	1	276.35	91.07	0.818	1.126	

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = LOAD&GO									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

DOT2	1	322.36	41.89	1	372.95	51.08	0.864	0.820	
EROS	1	134.63	83.14	1	145.51	89.77	0.925	0.926	
KTTFLCK	1	67.29	1.48	1	68.53	1.60	0.982	0.925	
NVERTEX	3	85.58	3.40	3	92.88	21.28	0.921	0.160	
OWL	1	113.75	3.05	1	123.64	4.99	0.920	0.611	

TOTAL	5	723.61	132.96	5	803.51	168.72	0.901	0.788	
MEAN	5	144.72	26.59	5	160.70	33.74	0.923	0.688	

Table 6. Summary of Results for Applications Problems -
Single Precision and Double Precision Floating Point.

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
USER JOBS AND TUNED KERNELS

27

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = LOADGO									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

DMATMUL	1	242.83	1.43	1	87.96	1.47	2.761	0.973	
EMATMUL	1	139.24	1.46	1	88.47	1.43	1.574	1.021	
PORTLIBD	1	116.57	2.58	1	78.05	3.75	1.494	0.688	
PORTLIBE	1	71.51	2.66	1	82.75	6.65	0.864	0.400	
FSQRT	1	296.61	1.35	1	82.66	2.08	3.588	0.649	
MINVERT	1	80.63	1.38	1	69.82	1.32	1.155	1.045	
NATRAN	1	88.98	2.11	1	79.69	4.42	1.117	0.477	

TOTAL	7	1036.37	12.97	7	569.40	21.12	1.820	0.614	
MEAN	7	148.05	1.85	7	81.34	3.02	1.793	0.751	

STEP = GO									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

BIGREBUS	1	506.52	382.78	1	279.36	335.52	1.813	1.141	
BISONINT	1	649.65	593.18	1	379.54	329.20	1.712	1.802	
BITSET	1	28.63	0.15	1	39.27	0.18	0.729	0.833	
DIF1DADJ	1	130.59	17.03	1	73.94	16.96	1.766	1.004	
DIF1DMOD	1	512.97	36.72	1	292.34	54.68	1.755	0.672	
DIF1DRL	1	35.51	17.51	1	21.70	16.37	1.636	1.070	
FX2DEMO	1	453.98	281.06	1	321.12	290.55	1.414	0.967	
MORETEST	2	33.39	0.25	2	40.56	0.44	0.823	0.562	
OVCBENCH	1	621.05	133.81	1	278.66	104.60	2.229	1.279	
REBUSTST	1	113.64	151.79	1	77.86	159.68	1.460	0.951	
SASBENCH	1	193.59	4.33	1	171.03	7.05	1.132	0.614	

TOTAL	11	3279.52	1618.61	11	1975.38	1315.23	1.660	1.231	
MEAN	11	298.14	147.15	11	179.58	119.57	1.497	0.990	

Table 7. Summary of Results for User Jobs and Tuned Kernels.

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
NRL BENCHMARK KERNELS

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM	
JOBNAME	JOB	CPU	WAIT	JOB	CPU	WAIT	CPU	WAIT
NRlich01	1	163.54	21.77	1	157.47	6.98	1.039	3.119
NRlich02	1	129.98	15.13	1	111.97	4.49	1.161	3.370
NRlich04	1	127.92	20.89	1	110.59	8.69	1.157	2.404
NRlich05	1	150.43	7.07	1	136.43	7.82	1.103	0.904
NRlich06	1	154.67	5.94	1	124.94	5.25	1.238	1.131
NRlich07	1	221.75	4.14	1	94.29	3.66	2.352	1.131
TOTAL	6	948.29	74.94	6	735.69	36.89	1.289	2.031
MEAN	6	158.05	12.49	6	122.61	6.15	1.341	2.010

STEP = GO

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
NRlich01	1	162.38	0.26	1	156.05	0.58	1.041	0.448
NRlich02	1	129.18	0.41	1	110.98	0.18	1.164	2.278
NRlich04	1	127.10	0.28	1	109.61	0.30	1.160	0.933
NRlich05	1	149.26	0.23	1	134.94	0.20	1.106	1.150
NRlich06	1	153.58	0.21	1	123.62	0.22	1.242	0.955
NRlich07	1	220.45	0.27	1	92.70	0.21	2.378	1.286
TOTAL	6	941.95	1.66	6	727.90	1.69	1.294	0.982
MEAN	6	156.99	0.28	6	121.32	0.28	1.348	1.175

Table 8. Summary of Results for Naval Research Laboratory Benchmark Kernels.

	<u>Total Steps</u>	<u>Total Jobs</u>	<u>Unique Jobs</u>	<u>Mean CPU Ratio AMDAHL/IBM</u>
ASP	2	2	2	.869
ASSEMBLER F	104	52	5	.915
FORTTRAN G	34	34	10	.776
FORTTRAN H	91	91	56	.814
OPT=0	58	58	27	.840
OPT=2	33	33	29	.791
LINK EDIT	82	68	21	.850
PL/1 F	16	6	3	.790
OS UTILITIES	116	106	23	.958
'IEB' UTILITIES	66	66	16	.966
'IEH' UTILITIES	50	42	9	.936
GO & LOAD&GO STEPS	313	185	113	1.291
MODEL JOBSTREAM	123	65	35	1.196
MODIFIED JOBSTREAM	147	77	39	1.248
APPLICATIONS PROBLEMS	20	20	16	1.281
LARGE USER CODES	9	9	9	1.534
SPECIAL JOB KERNELS	8	8	8	1.617
NRL KERNELS	6	6	6	1.348
SINGLE PRECISION GO STEPS	17	17	15	1.044
APPLICATIONS PROBLEMS	8	8	6	.901
LARGE USER CODES	1	1	1	1.117
SPECIAL JOB KERNELS	2	2	2	1.219
NRL KERNELS	5	5	5	1.142
FORTTRAN LIBRARY	1	1	1	.996
DOUBLE PRECISION GO STEPS	24	24	22	1.711
APPLICATIONS PROBLEMS	11	11	9	1.583
LARGE USER CODES	8	8	8	1.586
SPECIAL JOB KERNELS	4	4	4	2.250
FORTTRAN LIBRARY	1	1	1	1.706

Table 9. Benchmark Summary Data -
Mean CPU Time Performance Ratios.

IV. EVALUATION OF EXPERIMENT

Figures 5 and 6 show the hardware configurations used in the experiment. In each configuration the 2305 was used for SYS1.SYSJOBQE, the frequently used members of SYS1.LINKLIB, SYS1.FORTLIB, and SYS1.AMDLIB (a library of popular local mathematical subroutines). A single systems resident disk contained the remainder of O.S. Two disks were used as STORAGE/PERMANENTLY RESIDENT for the allocation of temporary and non-temporary datasets. One disk was used as PRIVATE/PERMANENTLY RESIDENT for the input datasets required by some of the jobs. Two disks were used as ASP queue packs.

The I/O device configurations were quite limited for such powerful CPUs. The limitation was imposed by the amount of hardware available on the AMDAHL benchmark machine. The only real bottleneck, however, was caused by the operating system's tendency to allocate most of the temporary datasets on the same disk. The STORAGE disk with the lowest address was much too busy on both the configurations. As a result, the CPU utilization was low for the two jobstreams, and the elapsed times for the streams were longer than they should have been. Since this problem is also present on our production system, the benchmark is believed valid despite the bottleneck.

A log was kept of the activities and problems during the running of the benchmark at AMDAHL and is included in Appendix B. The problems were minor, and to be expected since the AMDAHL hardware engineers had to reconfigure the test machine for the experiment. We were pleased that the benchmark runs were accomplished in only two days.

Figure 5. IBM 370/195 Benchmark Hardware Configuration.

Figure 6. AMDAHL 470V/6 Benchmark Hardware Configuration.

V. SUMMARY

The AMDAHL 470V/6 compares favorably with the IBM 370/195 for certain classes of work. It was 10-20 percent faster at running ASP, compilers, and the Linkage Editor. The higher CPU utilization and shorter run time for the Model Jobstream on the AMDAHL machine are partially attributed to its ability to run the operating system faster than the 195. The 195 was faster, on average, at running GØ steps, which appears to be due almost entirely to the 195's high performance double precision floating point. Programs using little or no floating point or only single precision ran faster, or only marginally slower, on AMDAHL. For double precision, however, applications codes ran typically 20-80 percent faster and tuned kernels up to 400 percent faster on the 195. The absence of a "loop mode" on AMDAHL seemed adequately compensated for by its faster cache memory access time.

ACKNOWLEDGMENTS

The cooperation and assistance of Bob Phillips and his co-workers at AMDAHL are gratefully acknowledged. From AMD, Dave Jacobsohn made the initial contacts and helped get the trip set up; and Louis Just kept the benchmark log and acted as our troop leader.

APPENDIX A

Benchmark ASP Initialization Deck

```

//BENCHASP JOB (W17783.50..1439).CLASS=A.REGION=738K.MSGLEVEL=1
//GOASP PROC RV=RES195.RU=3330.AV=PACK14.AU=3330.
//          QU=3330.Q1=PACK63.Q2=PACK60
// EXEC PGM=ASPNUC.DPRTY=13
//STEPLIB DD DSN=ASP.V3M10.CR3.DISP=SHR.
//          UNIT=&RU.VOL=SER=&RV
//          DD DSN=SYSA.LINKLIB.DISP=SHR
//ASPQ1 DD DSN=ASP.BENCH.Q1.DISP=OLD.
//          UNIT=&QU.VOL=SER=&Q1
//ASPQ2 DD DSN=ASP.BENCH.Q2.DISP=OLD.
//          UNIT=&QU.VOL=SER=&Q2
//CHKPNT DD DSN=ASP.BENCH.CHKPNT.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//ASPD RDS DD DSN=B14591.AMDAHL.BENCH.DISP=SHR.UNIT=3330.VOL=SER=PACK14
//CONTROL DD DSN=ASP.BENCH.CONTROL.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//MAIN DD DSN=ASP.BENCH.MAIN.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//BACKUP DD DSN=ASP.BENCH.BACKUP.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//NACCOUNT DD DSN=ASP.BENCH.NACCOUNT.DISP=MOD.
//          VOL=SER=&AV.UNIT=&AU
//SUPERCTL DD DSN=ASP.BENCH.SUPER.CONTROL.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//ACCTFILE DD DSN=ASP.BENCH.AUTHFILE.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//LHVAFILE DD DSN=ASP.BENCH.VALDFILE.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//STATFILE DD DSN=ASP.BENCH.STATFILE.DISP=MOD.
//          VOL=SER=&AV.UNIT=&AU
//ASPOUT DD SYSOUT=A
//ASPABEND DD SYSOUT=A.DCB=BLKSIZE=882
//ASPSNAP DD SYSOUT=A.DCB=BLKSIZE=882
//SYSABEND DD SYSOUT=A
//IEFRDER DD DUMMY
//IEFDATA DD DUMMY
//IEFPDSI DD DSN=SYSA.PROCLIB.DISP=SHR
//          DD DSN=SYSA.AMDPROC.DISP=SHR
//          PEND
//          EXEC GOASP
//ASPIN DD *

```

```

*****
***** BEGIN OF ASP INITIALIZATION DECK *****
*****
***** RESIDENT MODULES *****
*
RESIDENT.MODULE=(IEFVHCB,IEFVHF,IEFVHREP,IEFVHA)
RESIDENT.MODULE=(IEFMVTJA,IEFVJA,IEFVINA)
RESIDENT.MODULE=(IEFMVTR,IEFHRFK2,IEZDCODE)
RESIDENT.MODULE=(IEFVGM1,IEFVGM2,IEFVGM3,IEFVGM4,IEFVGM5,IEFVGM6)
RESIDENT.MODULE=(IEFVGM7,IEFVGM8,IEFVGM9,IEFVGM10,IEFVGM11,IEFVGM12)
RESIDENT.MODULE=(IEFVGM13,IEFVGM14,IEFVGM15,IEFVGM16,IEFVGM17,IEFVGM18)
RESIDENT.MODULE=(IEFVGM19,IEFVGM70,IEFVGM71,IEFVGM78)
RESIDENT.MODULE=(PRTSETUP,JSS,MSVMVT,PRTERM)
RESIDENT.MODULE=(PRTOUT,MAIN,IAINIO,RDLOGIC,ISENDTSK)
RESIDENT.MODULE=(ISLOGIC,ISJOBORD,PURGE,PTINISH)
RESIDENT.MODULE=(MSVLOCAL,MDSDRIVR,MSVINIT,MSVTERM)
RESIDENT.MODULE=(MPCDATA,MPCDATA)
RESIDENT.MODULE=(PRTDATA)

```

```

RESIDENT.MODULE=(RCHDATA.CR.RIDATA.RIDATA.RIDATA)                                00152000
RESIDENT.MODULE=(RDDATA.PURDATA.MDSDATA.CONTRAP.PN.PRINT)
RESIDENT.MODULE=(MSVDATA.MSVDATA.MSVDATA.MSVDATA.MSVDATA)                        00156000
RESIDENT.MODULE=(MSVDATA.MSVDATA.MSVDATA.MSVDATA.MSVDATA)                        00157000
RESIDENT.MODULE=(CON=1052.CONSANAL.RICBAM.RIEXITS.DJCUPDAT)
COLDSTART.JOBNO=(1.9999)
*
*****      TRACK CARDS & BUFFER CARDS FOR SYSTEM TESTING (2314)      00174000
*
BUFFER.AMOUNT=115.BUFSIZE=1688.RECORDS=7.IOBS=12.TAT=HALF                      00175000
TRACK.DDNAME=ASPQ1                                                                00176000
TRACK.DDNAME=ASPQ2
*
*****      REQUIRED STORAGE NEEDS
*
OPTIONS.ADDSAVE=40.DUMP=OS
ASPCORE.MINCORE=14K.MARBCORE=24K
ENDASPIO
*
*****      RESIDENCY OPTIONS
*
RESCTLBK.ASG=20.FCT=30.RQ=400.VUT=30
*
*****      READER/INTERPRETER
*
RIDATSTN.SYS1.AMDLIB.SYS1.SORTLIB.SYS1.PL1LIB.SYS1.FORTLIB
RIDATSTN.SYS1.PROCLIB.SYS1.LINKLIB.SYS1.LNKLIB.SYS1.AMDPROC
RIDATSTN.SYS1.MACLIB.SYS1.SVCLIB.SYS1.AMDMAC.SYS1.AMDLIB2
RIDATSTN.SYS1.PLICLNK.SYS1.PLICMIX.SYS1.PLIBASE.SYS1.PLITASK
RIDATSTN.SYS1.FORTHX.SYS1.FORTLIB2.SYS1.FORTG1.PLI.CHECK.LINKLIB
RIDATSTN.PLI.TRANSLIB.SYS1.DUMMYLIB.SYS2.IMSLIB.PLI.OPT.LINKLIB
RI.BDL=(FTGCLG.FTGCEG.FTGCEP.FTHCLG.FTHCEG.FTHCEP)
RIPARM.PARM=(00099905001024906431SYSDA E00011A)
DEVICE.STYPE=OSRDR.SUPPORT=(NONE.OSR11).GTYPE=ARI
DEVICE.STYPE=OSRDR.SUPPORT=(NONE.OSR12.LOG.OFF).GTYPE=ARI
DEVICE.STYPE=OSRDR.SUPPORT=(NONE.OSR13.LOG.OFF).GTYPE=ARI
*
*****      MAIN SERVICE
*
*
*          SY1
MAINPROC.NAME=SY1.MAINCTC=810.ADAPTER=810.CTCCUA=(1.2.3.4).MDEST=M1.
SELECT=SHIFT1.
SYSTEM=LOCAL.
RID=R1#.SID=S1#.MSGCLASS=C.JOBCLASS=(D.E.F.G)
DEVICE.STYPE=MAIN.SUPPORT=(810.SY1..OFF).GTYPE=SYS
*
*          SHIFT1
SELECT.NAME=SHIFT1.MINIT=11.MBAR=14.SBAR=13.SJSPAN=255.MJSPAN=60.
REGROUP=(E.EXPRESS.EXP.EXPRESS).
DISPLAY=NONE.SDEPTH=40.INCR=3.GROUP=(EXPRESS.4.G2250.1.ASPBATCH.6).
DPRTY=0.INCL=12.MPSPAN=5.SPSPAN=3.CHOICE=(BJOB.FMIX.FFIT).CLASS=/N
*
*          SHIFT2
SELECT.NAME=SHIFT2.MINIT=12.MBAR=14.SBAR=13.MJSPAN=255.SJSPAN=255.
REGROUP=(E.NEXPRESS.EXP.NEXPRESS).
DISPLAY=NONE.SDEPTH=40.INCR=3.DPRTY=0.
GROUP=(ASPBATCH.10.G64K.1.NEXPRESS.1).
MPSPAN=5.SPSPAN=5.CHOICE=(BJOB.FMIX.FFIT).CLASS=/N.INCL=12
*
*          SHIFT3
SELECT.NAME=SHIFT3.MINIT=11.MBAR=14.SBAR=13.MJSPAN=255.SJSPAN=255.
REGROUP=(E.NEXPRESS.EXP.NEXPRESS).
DISPLAY=NONE.SDEPTH=40.INCR=3.DPRTY=0.

```

```

00182000
00183000
00184000
00185000
00186000
00187000
00188000
00189000
00190000
00191000
00192000
00193000
00194000
00195000
00196000
00197000
00198000
00199000
00200000
00201000
00202000
00203000
00204000
00205000
00206000
00207000
00208000
00209000
00210000
00211000
00212000
X
00214000
00215000
X00216000
X00216100
X00217000
00218000
00219000
X00220000
X00220100
X00221000
X00222000
00223000
00224000
X00225000
X00225100
X00226000

```



```

GROUP=(ASPBATCH.8.G64K.1.NEXPRESS.1).
MPSPAN=5.SPSPAN=5.INCL=12.CHOICE=(BFIT)
*
SYSPROGM
SELECT.NAME=SYSPROGM.GROUP=(SYSPROGM.1).DPRTY=2
*
GROUPS AND CLASSES
CLASS.NAME=A.IORATE=HIGH.JPRTY=ASP.NCLASS=EXP
CLASS.NAME=B.IORATE=MED.JPRTY=ASP.NCLASS=EXP
CLASS.NAME=C.IORATE=LOW.JPRTY=ASP.NCLASS=EXP
CLASS.NAME=J.IORATE=HIGH.JPRTY=ASP.NCLASS=EXP
CLASS.NAME=K.IORATE=MED.JPRTY=ASP.NCLASS=EXP
CLASS.NAME=L.IORATE=LOW.JPRTY=ASP.NCLASS=EXP
CLASS.NAME=N.JPRTY=ASP
GROUP.NAME=EXPRESS.EXRESC=(SY1.4.800K.IPL.MANUAL).PRTY=0
GROUP.NAME=NEXPRESS.EXRESC=(SY1.1..IPL.MANUAL).PRTY=0
CLASS.NAME=E.IORATE=HIGH.JPRTY=ASP.ANLPRTY=(13.N.11).
LIMITS=(2..2.250.1.1).GROUP=EXPRESS
CLASS.NAME=EXP.IORATE=HIGH.JPRTY=ASP.ANLPRTY=(13.N.11).
LIMITS=(2..2.250.1.1).GROUP=EXPRESS
GROUP.NAME=G2250.EXRESC=(SY1.1.500K.DYNAMIC.DYNAMIC).PRTY=1
CLASS.NAME=G.IORATE=HIGH.JPRTY=ASP.GROUP=G2250
GROUP.NAME=G64K.EXRESC=(SY1.1.64K.DYNAMIC.DYNAMIC).PRTY=1
CLASS.NAME=TPT.IORATE=HIGH.JPRTY=ASP.GROUP=G64K
GROUP.NAME=SYSPROGM.EXRESC=(SY1.1)
CLASS.NAME=S.IORATE=HIGH.JPRTY=ASP.SYSTEM=ANY.GROUP=SYSPROGM
*
***** CONSOLES
*
CONSOLE.DDNAME=CN1.TYPE=3215.UNIT=009.MAIN=SY1.ALTCON=CN2.
DEST=OUTPUT
CONSOLE.DDNAME=CN2.TYPE=3060.UNIT=4F0.ALTCON=CN1.
DEST=NONE
*
***** MDS
*
SETPARAM.DEPTH=50.MDSL0G=S32.REMOUNT=5
***** TAPES
SETNAME.MTYPE=34206.
NAMES=(3420-6.TAPE6250.3420-8.DUALDENS.3400-6.3400-5)
*
***** SY1 DEVICES - TAPES
*
DEVICE.STYPE=34206.SUPPORT=(5A5.T30.S1).MTYPE=34206.MAIN=(5A5.SY1.S1). X
GTYPE=TAG
DEVICE.STYPE=34206.SUPPORT=(5A6.T31.S1).MTYPE=34206.MAIN=(5A6.SY1.S1). X
GTYPE=TAG
DEVICE.STYPE=34206.SUPPORT=(5A7.TF0.S1).MTYPE=34206.MAIN=(5A7.SY1.S1). X
GTYPE=TAG
*
***** SUPPORT UNIT RECORD DEVICES
*
DEVICE.STYPE=2540.SUPPORT=(000.RD1).GTYPE=RDR.CHRGE=YES
DEVICE.STYPE=2540.SUPPORT=(000.PU1.D2).GTYPE=PUN
DEVICE.STYPE=1403.SUPPORT=(00E.PR1.D2).GTYPE=PRT.CHRGE=YES
PRINTER.NAME=PR1.FORMS=NO.TRAIN=NO.BUFDED=YES
*
***** ANL ACCOUNTING CONTROL CARDS (PRECEDE STANDARD CARDS)
*
PRIORITY.T=(13.3.00).H=(11.1.50).N=(09.1.00).L=(6.0.80).S=(0.0.60)
ACCNT1.CPUCHRG=00.03194.PRINT=00.0001.PUNCH=00.001.DISKSETP=01.00
ACCNT2.TAPESETP=00.25.PREEL=00.50.FILM=02.00.SPECPR=05.00

```

X00227000
00228000
00229000
00230000
00231000

00241000
00242000
X
00244000

X
00246000
00247000

00249000

00252000

X

X

00271000

00272000

00273000

00274000

00295000

X00301000

00302000

00374000

00375000

00376000

00426000

00427000

00428000

00436000

00437000

00429000

00439000

00501000

00502000

00503000

00504000

00505000

00506000

```

ACCONT3.SPECPU=02.00.2250=20.00.OTCCARDS=00.001.
STANDBY=15.00.CPUREGN=00.00361.WAITREGN=00.00361.WAITCHRG=00.03194
*
*****      STANDARDS
*
STANDARDS.FORMS=STANDARD.CARRIAGE=STANDARD.TRAIN=PN.LINES=(1.DUMP).
HBAR=ON.TBAR=61.RBAR=2050.RTBAR=220000.
CARDS=(2.DUMP).PRTY=09.FLOCATE=NO.DLOCATE=YES.CONSBUF=20.SQS=6K.
FAILURE=CANCEL.NOPU=A.CLASS=J.FETCH=ALL.MLOG=NO
SYSOUT.
COPIES=0.
CLASS=A
SYSOUT.CLASS=B.TYPE=PUNCH
SYSOUT.CLASS=C
*
*****
*****      END ASP INITIALIZATION DECK      *****
*****
*
ENDINISH
IPL.NAME=SV1.TYPE=MVT
S=S MT.REGION=36K
IPL.END

```

```

X00507000
00508000
00509000
00510000
00511000
#00512000
#00513000
#00514000
X
X
00517000
00518000
00519000
00601000
00602000
00603000
00604000
00605000
00606000

```

APPENDIX B

AMDAHL Benchmark Log

AMDAHL Benchmark LogThursday, September 4, 1975

9:40 Shown machine. IPL showed need for reconfiguration.

10:45 Still configuring. They agreed to provide a Testdata tape for our later use.

I/O errors in NOVA disk. Dropped back to an older system.

ITEL controller is out. ITEL was notified before we arrived.

Problems finding manuals -
Messages and Codes
OS Utilities
ASP Manuals

11:10 Bringing up AMDAHL system to DASDI the drum. Drum has invalid VOLID. Hardware problem reported to be fixed.

11:20 Unsuccessful in cleaning up packs and drum. Hampered due to lack of OS Utilities Manual. Bringing disks would have saved time.

11:35 Drum is down.

Software support brought in.

12:05 Go to lunch.

ITEL work interfered with IPL.

2:15 We have the machine.

2:50 ASRLIB incorrectly cataloged.

3:05 We are up.

3:15 Lost interrupt restoring Pack 14.

3:30 Interface control check.

3:40 Blamed on ITEL controller. Disabled one controller.

3:45 Found someone moving packs.

4:05 JCL error (lost 15 minutes).

4:10 ASP is up.

No ASP manuals. They said they had them.

4:15 Started STREAM #1. SCR001 was on wrong drive.

4:30 Started STREAM #1 again.

5:15 Finished.

Friday, September 5, 1975

9:05 Mounted packs and tapes.
ITEL controller reported fixed but has not been tested.
One bank of 3330's were switched to another machine.

9:40 Lost ITEL controller. IPL without it.

10:00 Up and running.

10:15 Consoles switched - maybe interrupt on 810?

10:25 Restart.

1:15 Mount packs.

1:40 Console switch - press interrupt and it switched back OK.

2:05 Console switch again.

2:28 Channel problem - blew system. Broken toggle on CE channel configurator.

3:00 We got machine back. Toggle fixed.

3:15 Main store bit error (old memory).

3:30 We got it back.

4:10 Completed user jobs.
Started second run of STREAM #1.

5:30 Completed second run of STREAM #1. Started NRL jobs and last of user jobs.

6:20 Started STREAM #2.

6:45 Lost CRT but 470 kept running.
Reloaded NOVA and lost nothing.

7:10 Done.

APPENDIX C

Description of Current User Jobs
Included in the Benchmark

BIGREBUS/REBUSTST

REBUS is a nuclear reactor fuel cycle management code dominated by a two-dimensional diffusion theory neutronics model. The program is coded primarily in FORTRAN H (OPT=2) with some small assembler language subroutines included for utility functions or performance. The rate determining steps in the code are small loops dominated by double precision floating point multiplication and addition. On the 370/195, this program takes advantage of "loop mode," fast double precision floating point arithmetic, and some overlap of independent floating point operations.

For further information see FRA-TM-62.

BISONINT

BISON (ANL7271) is a quantum chemical system for the computation of wave-functions, energies, properties, and charge densities of atoms and diatomic molecules using the Hartree Fock self-consistent field method. The time consuming parts of BISON rest in the calculation of numerous integrals by numerical quadrature. These computations are dominated by small loops in which the integrals are assembled as scalar products of pairs of double precision floating point vectors. BISON benefits from the "loop mode" feature of the 370/195 as well as the fast floating point hardware and the high speed buffer storage.

The benchmark problem is an integrals only calculation for HgH at 3.0 bohrs with a 30 X 30 Gaussian grid and a 10 term 50 point Simpson integration. The basis set was 17 X 10 X 5 on Hg and 3 X 5 on H.

DIF1DADJ,DIF1DMOD,DIF1DRL

DIF1D (ANL-7715) is a one-dimensional diffusion theory neutronics model for nuclear reactor design studies. The program is dominated by small loops containing predominantly double precision floating point arithmetic. On the 370/195 this program spends much time in "loop mode" and benefits from the fast floating point hardware.

FX2DEMO

FX2 is a program for the study of abnormal transient conditions in fast reactors, including accidents involving reactor material motion and disassembly. The model includes a two-dimensional diffusion theory neutronics calculation and a two-dimensional hydrodynamics model to treat material motion. The program makes heavy use of double precision floating point arithmetic and includes some small subroutines written in assembler code for performance. On the 370/195 this problem benefits from the fast floating point arithmetic and "loop mode."

NATLAN

NATLAN is a FORTRAN program for the calculation of pressure transients in hydraulic networks using the "method of characteristics." The calculation is dominated by single precision floating point arithmetic and address calculation for triply dimensioned arrays. This program benefits from the overlap of floating point arithmetic on the 370/195.

OVCBENCH

OVC (ANL-7955) is a quantum chemical computing system for the calculation of multi-configuration self-consistent field wave functions, energies, and properties for atoms, diatomic molecules, and polyatomic molecules. In addition, the program is capable of generating the necessary molecular integrals when Gaussian type expansion basis sets are used. The time consuming paths in the program are the integral generation, which involves much sub-routine linkage, indexing, addressing, and floating point arithmetic, and the MCSCF iterations which are dominated by scalar products of double precision floating point vectors.

The benchmark problem is a Gaussian integral and MCSCF calculation for N_2^+ with a 4S3p basis on the atoms and 15 configurations and 15 iterations in the MCSCF. On the 370/195, the scalar products (about one half of the CPU time) benefit from "loop mode," fast double precision floating point, overlap in the floating point unit, and the high speed buffer storage.

SASBENCH

The SAS (ANL-8138) code is an LMFBR accident analysis code that calculates the consequences of a fast reactor accident from the preaccident stage up to the point of large scale fuel motion or disassembly. The program uses double precision floating point arithmetic. However, the large numbers of variable names, arrays, and large common blocks coupled with the use of the FORTRAN G compiler insures a large proportion of fixed point instructions in indexing and addressing functions.

APPENDIX D

Description of Tuned Job Kernels Included
in the Benchmark

BITSET

BITSET includes two assembly language subroutines--BITON and BITON1--which allow a FORTRAN program to manipulate individual bits. These routines contain only fixed point, logical, and shifting operations, and represent two versions in a series of tuned codes for this purpose. Both have been tuned for the 370/195 in the sense that sequences of dependent operations and interlocks on register availability for address generation have been avoided. The tuning performed on these routines should provide for high performance on pipelined models of the 360/370 series.

The benchmark problem invokes BITON and BITON1 repeatedly from a FORTRAN driver routine using the FORTRAN CALL statement and includes the linkage overhead associated with that statement.

54
BITON

CSECT
USING *,15
ST 2,28(0,13)
L 2,0(0,1)
L 1,4(0,1)
L 0,0(0,1)
S 0,ONE

*

SRDL 0,3
SRL 1,29
AR 2,0
A 1,=A(MASK)
OC 0(1,2),0(1)
L 2,28(0,13)
BR 14
DS 0D

ONE
MASK

DC F'1'
DC X'8040201008040201'
END

SET BASE REGISTER.
SAVE REGISTER TWO IN CALLERS SAVEAREA.
LOAD STARTING ADDRESS OF BIT STRING.
LOAD ADDRESS OF BIT OFFSET IN STRING.
LOAD VALUE OF BIT OFFSET IN REG0.
DECREMENT OFFSET BY 1 TO GET OFFSET
RELATIVE TO ZERO ORIGIN.
GET BYTE OFFSET WITHIN STRING. SHIFT
BIT OFFSET WITHIN BYTE INTO REGISTER 1.
GET ADDRESS OF BYTE TO BE MODIFIED.
OBTAIN ADDRESS OF MASK TO TURN ON BIT.
TURN ON BIT UNDER 1 IN MASK.
RESTORE REGISTER TWO FOR RETURN.
RETURN TO CALLING PROGRAM.
ALLIGN CONSTANTS TO DOUBLEWORD BOUNDARY.

BITON1

CSECT
USING *,15
ST 2,28(0,13)
L 2,0(0,1)
L 1,4(0,1)
L 0,0(0,1)
L 1,SEVEN
S 0,ONE

*

NR 1,0
SRL 0,3
A 1,=A(MASK)
AR 2,0
OC 0(1,2),0(1)
L 2,28(0,13)
BR 14
DS 0D

ONE

DC F'1'
DS 0D

SEVEN

DC F'7'
DS 0D

MASK

DC X'8040201008040201'
END

SET BASE REGISTER.
SAVE REGISTER TWO IN CALLERS SAVEAREA.
LOAD STARTING ADDRESS OF BIT STRING.
LOAD ADDRESS OF BIT OFFSET IN STRING.
LOAD VALUE OF BIT OFFSET IN REG0.

DECREMENT OFFSET BY 1 TO GET OFFSET
RELATIVE TO ZERO ORIGIN.

OBTAIN ADDRESS OF MASK TO TURN ON BIT.
GET ADDRESS OF BYTE TO BE MODIFIED.
TURN ON BIT UNDER 1 IN MASK.
RESTORE REGISTER TWO FOR RETURN.
RETURN TO CALLING PROGRAM.
ALLIGN CONSTANTS TO DOUBLEWORD BOUNDARY.

DMATMUL/EMATMUL

DMATMUL and EMATMUL perform floating point matrix multiplication using five different algorithms and ten different matrix dimensions in double and single precision respectively. Varying in the number of explicit matrix indices coded and the number of terms computed within the innermost loop, the algorithms increase in floating point boundedness and in the degree of overlap of floating point operations as the number of matrix indices decreases and the number of terms in the inner loop increases. All of the algorithms execute with their inner loops in "loop mode" on the 370/195.

The algorithms, in order of increasing floating point boundedness and floating point overlap, are:

<u>ALGORITHM</u>	<u>INDICES</u>	<u>TERMS IN INNER LOOP</u>
CRITH	2	1
BRITH	1	1
ERITH	1	2
FRITH	1	2
DRITH	1	4

These algorithms were developed in the course of tuning the SYN3D reactor design and engineering code.

FORTLIBE/FORTLIBD

FORTLIBE and FORTLIBD invoke respectively single and double precision versions of the frequently executed FORTRAN library functions EXP, LOG, SIN, SQRT, and exponentiation of a floating point number to a floating point power. These routines are optimized for machines unlike the 370/195 and assume that floating point operations are slow, double precision is slower than single precision, normalized arithmetic is slower than unnormalized arithmetic, and no penalty attaches to mixing single and double precision instructions. As these assumptions are all invalid on the 195, these codes are far from optimal on that machine.

FORTLIBE/FORTLIBD were written to sample execution times of selected FORTRAN library functions.

FSQRT

FSQRT contains two FORTRAN coded double precision routines to compute an array of square roots from an array of arguments and initial guesses using two different four term Newton-Raphson algorithms. The subroutines are in "loop mode" on the 370/195 and make heavy use of floating point double precision arithmetic. There is substantial floating point overlap possible in one of the algorithms.

The square root algorithms were developed while tuning a liquid water molecular dynamics code of Dr. A. Rahman at Argonne.

```

SUBROUTINE FSQRT(ARG,ROOT,N)
IMPLICIT REAL*8 (A-H,O-Z)

```

```

C
C THIS SUBROUTINE COMPUTES AN ARRAY OF SQUARE ROOTS FROM AN ARRAY
C OF ARGUMENTS USING A FOUR TERM NEWTON RAPHSON ITERATION AND A
C STARTING GUESS SUPPLIED BY THE CALLER. THE STARTING GUESSES ARE
C PLACED IN ARRAY ROOT BEFORE THE CALL AND THE SQUARE ROOTS ARE
C RETURNED IN THE SAME ARRAY ROOT.
C

```

```

    DIMENSION ARG(1),ROOT(1)

```

```

C
DO 100 I = 1, N
RR = ARG (I)
R = .5 * (ROOT (I) + RR / ROOT (I) )
R = RR / R + R
RR = RR + RR
RR = RR + RR
R = RR / R + R
RR = RR + RR
RR = RR + RR
R = RR / R + R
ROOT (I) = .125 * R
100 CONTINUE
RETURN
END

```

```

SUBROUTINE HSQRT(ARG,ROOT,N)
IMPLICIT REAL*8 (A-H,O-Z)

```

```

C
C THIS SUBROUTINE COMPUTES AN ARRAY OF SQUARE ROOTS FROM AN ARRAY
C OF ARGUMENTS USING A FOUR TERM NEWTON RAPHSON ITERATION AND A
C STARTING GUESS SUPPLIED BY THE CALLER. THE STARTING GUESSES ARE
C PLACED IN ARRAY ROOT BEFORE THE CALL AND THE SQUARE ROOTS ARE
C RETURNED IN THE SAME ARRAY ROOT.
C

```

```

    DIMENSION ARG(1),ROOT(1)

```

```

C
DO 100 I = 1, N
RR = ARG (I)
R = .5 * (ROOT (I) + RR / ROOT (I) )
R = RR / R + R
R = .5 * R
R = RR / R + R
R = .5 * R
R = RR / R + R
ROOT (I) = .5 * R
100 CONTINUE
RETURN
END

```

MINVERT

MINVERT is a double precision FORTRAN matrix inversion problem (Gauss-Jordan reduction). The inversion subroutine is dominated by two small loops, one of which is floating point dominated and one of which is dominated by address calculation and branching. MINVERT benefits from "loop mode" on the 370/195 and the ability to overlap floating point operations.

MINVERT was written for use in the SYN3D and MC-2 reactor design and engineering codes.

MORETEST

MORE is an assembly language subroutine to perform a binary search of a large table of single precision floating point numbers. The only floating point operation in the subroutine is floating point compare. Optimization of this program for the 370/195 involved primarily keeping the loops small, separating register modification from register use in addressing, and separating condition code setting instructions from their associated branches.

MOREX

CSECT

COPY EQUATE

USING *,15

DS 0D

ST 3,32(13)

L 3,4(1)

ST 4,36(13)

L 4,8(1)

ST 5,40(13)

L 5,12(1)

L 0,=XL4'00FFFFFF8'

L 1,0(1)

S 1,=F'4'

L 3,0(3)

SLL 3,2

L 4,0(4)

SLL 4,2

LE 2,0(5)

LR 5,3

AR 5,4

NR 5,0

CE 2,0(1,3)

SRL 5,1

ST 6,44(13)

BC LT,INNER

LR 4,3

BC 15,RETURN

CNOP 0,8

OUTER

DS 0H

INNER

CE 2,0(1,5)

LR 6,5

BC LT,XLT

AR 5,3

NR 5,0

SRL 5,1

LR 4,6

BC 15,INNER

XLT

DS 0H

AR 5,4

NR 5,0

CR 6,3

SRL 5,1

LR 3,6

BC NE,OUTER

RETURN

LR 0,4

SRL 0,2

RETURN (3,6)

END

PROVIDE DOUBLEWORD ALIGNMENT FOR LOOP MODE
TARGET FOR 'QUICK' LOOP.

APPENDIX E

Description of Naval Research Laboratory
Benchmark Kernels

NRLICH01

NRLICH01 invokes repeatedly a finite Fast Fourier Transform of length 64. The kernel uses single precision floating point and contains several short loops which will fit in "loop mode" on the 370/195. The loops are slowed on the 195 by the existence of addressing interlocks.

This benchmark kernel (minus the driver which invokes it) is reproduced on the next page.


```
C      OUTR(KPNG) = CR(K) - STOUTR(K)  
124     OUTI(KPNG) = CI(K) - STOUTI(K)  
        DO 121 K = 1, 2  
  
C                                         GN ,1 = K 121 OD  
121    OUTR(K) = CR(K) + STOUTR(K)  
       OUTI(K) = CI(K) + STOUTI(K)  
C     KERNEL * * * * *  
C                                     * * * * *END  
  
       RETURN  
  
       END
```

NRLICH02

NRLICH02 invokes a "particle pushing algorithm" and contains a mix of single precision floating point addition, fixed point addressing instructions, and float-to-fixed mode conversion. Some pipelining of floating point addition will be achieved on the 370/195, but overall performance will suffer from the large number of addressing interlocks in the kernel loop.

This kernel (minus its driver) is reproduced on the next page.

END

NRLICH04

NRLICH04 is a single precision floating point ordinary differential equation solver using a Runge-Kutta algorithm. The kernel contains many small loops which will execute in "loop mode" on the 370/195, and some overlap of floating point operations will occur.

The kernel (minus its driver) is reproduced on the following page.

NRLICH05

NRLICH05 is a two-dimensional mode coupling problem in single precision floating point, using a Runge-Kutta integrator. The loops contain a high proportion of fixed point and branching instructions (logical IF) and suffer reduced performance on the 370/195 due to addressing interlocks.

The kernel (minus its driver) is reproduced on the following pages.

SUBROUTINE DERIV (Y, DY, N1, N2)

C
C

```

      KERNEL * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * STA
      REAL    Y(10), DY(10)
      REAL    T(10,10), DYMAX(10), DYMIN(10)
      COMMON  T, DYMAX, DYMIN

```

C
C

CALCULATE THE DERIVATIVES FOR THE RUNGE-KUTTA INTEGRATOR.

```

      DO 1 I = N1, N2
        DY(I) = 0.0
        DO 1 J = N1, N2
          DY(I) = DY(I) + T(I,J)*Y(J)
        DO 2 I = N1, N2
          DY(I) = AMIN1(DY(I), DYMAX(I))
        DO 3 I = N1,N2
          DY(I) = AMAX1(DY(I), DYMIN(I))
        DO 4 I = N1,N2
          IF (Y(I) .GT. 2.0*DYMAX(I)) DY(I) = -ABS(DY(I))
          IF (Y(I) .LT. 2.0*DYMIN(I)) DY(I) = ABS(DY(I))
        KERNEL *****END
```

C
C

RETURN

END

```

SUBROUTINE RKGDEQ (DERIVY, Y, DY, Q, NEQFST, NEQLST, DX)

```

C
C

KERNEL * * * * *

```

      REAL Y(1000), DY(1000), Q(1000)
      REAL A(4), B(4), C(4)
      DATA A /0.5, 0.29289322, 1.7071068, 0.16666667/,
1         B /2.0, 1.0, 1.0, 2.0/,
2         C /0.5, 0.29289322, 1.7071068, 0.5/
      DO 1 J = 1, 4
      CALL DERIVY (Y, DY, NEQFST, NEQLST)
      DO 2 I = NEQFST, NEQLST
      T = A(J)*(DY(I) - B(J)*Q(I))
      Y(I) = Y(I) + DX*T
      Q(I) = Q(I) + 3.0*T - C(J)*DY(I)
2      CONTINUE
1      CONTINUE

```

C
C

KERNEL * * * * *END

RETURN

END

```

C
COMMON  * * * * *
COMMON
      INTEGER  NOI, NOJ, IMIN, IMAX, JMIN, JMAX
      REAL     VP(225,225)
      COMMON   NOI, NOJ, IMIN, IMAX, JMIN, JMAX, VP
COMMON
COMMON  * * * * *
C
C
C      KERNEL  * * * * * START
C
      REAL     D(2,250), DD(2,250)
      INTEGER  IPLIM(2,25), JPLIM(2,25)
      INTEGER  ICALL
      DATA    ICALL /0/
C
C      INITIALIZE ON THE FIRST CALL.
      ICALL = ICALL + 1
      IF (ICALL.EQ.1) GO TO 50
C
C      THE GAMMA TERMS ARE EVALUATED FIRST.
51      NOK = NEQLST/2
      DO 2 K = 1, NOK
      IF (ABS(D(1,K)) .LT. 1.0E-15) D(1,K) = 0.0
      IF (ABS(D(2,K)) .LT. 1.0E-15) D(2,K) = 0.0
      2  CONTINUE
C
C
C      THE LCOP OVER THE VP SUMS FOR THE K + K' TERMS.
      DO 11 I = 1, NOI
      IPMIN = IPLIM(1,I)
      IPMAX = IPLIM(2,I)
      DO 11 J = 1, NOJ
      JPMIN = JPLIM(1,J)
      JPMAX = JPLIM(2,J)
      K = I + NOI*(J-1)
      SUM1 = 0.0
      SUM2 = 0.0
      KPST = IPMIN - 1 - NOI
      KPKPST = K + KPST - 1 + (IMIN + NOI*JMIN)
C
C      THE INNER LOOPS BEGIN HERE.
      DO 12 JP = JPMIN, JPMAX
      KP = KPST + NOI*JP
      KPKP = KPKPST + NOI*JP
      DO 12 IP = IPMIN, IPMAX
      KP = KP + 1
      KPKP = KPKP + 1
C
C      THE TERMS ARE ACCUMULATED IN SUM. MISSING THE FACTOR OF I.
      SUM1 = SUM1 + VP(K,KP)*(D(1,KP)*D(1,KPKP)
1          + D(2,KP)*D(2,KPKP))
      12  SUM2 = SUM2 + VP(K,KP)*(D(1,KP)*D(2,KPKP)
1          - D(2,KP)*D(1,KPKP))
C
C      THE DERIVATIVES ARE UPDATED USING SUM. NOTE THE FACTOR OF I.
      DD(1,K) = - SUM2
      11  DD(2,K) = SUM1
C
C      THE VALUE OF THE DERIVATIVES ARE LIMITED.

```

[illegible]

NRLICH06

NRLICH06 is a hydrodynamics calculation using an FCT algorithm coded in single precision floating point. The kernel contains many small loops that will operate in "loop mode" on the 370/195 and achieve some overlap in the floating point unit.

The kernel (minus its driver) is reproduced on the following page.

NRLICH07

NRLICH07 is a floating point matrix and vector arithmetic exerciser. Single and double precision are used equally, but they are never mixed in the same expression. Most of the work is in "loop mode" on the 370/195, and much overlap of floating point multiply and add should be achieved.

The entire kernel (including driver) is reproduced in the following pages.

C
C
C
C

NRL BENCHMARK TEST 7(F)
JAY PAUL BORIS
WASHINGTON, D. C.

MATRICES AND VECTORS
NAVAL RESEARCH LAB CODE 7706
202 - 767 - 3142

```

      REAL      T(104,104), S(104,104), U(104,104), A(104), B(104),
1          C(104), RAND(208)
      DOUBLE PRECISION TD(104,104), SD(104,104), UD(104,104),
1          AD(104), BD(104), CD(104), FACTD, RANDD(208)
      INTEGER   IRAND(107)
1000  FORMAT (I6, F12.5)
1001  FORMAT ('NRL BENCHMARK TEST 7 - MATRICES AND VECTORS ',
1      /, 5X, 'NSTEP = ', I6, 5X, ' AND DATUM = ', F12.5, //)
1002  FORMAT (3X, 8D14.6)
1003  FORMAT ('OAT STEP ', I5, ' C AND CD ARE ')
1004  FORMAT (3X, 8E14.6)
1005  FORMAT (1X, /)
C     THE FIRST 107 RANDOM NUMBERS FROM THE A&S RANDOM DIGIT TABLES.
      DATA IRAND /53479,81115,98036,12217,59526,40238,40577,39351,
1          43211,69255,97344,70328,58116,91964,26240,44643,83287,
2          97391,92823,77578,66023,38277,74523,71118,84892,13956,
3          98899,92315,65783,59640,99776,75723,03172,43112,83086,
4          81982,14538,26162,24899,20551,30176,48979,92153,38416,
5          42436,26636,83903,44722,69210,69117,81874,83339,14988,
6          99937,13213,30177,47967,93793,86693,98854,19839,90630,
7          71836,95053,55532,60908,84108,55342,48479,63799,09337,
8          33435,53869,52769,18001,25820,96198,66518,78314,97013,
9          31151,58295,40823,41330,21093,93882,49192,44876,47185,
A          81425,67619,52515,03037,81699,17106,64982,60834,85319,
B          47814,08075,61946,48790,11602,83043,22257,11832,04344/
      RANDOM(I) = 1.0E-5*FLOAT(IRAND(I+1))

C
C     INITIALIZE THE PROGRAM. DATUM RESTRICTED TO THE RANGE 0.0 TO 1.0.
C     IF DATUM > .9, THE TWO SOLUTIONS, DOUBLE AND SINGLE, ARE THE SAME.
      READ (5, 1000) NSTEP, DATUM
      WRITE (6, 1001) NSTEP, DATUM
      II = 0
      IF (DATUM .GT. 0.90) II = 1
      III = II + 1
      DO 1 I = 1, 104
      A(I) = 1.0
      AD(I) = 1.0
      B(I) = 1.0
      BD(I) = 1.0
      IRANDX = MOD(2*I-1, 107)
      RAND(2*I-1) = RANDOM(IRANDX)
      IRANDX = MOD(2*I, 107)
      RAND(2*I) = RANDOM(IRANDX)
      RANDD(2*I-1) = RAND(2*I-1)
      RANDD(2*I) = RAND(2*I)
      DO 1 J = 1, 104
      IJ = I + 104*(J-1)
      IRANDX = MOD(IJ+II, 107)
      T(I,J) = RANDOM(IRANDX)
      IRANDX = MOD(IJ+1, 107)
      TD(I,J) = RANDOM(IRANDX)
      IRANDX = MOD(IJ+III, 107)
      S(I,J) = -0.5*(RANDOM(IRANDX) + DATUM)
      IRANDX = MOD(IJ+2, 107)
1      SD(I,J) = -0.5*(RANDOM(IRANDX) + DATUM)

C
C
C     THE LOOP OVER STEPS IS BEGIN.
      DO 100 ISTEP = 1, NSTEP

```

```
C      KERNEL * * * * * START
          DO 9 I = 1, 104
            C(I) = 1.0
C      9    CD(I) = 1.0

          DO 10 I = 10, 95
            J1 = I - 9
            J2 = I + 9
            DO 10 J = J1, J2
C      10    A(I) = A(I) - T(I,J)*S(J,I)

          DO 11 I = 10, 95
            J1 = I - 9
            J2 = I + 9
            DO 11 J = J1, J2
C      11    AD(I) = AD(I) - TD(I,J)*SD(J,I)

          IC = MOD(ISTEP-1,82) + 10
          I1 = IC - 9
          I2 = IC + 9
          DO 20 I = I1, I2
            DO 20 J = 10, 95
C      20    B(I) = B(I) + T(J,I) - S(I,J)

          DO 21 I = I1, I2
            DO 21 J = 10, 95
C      21    BD(I) = BD(I) + TD(J,I) - SD(I,J)

          FACT = 1.0E+0/173.0E+0
          FACTD = 1.0D+0/173.0D+0
          DO 22 I = 1, 104
            A(I) = 0.05E+0*A(I)
            AD(I) = 0.05D+0*AD(I)
            B(I) = FACT*B(I)
C      22    BD(I) = FACTD*BD(I)

          II = MOD(ISTEP,104) + 1
          DO 23 I = 1, 104
            A(I) = 0.5*(A(I) + RAND(I+II))
            B(I) = 0.5*(B(I) + RAND(I+II))
            AD(I) = 0.5*(AD(I) + RAND(I+II))
C      23    BD(I) = 0.5*(BD(I) + RAND(I+II))

          DO 24 I = 1, 104
            DO 24 J = 1, 104
C      24    U(J,I) = A(I) + B(J)

          DO 25 I = 1, 104
            DO 25 J = 1, 104
C      25    UD(J,I) = AD(I) + BD(J)

          DO 30 I = 1, 104
            DO 30 J = 1, I
C      30    C(J) = C(J) + U(J,I)/C(J)

          DO 31 I = 1, 104
            DO 31 J = 1, I
C      31    CD(J) = CD(J) + UD(J,I)/CD(J)
```



```

DO 50 I = 1, 104
DO 50 J = 1, 104
T(I,J) = AD(I)*BD(J)
TD(I,J) = AD(I)*BD(J)
S(J,I) = -0.5*(A(J) + B(I))
50 SD(J,I) = -0.5*(AD(J) + BD(I))
C  KERNEL ***** END
C
C  DIAGNOSTICS ARE PRINTED.
    IF (ISTEP.GT.4 .AND. ISTEP.NE.NSTEP) GO TO 100
    WRITE (6, 1003) ISTEP
    WRITE (6, 1004) (C(I), I = 1, 80)
    WRITE (6, 1005)
    WRITE (6, 1002) (CD(I), I = 1, 80)
C
C 100  CONTINUE
C
      STOP
      END

```

APPENDIX F

Detailed Results For All Benchmark Job Groups

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

JOBNAME	JOB	CPU	WAIT	JOB	CPU	WAIT	CPU	WAIT
BMKJS01A	4	1.82	38.82	4	2.16	33.79	0.841	1.149
BMKJS02A	3	2.51	32.92	3	3.16	28.19	0.792	1.168
BMKJS03A	1	8.57	19.95	1	8.29	18.91	1.034	1.055
BMKJS03B	1	5.09	6.85	1	4.99	9.45	1.020	0.725
BMKJS04A	2	87.68	21.12	2	89.66	21.22	0.978	0.995
BMKJS05A	1	68.88	23.02	1	39.41	11.59	1.748	1.986
BMKJS06A	1	3.98	15.31	1	4.76	11.59	0.836	1.321
BMKJS06B	1	3.66	19.10	1	3.80	18.27	0.963	1.045
BMKJS07A	3	0.88	13.77	3	1.07	9.66	0.825	1.426
BMKJS07B	1	1.06	19.85	1	1.18	15.25	0.898	1.302
BMKJS08A	1	1.29	8.92	1	1.53	8.09	0.843	1.103
BMKJS08B	1	1.24	20.27	1	1.57	7.88	0.790	2.572
BMKJS09A	1	14.43	214.56	1	13.10	520.09	1.102	0.413
BMKJS09B	1	10.24	151.98	1	10.59	452.48	0.967	0.336
BMKJS10A	2	0.75	8.05	2	0.95	7.28	0.785	1.106
BMKJS10B	2	0.71	7.70	2	0.90	9.01	0.789	0.855
BMKJS11A	1	11.01	16.74	1	11.78	11.59	0.935	1.444
BMKJS11B	1	9.27	9.87	1	9.21	15.73	1.007	0.627
BMKJS12A	1	25.90	71.59	1	28.23	76.68	0.917	0.934
BMKJS13A	1	3.85	31.81	1	4.24	56.85	0.908	0.560
BMKJS13B	1	3.14	26.94	1	3.67	36.35	0.856	0.741
BMKJS14A	1	164.91	64.07	1	106.83	35.20	1.544	1.820
BMKJS15A	1	13.20	23.37	1	16.65	24.98	0.793	0.936
BMKJS15B	1	6.54	30.63	1	7.62	38.95	0.858	0.786
BMKJS16A	1	12.45	28.09	1	14.24	22.50	0.874	1.248
BMKJS17A	1	26.26	58.23	1	31.21	35.29	0.841	1.650
BMKJS18A	1	101.61	17.53	1	42.95	11.04	2.366	1.588
BMKJS19A	1	128.41	76.25	1	130.91	69.89	0.981	1.091
BMKJS19B	1	89.77	54.55	1	88.77	41.08	1.011	1.328
BMKJS20A	1	4.07	16.20	1	5.06	13.56	0.804	1.195
BMKJS21A	3	2.80	58.83	3	3.10	65.25	0.904	0.902
BMKJS21B	7	0.20	4.43	7	0.22	5.69	0.914	0.779
BMKJS22A	1	24.75	87.56	1	32.39	107.27	0.764	0.816
BMKJS23A	1	1.09	5.59	1	1.27	7.49	0.858	0.746
BMKJS23B	1	1.22	9.91	1	1.39	10.30	0.878	0.962
BMKJS24A	1	123.36	187.04	1	146.90	149.85	0.840	1.248
BMKJS24B	1	4.90	23.55	1	5.63	19.40	0.870	1.214
COMPMOVE	1	0.43	20.63	1	0.52	13.46	0.827	1.533
COPY1	1	1.30	118.99	1	1.34	119.00	0.970	1.000
COPY2	1	0.10	2.37	1	0.10	2.80	1.000	0.846
GENER1	5	0.23	19.44	5	0.23	26.68	1.027	0.729
GENER2	7	0.11	3.87	7	0.12	8.10	0.885	0.478
GENUPDTE	3	0.45	5.58	3	0.46	4.68	0.971	1.193
LIST1	3	0.24	5.43	3	0.22	4.07	1.076	1.334
LIST2	3	0.20	5.61	3	0.20	5.55	1.034	1.010
LIST3	2	0.59	21.58	2	0.53	19.67	1.103	1.097

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = ASM									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

BMKJS13A	2	0.65	9.15	2	0.70	23.00	0.929	0.398	
BMKJS13B	2	0.62	9.54	2	0.71	13.74	0.873	0.694	
BMKJS19A	2	0.64	13.12	2	0.75	14.95	0.860	0.877	
BMKJS21A	39	0.22	4.53	39	0.24	5.02	0.904	0.902	
BMKJS21B	7	0.20	4.43	7	0.22	5.69	0.914	0.779	

TOTAL	52	13.62	271.14	52	15.13	339.00	0.900	0.800	
MEAN	5	0.47	8.15	5	0.52	12.48	0.896	0.730	

STEP = EDT									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
BMKJS01A	8	0.34	13.74	8	0.41	11.29	0.819	1.217	
BMKJS02A	3	0.51	16.58	3	0.67	14.99	0.760	1.106	
BMKJS03A	2	0.17	7.07	2	0.21	6.85	0.833	1.033	
BMKJS04A	4	0.18	7.22	4	0.22	6.80	0.778	1.061	
BMKJS05A	1	0.16	5.22	1	0.20	3.16	0.800	1.652	
BMKJS06A	1	0.23	11.51	1	0.27	6.91	0.852	1.666	
BMKJS07A	3	0.18	6.49	3	0.19	4.37	0.947	1.485	
BMKJS09A	1	0.17	5.48	1	0.20	3.73	0.850	1.469	
BMKJS10A	2	0.12	3.20	2	0.15	2.97	0.742	1.077	
BMKJS11A	1	0.18	10.77	1	0.22	7.23	0.818	1.490	
BMKJS12A	1	0.55	11.97	1	0.58	12.63	0.948	0.948	
BMKJS13A	1	0.25	5.13	1	0.24	6.65	1.042	0.771	
BMKJS14A	1	0.40	15.58	1	0.43	9.56	0.930	1.630	
BMKJS15A	1	0.42	16.05	1	0.49	12.65	0.857	1.269	
BMKJS15B	1	0.49	11.80	1	0.52	23.30	0.942	0.506	
BMKJS16A	1	0.22	4.98	1	0.25	6.92	0.880	0.720	
BMKJS17A	1	0.55	15.20	1	0.49	11.06	1.122	1.374	
BMKJS18A	1	0.17	6.42	1	0.19	4.02	0.895	1.597	
BMKJS19A	1	0.41	11.50	1	0.55	12.11	0.745	0.950	
BMKJS19B	1	0.50	15.29	1	0.64	16.52	0.781	0.926	
BMKJS20A	1	0.29	6.72	1	0.37	5.46	0.784	1.231	
TOTAL	37	11.05	382.16	37	13.16	337.13	0.840	1.134	
MEAN	21	0.31	9.90	21	0.36	9.01	0.863	1.199	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

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AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = FTG									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

BMKJS02A	3	0.30	2.10	3	0.37	2.12	0.811	0.994	
BMKJS03A	1	1.39	2.63	1	1.84	2.11	0.755	1.246	
BMKJS03B	1	1.35	1.87	1	1.81	3.38	0.746	0.553	
BMKJS04A	2	1.14	1.59	2	1.49	2.55	0.766	0.625	
BMKJS06A	1	2.69	1.56	1	3.38	2.19	0.796	0.712	
BMKJS07A	3	0.47	1.92	3	0.60	1.53	0.778	1.255	
BMKJS10A	2	0.46	1.31	2	0.63	1.24	0.736	1.060	
BMKJS10B	2	0.46	1.55	2	0.61	2.10	0.756	0.740	
BMKJS11A	1	2.59	2.82	1	3.31	2.10	0.782	1.343	
BMKJS15A	1	11.16	4.52	1	14.43	7.13	0.773	0.634	

TOTAL	17	25.62	34.39	17	33.15	39.62	0.773	0.868	
MEAN	10	2.20	2.19	10	2.85	2.64	0.770	0.916	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM	
STEP = FTH								

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT

BMKJS05A	1	2.45	11.15	1	3.13	5.76	0.783	1.936
BMKJS06B	1	0.88	3.17	1	1.07	2.70	0.822	1.174
BMKJS07B	1	0.54	7.17	1	0.64	4.99	0.844	1.437
BMKJS08A	1	0.38	5.31	1	0.43	1.72	0.884	3.087
BMKJS08B	1	0.34	2.32	1	0.44	3.04	0.773	0.763
BMKJS09A	1	0.69	1.40	1	0.84	2.95	0.821	0.475
BMKJS09B	1	0.72	4.68	1	0.83	2.66	0.867	1.759
BMKJS11B	1	1.48	2.35	1	1.75	4.74	0.846	0.496
BMKJS12A	1	23.10	56.93	1	27.34	61.92	0.845	0.919
BMKJS13A	1	0.85	3.43	1	0.98	1.96	0.867	1.750
BMKJS13B	1	0.81	2.26	1	0.95	1.73	0.853	1.306
BMKJS14A	1	10.98	43.53	1	13.43	22.57	0.818	1.929
BMKJS15B	1	6.03	18.73	1	7.07	15.55	0.853	1.205
BMKJS16A	1	6.60	16.25	1	8.01	12.00	0.824	1.354
BMKJS17A	1	19.63	41.02	1	23.61	21.59	0.831	1.900
BMKJS18A	1	2.01	4.89	1	2.38	5.13	0.845	0.953
BMKJS19A	1	5.34	32.76	1	6.18	22.56	0.864	1.452
BMKJS19B	1	4.95	30.14	1	5.93	19.54	0.835	1.542
BMKJS20A	1	3.67	8.24	1	4.55	6.84	0.807	1.205
BMKJS23A	1	0.90	1.92	1	1.05	3.32	0.857	0.578
BMKJS23B	1	0.93	3.94	1	1.06	2.64	0.877	1.492
BMKJS24A	1	1.66	6.83	1	1.96	4.77	0.847	1.432
BMKJS24B	1	1.63	11.54	1	1.91	4.73	0.853	2.440

TOTAL	23	96.57	319.96	23	115.54	235.41	0.836	1.359
MEAN	23	4.20	13.91	23	5.02	10.24	0.840	1.417

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

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AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = GO									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

BMKJS01A	12	0.07	1.18	12	0.08	1.18	0.888	1.001	
BMKJS02A	9	0.11	2.34	9	0.12	1.92	0.891	1.214	
BMKJS03A	4	1.71	0.79	4	1.51	0.78	1.133	1.023	
BMKJS04A	6	28.73	1.69	6	29.24	1.69	0.983	1.003	
BMKJS05A	3	22.09	2.22	3	12.03	0.89	1.837	2.491	
BMKJS06A	3	0.35	0.75	3	0.37	0.83	0.955	0.900	
BMKJS07A	12	0.06	1.34	12	0.07	0.94	0.843	1.426	
BMKJS09A	3	4.52	69.23	3	4.02	171.14	1.125	0.405	
BMKJS10A	6	0.06	1.18	6	0.06	1.02	1.000	1.151	
BMKJS11A	3	2.75	1.05	3	2.75	0.75	0.999	1.394	
BMKJS12A	2	1.12	1.34	2	0.15	1.06	7.258	1.263	
BMKJS13A	3	0.48	1.65	3	0.54	0.74	0.894	2.220	
BMKJS14A	2	76.76	2.48	2	46.48	1.53	1.651	1.616	
BMKJS15A	3	0.54	0.93	3	0.58	1.73	0.936	0.538	
BMKJS15B	1	0.02	0.10	1	0.03	0.10	0.667	1.000	
BMKJS16A	4	1.41	1.71	4	1.49	0.89	0.941	1.916	
BMKJS17A	2	3.04	1.00	2	3.55	1.32	0.855	0.761	
BMKJS18A	3	33.14	2.07	3	13.46	0.63	2.462	3.291	
BMKJS19A	3	40.46	1.92	3	40.89	1.77	0.989	1.083	
BMKJS19B	2	42.16	4.56	2	41.10	2.51	1.026	1.817	
BMKJS20A	3	0.04	0.41	3	0.05	0.42	0.786	0.984	

TOTAL	89	747.05	338.08	89	597.36	615.37	1.251	0.549	
MEAN	21	12.36	4.76	21	9.46	9.23	1.387	1.357	

STEP = IEBCOMPR

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
COMPMOVE	1	0.07	2.25	1	0.08	1.41	0.875	1.596	
TOTAL	1	0.07	2.25	1	0.08	1.41	0.875	1.596	
MEAN	1	0.07	2.25	1	0.08	1.41	0.875	1.596	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

STEP = IEBCOPY

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
COPY1	1	1.30	118.99	1	1.34	119.00	0.970	1.000
COPY2	1	0.10	2.37	1	0.10	2.80	1.000	0.846
TOTAL	2	1.40	121.36	2	1.44	121.80	0.972	0.996
MEAN	2	0.70	60.68	2	0.72	60.90	0.985	0.923

STEP = IEBGENER

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
GENER1	5	0.23	19.44	5	0.23	26.68	1.027	0.729
GENER2	7	0.11	3.87	7	0.12	8.10	0.885	0.478
TOTAL	12	1.93	124.31	12	2.00	190.13	0.965	0.654
MEAN	2	0.17	11.66	2	0.18	17.39	0.956	0.603

STEP = IEBPTPCH

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
PTPCH1	1	0.20	1.52	1	0.18	1.39	1.111	1.094
PTPCH2	2	0.14	3.46	2	0.13	2.10	1.115	1.646
TOTAL	3	0.49	8.45	3	0.44	5.60	1.114	1.509
MEAN	2	0.17	2.49	2	0.15	1.75	1.113	1.370

STEP = IEBUPDAT

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
UPDAT1	3	0.18	2.88	3	0.19	2.59	0.947	1.112
UPDAT2	1	0.20	5.40	1	0.19	9.09	1.053	0.594
TOTAL	4	0.74	14.03	4	0.76	16.85	0.974	0.833
MEAN	2	0.19	4.14	2	0.19	5.84	1.000	0.853

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

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AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = IEBUPDTE									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

GENUPDTE	3	0.38	4.57	3	0.39	3.52	0.966	1.300	
UPDTE1	1	0.08	4.31	1	0.11	2.76	0.727	1.562	
UPDTE2	2	0.09	3.12	2	0.13	3.18	0.760	0.983	
UPDTE3	1	0.04	0.21	1	0.04	0.99	1.000	0.212	
UPDTE4	1	0.35	3.00	1	0.34	1.30	1.029	2.308	
UPDTE5	1	0.09	6.30	1	0.13	2.25	0.692	2.800	
UPDTE6	2	0.18	1.96	2	0.18	1.93	1.029	1.018	

TOTAL	11	2.24	37.70	11	2.39	28.05	0.937	1.344	
MEAN	7	0.17	3.35	7	0.19	2.27	0.886	1.455	

STEP = IEHLIST									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
LIST1	3	0.24	5.43	3	0.22	4.07	1.076	1.334	
LIST2	3	0.20	5.61	3	0.20	5.55	1.034	1.010	
LIST3	2	0.59	21.58	2	0.53	19.67	1.103	1.097	
LIST4	3	0.11	6.68	3	0.14	4.73	0.786	1.412	
LIST5	2	0.31	26.31	2	0.36	19.81	0.863	1.328	
TOTAL	13	3.46	148.93	13	3.47	122.03	0.997	1.220	
MEAN	5	0.29	13.12	5	0.29	10.77	0.972	1.236	

STEP = IEHMOVE									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
COMPMOVE	1	0.36	18.38	1	0.44	12.05	0.818	1.525	
MOVE1	3	0.32	13.28	3	0.33	4.52	0.960	2.935	
UTILITY1	1	0.31	11.49	1	0.37	7.57	0.838	1.518	
TOTAL	5	1.62	69.70	5	1.80	33.19	0.900	2.100	
MEAN	3	0.33	14.38	3	0.38	8.05	0.872	1.993	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = IEHPRGM									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

GENUPDTE	3	0.07	1.01	3	0.07	1.16	1.000	0.868	
UTILITY1	4	0.07	1.23	4	0.08	0.92	0.871	1.335	

TOTAL	7	0.48	7.97	7	0.52	7.19	0.923	1.108	
MEAN	2	0.07	1.12	2	0.07	1.04	0.935	1.102	

STEP = LOAD&GO									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

BMKJS03B	2	1.87	2.49	2	1.59	3.03	1.176	0.820	
BMKJS06B	3	0.93	5.31	3	0.91	5.19	1.018	1.023	
BMKJS07B	3	0.17	4.23	3	0.18	3.42	0.963	1.236	
BMKJS08A	2	0.45	1.80	2	0.55	3.18	0.827	0.567	
BMKJS08B	2	0.45	8.97	2	0.56	2.42	0.796	3.709	
BMKJS09B	2	4.76	73.65	2	4.88	224.91	0.975	0.327	
BMKJS10B	4	0.12	3.07	4	0.14	3.45	0.860	0.889	
BMKJS11B	3	2.60	2.51	3	2.49	3.66	1.044	0.684	
BMKJS13B	2	0.54	2.80	2	0.65	3.56	0.838	0.785	
BMKJS22A	2	7.46	30.70	2	9.59	35.02	0.777	0.877	
BMKJS23A	2	0.09	1.84	2	0.11	2.09	0.864	0.880	
BMKJS23B	3	0.10	1.99	3	0.11	2.55	0.879	0.779	
BMKJS24A	2	60.85	90.10	2	72.47	72.54	0.840	1.242	
BMKJS24B	2	1.63	6.01	2	1.86	7.34	0.879	0.819	

TOTAL	34	168.11	491.13	34	196.17	766.50	0.857	0.641	
MEAN	14	5.86	16.82	14	6.86	26.60	0.910	1.046	

STEP = PL1									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

BMKJS01A	4	0.92	7.80	4	1.08	7.69	0.848	1.015	
BMKJS02A	3	1.37	7.23	3	1.76	5.31	0.780	1.361	
BMKJS22A	1	9.83	26.15	1	13.20	37.22	0.745	0.703	

TOTAL	8	17.63	79.07	8	22.82	83.92	0.773	0.942	
MEAN	3	4.04	13.73	3	5.35	16.74	0.791	1.026	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

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AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = IEBUTIL									
-----				*-----*			*-----*		
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
-----				*-----*			*-----*		
COMPMOVE	1	0.07	2.25	1	0.08	1.41	0.875	1.596	
COPY1	1	1.30	118.99	1	1.34	119.00	0.970	1.000	
COPY2	1	0.10	2.37	1	0.10	2.80	1.000	0.846	
GENER1	5	0.23	19.44	5	0.23	26.68	1.027	0.729	
GENER2	7	0.11	3.87	7	0.12	8.10	0.885	0.478	
GENUPDTE	3	0.38	4.57	3	0.39	3.52	0.966	1.300	
PTPCH1	1	0.20	1.52	1	0.18	1.39	1.111	1.094	
PTPCH2	2	0.14	3.46	2	0.13	2.10	1.115	1.646	
UPDAT1	3	0.18	2.88	3	0.19	2.59	0.947	1.112	
UPDAT2	1	0.20	5.40	1	0.19	9.09	1.053	0.594	
UPDTE1	1	0.08	4.31	1	0.11	2.76	0.727	1.562	
UPDTE2	2	0.09	3.12	2	0.13	3.18	0.760	0.983	
UPDTE3	1	0.04	0.21	1	0.04	0.99	1.000	0.212	
UPDTE4	1	0.35	3.00	1	0.34	1.30	1.029	2.308	
UPDTE5	1	0.09	6.30	1	0.13	2.25	0.692	2.800	
UPDTE6	2	0.18	1.96	2	0.18	1.93	1.029	1.018	
-----				*-----*			*-----*		
TOTAL	33	6.87	308.10	33	7.11	363.84	0.966	0.847	
MEAN	16	0.23	11.48	16	0.24	11.82	0.949	1.205	
-----				*-----*			*-----*		

STEP = IEHUTIL									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
COMPMOVE	1	0.36	18.38	1	0.44	12.05	0.818	1.525	
GENUPDTE	3	0.07	1.01	3	0.07	1.16	1.000	0.868	
LIST1	3	0.24	5.43	3	0.22	4.07	1.076	1.334	
LIST2	3	0.20	5.61	3	0.20	5.55	1.034	1.010	
LIST3	2	0.59	21.58	2	0.53	19.67	1.103	1.097	
LIST4	3	0.11	6.68	3	0.14	4.73	0.786	1.412	
LIST5	2	0.31	26.31	2	0.36	19.81	0.863	1.328	
MOVE1	3	0.32	13.28	3	0.33	4.52	0.960	2.935	
UTILITY1	5	0.12	3.29	5	0.14	2.25	0.853	1.458	
TOTAL	25	5.56	226.60	25	5.79	162.41	0.960	1.395	
MEAN	9	0.26	11.28	9	0.27	8.20	0.944	1.441	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = UTILITY									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

COMPMOVE	2	0.21	10.31	2	0.26	6.73	0.827	1.533	
COPY1	1	1.30	118.99	1	1.34	119.00	0.970	1.000	
COPY2	1	0.10	2.37	1	0.10	2.80	1.000	0.846	
GENER1	5	0.23	19.44	5	0.23	26.68	1.027	0.729	
GENER2	7	0.11	3.87	7	0.12	8.10	0.885	0.478	
GENUPDTE	6	0.22	2.79	6	0.23	2.34	0.971	1.193	
LIST1	3	0.24	5.43	3	0.22	4.07	1.076	1.334	
LIST2	3	0.20	5.61	3	0.20	5.55	1.034	1.010	
LIST3	2	0.59	21.58	2	0.53	19.67	1.103	1.097	
LIST4	3	0.11	6.68	3	0.14	4.73	0.786	1.412	
LIST5	2	0.31	26.31	2	0.36	19.81	0.863	1.328	
MOVE1	3	0.32	13.28	3	0.33	4.52	0.960	2.935	
PTPCH1	1	0.20	1.52	1	0.18	1.39	1.111	1.094	
PTPCH2	2	0.14	3.46	2	0.13	2.10	1.115	1.646	
UPDAT1	3	0.18	2.88	3	0.19	2.59	0.947	1.112	
UPDAT2	1	0.20	5.40	1	0.19	9.09	1.053	0.594	
UPDTE1	1	0.08	4.31	1	0.11	2.76	0.727	1.562	
UPDTE2	2	0.09	3.12	2	0.13	3.18	0.760	0.983	
UPDTE3	1	0.04	0.21	1	0.04	0.99	1.000	0.212	
UPDTE4	1	0.35	3.00	1	0.34	1.30	1.029	2.308	
UPDTE5	1	0.09	6.30	1	0.13	2.25	0.692	2.800	
UPDTE6	2	0.18	1.96	2	0.18	1.93	1.029	1.018	
UTILITY1	5	0.12	3.29	5	0.14	2.25	0.853	1.458	

TOTAL	58	12.43	534.70	58	12.90	526.25	0.964	1.016	
MEAN	23	0.24	11.83	23	0.25	11.04	0.949	1.290	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP TOTALS

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
STEPNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
ASM	52	0.26	5.21	52	0.29	6.52	0.900	0.800	
EDT	37	0.30	10.33	37	0.36	9.11	0.840	1.134	
FTG	17	1.51	2.02	17	1.95	2.33	0.773	0.868	
PTH	23	4.20	13.91	23	5.02	10.24	0.836	1.359	
GO	89	8.39	3.80	89	6.71	6.91	1.251	0.549	
IEBCOMPR	1	0.07	2.25	1	0.08	1.41	0.875	1.596	
IEBCOPY	2	0.70	60.68	2	0.72	60.90	0.972	0.996	
IEBGENER	12	0.16	10.36	12	0.17	15.84	0.965	0.654	
IEBPTPCH	3	0.16	2.82	3	0.15	1.87	1.114	1.509	
IEBUPDAT	4	0.18	3.51	4	0.19	4.21	0.974	0.833	
IEBUPDTE	11	0.20	3.43	11	0.22	2.55	0.937	1.344	
IEHLIST	13	0.27	11.46	13	0.27	9.39	0.997	1.220	
IEHMOVE	5	0.32	13.94	5	0.36	6.64	0.900	2.100	
IEHPRGM	7	0.07	1.14	7	0.07	1.03	0.923	1.108	
LOAD&GO	34	4.94	14.44	34	5.77	22.54	0.857	0.641	
PL1	8	2.20	9.88	8	2.85	10.49	0.773	0.942	
TOTAL	318	1092.08	2450.62	318	1006.23	2943.19	1.085	0.833	
MEAN	16	1.50	10.57	16	1.57	10.75	0.930	1.103	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODEL JOBSTREAM

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP MEANS

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
STEPNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT	CPU	WAIT	
ASM	5	0.47	8.15	5	0.52	12.48	0.896	0.730	
EDT	21	0.31	9.90	21	0.36	9.01	0.863	1.199	
FTG	10	2.20	2.19	10	2.85	2.64	0.770	0.916	
FTH	23	4.20	13.91	23	5.02	10.24	0.840	1.417	
GO	21	12.36	4.76	21	9.46	9.23	1.387	1.357	
IEBCOMPR	1	0.07	2.25	1	0.08	1.41	0.875	1.596	
IEBCOPY	2	0.70	60.68	2	0.72	60.90	0.985	0.923	
IEBGENER	2	0.17	11.66	2	0.18	17.39	0.956	0.603	
IEBPTPCH	2	0.17	2.49	2	0.15	1.75	1.113	1.370	
IEBUPDAT	2	0.19	4.14	2	0.19	5.84	1.000	0.853	
IEBUPDTE	7	0.17	3.35	7	0.19	2.27	0.886	1.455	
IFHLIST	5	0.29	13.12	5	0.29	10.77	0.972	1.236	
IEHMOVE	3	0.33	14.38	3	0.38	8.05	0.872	1.993	
IEHPRGM	2	0.07	1.12	2	0.07	1.04	0.935	1.102	
LOAD&GO	14	5.86	16.82	14	6.86	26.60	0.910	1.046	
PL1	3	4.04	13.73	3	5.35	16.74	0.791	1.026	
TOTAL	123	487.51	1261.80	123	471.47	1399.06	1.034	0.902	
MEAN	16	1.98	11.42	16	2.04	12.27	0.941	1.176	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODIFIED MODEL JOBSTREAM

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

-----	*-----*	*-----*	*-----*	*-----*	*-----*	*-----*	*-----*	*-----*	*-----*
JOBNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT	CPU	WAIT	
-----	*-----*	*-----*	*-----*	*-----*	*-----*	*-----*	*-----*	*-----*	*-----*
BMKJSMP1	1	174.77	7.64	1	249.11	5.17	0.702	1.478	
BMKJS01A	4	1.80	36.69	4	2.17	35.33	0.831	1.038	
BMKJS02A	3	2.50	31.46	3	3.18	30.13	0.785	1.044	
BMKJS03A	1	8.63	15.85	1	8.05	15.44	1.072	1.027	
BMKJS03B	1	5.22	5.28	1	4.95	4.31	1.055	1.225	
BMKJS04A	2	98.34	20.48	2	71.83	21.92	1.369	0.934	
BMKJS05A	5	67.25	12.44	5	39.64	10.52	1.697	1.182	
BMKJS06A	1	3.92	16.69	1	4.79	12.83	0.818	1.301	
BMKJS06B	1	3.69	17.34	1	3.76	11.44	0.981	1.516	
BMKJS07A	3	0.84	11.53	3	1.07	10.38	0.786	1.111	
BMKJS07B	1	1.04	16.45	1	1.17	14.37	0.889	1.145	
BMKJS08A	1	1.26	9.23	1	1.54	7.88	0.818	1.171	
BMKJS08B	1	1.30	7.74	1	1.54	8.67	0.844	0.893	
BMKJS09A	1	14.25	520.20	1	15.24	588.53	0.935	0.884	
BMKJS09B	1	9.98	466.03	1	10.65	390.21	0.937	1.194	
BMKJS10A	2	0.80	7.80	2	0.96	6.70	0.833	1.163	
BMKJS10B	2	0.74	7.05	2	0.89	8.13	0.831	0.867	
BMKJS11A	1	10.65	11.66	1	11.76	12.02	0.906	0.970	
BMKJS11B	1	9.28	6.64	1	9.06	12.44	1.024	0.534	
BMKJS12A	1	25.71	68.95	1	28.07	59.44	0.916	1.160	
BMKJS13A	1	3.70	35.40	1	4.34	38.15	0.853	0.928	
BMKJS13B	1	3.15	27.04	1	3.65	26.79	0.863	1.009	
BMKJS14A	1	157.82	36.47	1	104.19	34.95	1.515	1.043	
BMKJS15A	1	12.71	13.73	1	15.71	9.59	0.809	1.432	
BMKJS15B	1	6.53	47.84	1	7.67	37.18	0.851	1.287	
BMKJS16A	1	12.12	23.78	1	14.12	19.72	0.858	1.206	
BMKJS17A	1	25.96	53.37	1	30.78	37.14	0.843	1.437	
BMKJS18A	1	97.53	7.19	1	42.11	7.85	2.316	0.916	
BMKJS19A	1	128.70	58.18	1	129.43	62.12	0.994	0.937	
BMKJS19B	5	85.69	37.35	5	87.51	32.03	0.979	1.166	
BMKJS20A	1	4.01	13.23	1	4.94	10.96	0.812	1.207	
BMKJS21A	3	2.88	43.54	3	3.09	48.75	0.931	0.893	
BMKJS21B	7	0.21	3.29	7	0.21	4.53	0.980	0.727	
BMKJS22A	1	25.45	56.96	1	32.49	120.44	0.783	0.473	
BMKJS23A	1	1.09	5.45	1	1.24	4.72	0.879	1.155	
BMKJS23B	1	1.15	11.67	1	1.35	7.06	0.852	1.653	
BMKJS24A	1	124.29	159.39	1	147.63	153.92	0.842	1.036	
BMKJS24B	1	4.91	13.47	1	5.68	18.96	0.864	0.710	
COMPMOVE	1	0.48	16.54	1	0.52	13.79	0.923	1.199	
COPY1	1	1.45	86.34	1	1.54	118.81	0.942	0.727	
COPY2	1	0.11	2.53	1	0.10	2.89	1.100	0.875	
DMATMUL	1	252.57	13.02	1	94.48	13.99	2.673	0.931	
EMATMUL	1	145.18	11.51	1	91.32	13.02	1.590	0.884	
GENER1	5	0.23	19.65	5	0.21	29.57	1.093	0.664	
GENER2	7	0.10	6.19	7	0.12	6.22	0.835	0.995	
GENUPDTE	3	0.45	5.80	3	0.46	3.98	0.978	1.456	

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LIST1	3	0.22	5.86	3	0.23	4.20	0.971	1.395
LIST2	3	0.20	5.96	3	0.20	4.97	1.000	1.200
LIST3	2	0.52	20.91	2	0.54	18.39	0.954	1.137
LIST4	3	0.14	5.19	3	0.14	4.17	1.024	1.244
LIST5	2	0.31	24.94	2	0.35	17.10	0.873	1.458
MOVE1	3	0.35	13.81	3	0.34	5.48	1.010	2.518
NATRAN	1	94.43	19.62	1	86.53	15.95	1.091	1.230
PTPCH1	1	0.18	3.10	1	0.18	1.40	1.000	2.214
PTPCH2	2	0.12	2.28	2	0.13	2.35	0.962	0.972
UPDAT1	3	0.18	2.86	3	0.19	2.93	0.948	0.975
UPDAT2	1	0.26	4.21	1	0.20	8.97	1.300	0.469
UPDTE1	1	0.13	2.84	1	0.12	3.04	1.083	0.934
UPDTE2	2	0.10	3.18	2	0.13	2.99	0.808	1.063
UPDTE3	1	0.04	0.46	1	0.05	0.22	0.800	2.091
UPDTE4	1	0.34	3.34	1	0.35	1.75	0.971	1.909
UPDTE5	1	0.10	5.26	1	0.12	2.44	0.833	2.156
UPDTE6	2	0.18	1.91	2	0.17	1.69	1.029	1.127
UTILITY1	1	0.54	19.82	1	0.68	11.14	0.794	1.779

TOTAL	117	2375.43	3036.86	117	1995.79	3020.54	1.190	1.005
MEAN	64	25.61	35.18	64	21.64	35.19	1.007	1.166

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ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODIFIED MODEL JOBSTREAM

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AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = ASM									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

BMKJS13A	2	0.63	11.11	2	0.72	13.66	0.882	0.813	
BMKJS13B	2	0.61	10.95	2	0.70	9.64	0.871	1.136	
BMKJS19A	2	0.65	8.93	2	0.74	10.98	0.879	0.813	
BMKJS21A	39	0.22	3.35	39	0.24	3.75	0.931	0.893	
BMKJS21B	7	0.21	3.29	7	0.21	4.53	0.980	0.727	

TOTAL	52	13.88	215.65	52	15.08	246.55	0.920	0.875	
MEAN	5	0.47	7.53	5	0.52	8.51	0.909	0.876	

STEP = EDT									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
BMKJS01A	8	0.35	13.33	8	0.41	12.35	0.840	1.079	
BMKJS02A	3	0.49	16.40	3	0.67	15.53	0.735	1.056	
BMKJS03A	2	0.19	6.72	2	0.20	6.23	0.902	1.080	
BMKJS04A	4	0.18	6.92	4	0.22	7.59	0.800	0.911	
BMKJS05A	5	0.14	3.80	5	0.19	3.38	0.758	1.126	
BMKJS06A	1	0.21	8.66	1	0.28	8.70	0.750	0.995	
BMKJS07A	3	0.15	4.55	3	0.19	4.21	0.789	1.082	
BMKJS09A	1	0.19	6.16	1	0.20	5.36	0.950	1.149	
BMKJS10A	2	0.14	3.63	2	0.15	2.91	0.903	1.247	
BMKJS11A	1	0.17	8.38	1	0.23	6.59	0.739	1.272	
BMKJS12A	1	0.57	25.66	1	0.67	12.96	0.851	1.980	
BMKJS13A	1	0.22	7.13	1	0.26	6.04	0.846	1.180	
BMKJS14A	1	0.42	7.12	1	0.42	10.56	1.000	0.674	
BMKJS15A	1	0.36	9.94	1	0.47	6.45	0.766	1.541	
BMKJS15B	1	0.48	18.62	1	0.51	23.97	0.941	0.777	
BMKJS16A	1	0.21	6.49	1	0.26	6.24	0.808	1.040	
BMKJS17A	1	0.48	17.84	1	0.59	13.26	0.814	1.345	
BMKJS18A	1	0.19	2.28	1	0.19	2.39	1.000	0.954	
BMKJS19A	1	0.44	9.69	1	0.57	13.57	0.772	0.714	
BMKJS19B	5	0.48	10.58	5	0.63	11.34	0.759	0.933	
BMKJS20A	1	0.30	5.38	1	0.36	4.55	0.833	1.182	
TOTAL	45	13.44	423.11	45	16.63	400.88	0.808	1.055	
MEAN	21	0.30	9.49	21	0.37	8.77	0.836	1.110	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODIFIED MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = FTG									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
BMKJS02A	3	0.30	2.48	3	0.38	2.50	0.805	0.992	
BMKJS03A	1	1.38	0.96	1	1.82	1.55	0.758	0.619	
BMKJS03B	1	1.40	1.22	1	1.77	0.85	0.791	1.435	
BMKJS04A	2	1.08	1.63	2	1.52	1.78	0.714	0.913	
BMKJS06A	1	2.73	3.09	1	3.40	1.93	0.803	1.601	
BMKJS07A	3	0.47	1.94	3	0.60	1.98	0.785	0.978	
BMKJS10A	2	0.49	2.08	2	0.63	0.95	0.770	2.195	
BMKJS10B	2	0.48	1.90	2	0.61	1.78	0.795	1.067	
BMKJS11A	1	2.53	1.56	1	3.27	3.13	0.774	0.498	
BMKJS15A	1	10.77	1.29	1	13.58	0.90	0.793	1.433	
TOTAL	17	25.25	32.60	17	32.30	30.83	0.782	1.057	
MEAN	10	2.16	1.82	10	2.76	1.74	0.779	1.173	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODIFIED MODEL JOBSTREAM

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AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM	
STEP = FTH								

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT

BMKJSMP1	1	0.84	5.92	1	1.03	2.83	0.816	2.092
BMKJS05A	5	2.45	5.72	5	3.05	4.80	0.803	1.190
BMKJS06B	1	0.90	3.09	1	1.06	1.71	0.849	1.807
BMKJS07B	1	0.54	9.84	1	0.64	4.77	0.844	2.063
BMKJS08A	1	0.38	3.45	1	0.44	1.69	0.864	2.041
BMKJS08B	1	0.36	1.88	1	0.44	1.36	0.818	1.382
BMKJS09A	1	0.69	2.23	1	0.82	1.87	0.841	1.193
BMKJS09B	1	0.71	2.65	1	0.85	2.59	0.835	1.023
BMKJS11B	1	1.42	1.83	1	1.71	1.99	0.830	0.920
BMKJS12A	1	22.78	41.42	1	27.09	44.35	0.841	0.934
BMKJS13A	1	0.85	4.69	1	1.00	2.24	0.850	2.094
BMKJS13B	1	0.85	1.44	1	0.96	1.28	0.885	1.125
BMKJS14A	1	10.60	28.04	1	13.17	22.61	0.805	1.240
BMKJS15B	1	6.03	29.09	1	7.14	13.15	0.845	2.212
BMKJS16A	1	6.43	13.75	1	7.89	11.14	0.815	1.234
BMKJS17A	1	19.50	33.34	1	23.08	21.24	0.845	1.570
BMKJS18A	1	1.92	4.01	1	2.38	4.09	0.807	0.980
BMKJS19A	1	5.34	26.98	1	6.30	22.24	0.848	1.213
BMKJS19B	5	4.92	23.58	5	5.78	18.02	0.851	1.308
BMKJS20A	1	3.57	6.84	1	4.45	5.31	0.802	1.288
BMKJS23A	1	0.90	2.32	1	1.02	1.61	0.882	1.441
BMKJS23B	1	0.91	3.58	1	1.02	1.82	0.892	1.967
BMKJS24A	1	1.70	6.28	1	1.89	4.46	0.899	1.408
BMKJS24B	1	1.70	4.42	1	1.97	7.20	0.863	0.614
DMATMUL	1	1.31	10.33	1	1.64	11.26	0.799	0.917
EMATMUL	1	1.29	9.61	1	1.59	9.85	0.811	0.976
NATRAN	1	6.21	16.89	1	7.69	12.49	0.808	1.352

TOTAL	35	134.58	420.39	35	161.44	329.28	0.834	1.277
MEAN	27	3.89	11.23	27	4.67	8.81	0.839	1.392

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODIFIED MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = GO									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

BMKJS01A	12	0.07	1.10	12	0.08	1.19	0.845	0.923	
BMKJS02A	9	0.10	1.94	9	0.12	1.91	0.844	1.017	
BMKJS03A	4	1.72	0.36	4	1.45	0.36	1.182	1.007	
BMKJS04A	6	32.30	1.67	6	23.29	1.65	1.387	1.012	
BMKJS05A	15	21.55	0.97	15	12.13	0.78	1.777	1.246	
BMKJS06A	3	0.33	1.65	3	0.37	0.73	0.883	2.245	
BMKJS07A	12	0.05	1.26	12	0.07	1.05	0.786	1.202	
BMKJS09A	3	4.46	170.60	3	4.74	193.77	0.940	0.880	
BMKJS10A	6	0.06	0.69	6	0.06	0.95	1.000	0.733	
BMKJS11A	3	2.65	0.57	3	2.75	0.77	0.962	0.748	
BMKJS12A	2	1.18	0.93	2	0.15	1.06	7.613	0.878	
BMKJS13A	3	0.45	0.45	3	0.55	0.85	0.829	0.533	
BMKJS14A	2	73.40	0.65	2	45.30	0.89	1.620	0.736	
BMKJS15A	3	0.53	0.83	3	0.55	0.75	0.952	1.116	
BMKJS15B	1	0.02	0.13	1	0.02	0.06	1.000	2.167	
BMKJS16A	4	1.37	0.88	4	1.49	0.58	0.918	1.513	
BMKJS17A	2	2.99	1.09	2	3.55	1.32	0.841	0.830	
BMKJS18A	3	31.81	0.30	3	13.18	0.46	2.413	0.657	
BMKJS19A	3	40.54	1.22	3	40.36	1.45	1.004	0.839	
BMKJS19B	10	40.15	1.59	10	40.55	1.33	0.990	1.194	
BMKJS20A	3	0.05	0.34	3	0.04	0.37	1.077	0.918	

TOTAL	109	1331.23	628.89	109	1027.89	692.50	1.295	0.908	
MEAN	21	12.18	9.01	21	9.09	10.11	1.422	1.066	

STEP = IEBCOMPR

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
COMPMOVE	1	0.09	1.26	1	0.09	1.79	1.000	0.704	
TOTAL	1	0.09	1.26	1	0.09	1.79	1.000	0.704	
MEAN	1	0.09	1.26	1	0.09	1.79	1.000	0.704	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODIFIED MODEL JOBSTREAM

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

STEP = IEBCOPY

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
COPY1	1	1.45	86.34	1	1.54	118.81	0.942	0.727
COPY2	1	0.11	2.53	1	0.10	2.89	1.100	0.875
TOTAL	2	1.56	88.87	2	1.64	121.70	0.951	0.730
MEAN	2	0.78	44.43	2	0.82	60.85	1.021	0.801

STEP = IEBGENER

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
GENER1	5	0.23	19.65	5	0.21	29.57	1.093	0.664
GENER2	7	0.10	6.19	7	0.12	6.22	0.835	0.995
TOTAL	12	1.88	141.58	12	1.92	191.39	0.979	0.740
MEAN	2	0.17	12.92	2	0.17	17.89	0.964	0.830

STEP = IEBPTPCH

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
PTPCH1	1	0.18	3.10	1	0.18	1.40	1.000	2.214
PTPCH2	2	0.12	2.28	2	0.13	2.35	0.962	0.972
TOTAL	3	0.43	7.67	3	0.44	6.10	0.977	1.257
MEAN	2	0.15	2.69	2	0.15	1.87	0.981	1.593

STEP = IEBUPDAT

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
UPDAT1	3	0.18	2.86	3	0.19	2.93	0.948	0.975
UPDAT2	1	0.26	4.21	1	0.20	8.97	1.300	0.469
TOTAL	4	0.81	12.79	4	0.78	17.77	1.038	0.720
MEAN	2	0.22	3.53	2	0.20	5.95	1.124	0.722

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODIFIED MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = IEBUPDTE									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

GENUPDTE	3	0.39	4.84	3	0.39	3.04	1.009	1.593	
UPDTE1	1	0.13	2.84	1	0.12	3.04	1.083	0.934	
UPDTE2	2	0.10	3.18	2	0.13	2.99	0.808	1.063	
UPDTE3	1	0.04	0.46	1	0.05	0.22	0.800	2.091	
UPDTE4	1	0.34	3.34	1	0.35	1.75	0.971	1.909	
UPDTE5	1	0.10	5.26	1	0.12	2.44	0.833	2.156	
UPDTE6	2	0.18	1.91	2	0.17	1.69	1.029	1.127	

TOTAL	11	2.35	36.60	11	2.41	25.94	0.975	1.411	
MEAN	7	0.18	3.12	7	0.19	2.17	0.933	1.553	

STEP = IEHLIST									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
LIST1	3	0.22	5.86	3	0.23	4.20	0.971	1.395	
LIST2	3	0.20	5.96	3	0.20	4.97	1.000	1.200	
LIST3	2	0.52	20.91	2	0.54	18.39	0.954	1.137	
LIST4	3	0.14	5.19	3	0.14	4.17	1.024	1.244	
LIST5	2	0.31	24.94	2	0.35	17.10	0.873	1.458	
TOTAL	13	3.36	142.75	13	3.51	111.02	0.957	1.286	
MEAN	5	0.28	12.57	5	0.29	9.77	0.964	1.287	

STEP = IEHMOVE									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
COMPMOVE	1	0.39	15.28	1	0.43	12.00	0.907	1.273	
MOVE1	3	0.35	13.81	3	0.34	5.48	1.010	2.518	
UTILITY1	1	0.29	13.57	1	0.38	7.00	0.763	1.939	
TOTAL	5	1.72	70.27	5	1.84	35.45	0.935	1.982	
MEAN	3	0.34	14.22	3	0.38	8.16	0.893	1.910	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODIFIED MODEL JOBSTREAM

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AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = IEHPRGM									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

GENUPDTE	3	0.06	0.96	3	0.07	0.94	0.818	1.018	
UTILITY1	4	0.06	1.56	4	0.07	1.03	0.833	1.510	

TOTAL	7	0.43	9.13	7	0.52	6.97	0.827	1.310	
MEAN	2	0.06	1.26	2	0.07	0.99	0.826	1.264	

STEP = LOAD&GO									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
BMKJSMP1	1	173.93	1.72	1	248.08	2.34	0.701	0.735	
BMKJS03B	2	1.91	2.03	2	1.59	1.73	1.201	1.173	
BMKJS06B	3	0.93	4.75	3	0.90	3.24	1.033	1.465	
BMKJS07B	3	0.17	2.20	3	0.18	3.20	0.943	0.689	
BMKJS08A	2	0.44	2.89	2	0.55	3.10	0.800	0.934	
BMKJS08B	2	0.47	2.93	2	0.55	3.66	0.855	0.802	
BMKJS09B	2	4.63	231.69	2	4.90	193.81	0.946	1.195	
BMKJS10B	4	0.13	2.57	4	0.14	3.18	0.911	0.810	
BMKJS11B	3	2.62	1.60	3	2.45	3.48	1.069	0.460	
BMKJS13B	2	0.54	1.84	2	0.64	3.11	0.837	0.593	
BMKJS22A	2	7.76	20.67	2	9.69	47.70	0.800	0.433	
BMKJS23A	2	0.09	1.56	2	0.11	1.55	0.864	1.006	
BMKJS23B	3	0.08	2.70	3	0.11	1.75	0.727	1.544	
BMKJS24A	2	61.29	76.55	2	72.87	74.73	0.841	1.024	
BMKJS24B	2	1.60	4.52	2	1.85	5.88	0.865	0.770	
DMATMUL	1	251.26	2.69	1	92.84	2.73	2.706	0.985	
EMATMUL	1	143.89	1.90	1	89.73	3.17	1.604	0.599	
NATRAN	1	88.22	2.73	1	78.84	3.46	1.119	0.789	
TOTAL	38	826.70	742.50	38	706.49	729.97	1.170	1.017	
MEAN	18	41.11	20.42	18	33.67	20.10	1.046	0.889	

ARGONNE NATIONAL LABORATORY
 AMDAHL 470V/6 VS. IBM 370/195
 MODIFIED MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = PL1									

JOBNAME STEPS CPU WAIT STEPS CPU WAIT CPU WAIT									

BMKJS01A 4 0.90 6.74 4 1.10 7.07 0.820 0.953									
BMKJS02A 3 1.40 6.75 3 1.78 6.37 0.788 1.059									
BMKJS22A 1 9.93 15.62 1 13.10 25.03 0.758 0.624									

TOTAL 8 17.73 62.81 8 22.82 72.41 0.777 0.867									
MEAN 3 4.08 9.70 3 5.32 12.82 0.789 0.879									

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODIFIED MODEL JOBSTREAM

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AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = IEBUTIL									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

COMPMOVE	1	0.09	1.26	1	0.09	1.79	1.000	0.704	
COPY1	1	1.45	86.34	1	1.54	118.81	0.942	0.727	
COPY2	1	0.11	2.53	1	0.10	2.89	1.100	0.875	
GENER1	5	0.23	19.65	5	0.21	29.57	1.093	0.664	
GENER2	7	0.10	6.19	7	0.12	6.22	0.835	0.995	
GENUPDTE	3	0.39	4.84	3	0.39	3.04	1.009	1.593	
PTPCH1	1	0.18	3.10	1	0.18	1.40	1.000	2.214	
PTPCH2	2	0.12	2.28	2	0.13	2.35	0.962	0.972	
UPDAT1	3	0.18	2.86	3	0.19	2.93	0.948	0.975	
UPDAT2	1	0.26	4.21	1	0.20	8.97	1.300	0.469	
UPDTE1	1	0.13	2.84	1	0.12	3.04	1.083	0.934	
UPDTE2	2	0.10	3.18	2	0.13	2.99	0.808	1.063	
UPDTE3	1	0.04	0.46	1	0.05	0.22	0.800	2.091	
UPDTE4	1	0.34	3.34	1	0.35	1.75	0.971	1.909	
UPDTE5	1	0.10	5.26	1	0.12	2.44	0.833	2.156	
UPDTE6	2	0.18	1.91	2	0.17	1.69	1.029	1.127	

TOTAL	33	7.12	288.77	33	7.28	364.69	0.978	0.792	
MEAN	16	0.25	9.39	16	0.26	11.88	0.982	1.217	

STEP = IEHUTIL									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
COMPMOVE	1	0.39	15.28	1	0.43	12.00	0.907	1.273	
GENUPDTE	3	0.06	0.96	3	0.07	0.94	0.818	1.018	
LIST1	3	0.22	5.86	3	0.23	4.20	0.971	1.395	
LIST2	3	0.20	5.96	3	0.20	4.97	1.000	1.200	
LIST3	2	0.52	20.91	2	0.54	18.39	0.954	1.137	
LIST4	3	0.14	5.19	3	0.14	4.17	1.024	1.244	
LIST5	2	0.31	24.94	2	0.35	17.10	0.873	1.458	
MOVE1	3	0.35	13.81	3	0.34	5.48	1.010	2.518	
UTILITY1	5	0.11	3.96	5	0.14	2.23	0.794	1.779	
TOTAL	25	5.51	222.15	25	5.87	153.44	0.939	1.448	
MEAN	9	0.26	10.76	9	0.27	7.72	0.928	1.447	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODIFIED MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = UTILITY									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

COMPMOVE	2	0.24	8.27	2	0.26	6.89	0.923	1.199	
COPY1	1	1.45	86.34	1	1.54	118.81	0.942	0.727	
COPY2	1	0.11	2.53	1	0.10	2.89	1.100	0.875	
GENER1	5	0.23	19.65	5	0.21	29.57	1.093	0.664	
GENER2	7	0.10	6.19	7	0.12	6.22	0.835	0.995	
GENUPDTE	6	0.23	2.90	6	0.23	1.99	0.978	1.456	
LIST1	3	0.22	5.86	3	0.23	4.20	0.971	1.395	
LIST2	3	0.20	5.96	3	0.20	4.97	1.000	1.200	
LIST3	2	0.52	20.91	2	0.54	18.39	0.954	1.137	
LIST4	3	0.14	5.19	3	0.14	4.17	1.024	1.244	
LIST5	2	0.31	24.94	2	0.35	17.10	0.873	1.458	
MOVE1	3	0.35	13.81	3	0.34	5.48	1.010	2.518	
PTPCH1	1	0.18	3.10	1	0.18	1.40	1.000	2.214	
PTPCH2	2	0.12	2.28	2	0.13	2.35	0.962	0.972	
UPDAT1	3	0.18	2.86	3	0.19	2.93	0.948	0.975	
UPDAT2	1	0.26	4.21	1	0.20	8.97	1.300	0.469	
UPDTE1	1	0.13	2.84	1	0.12	3.04	1.083	0.934	
UPDTE2	2	0.10	3.18	2	0.13	2.99	0.808	1.063	
UPDTE3	1	0.04	0.46	1	0.05	0.22	0.800	2.091	
UPDTE4	1	0.34	3.34	1	0.35	1.75	0.971	1.909	
UPDTE5	1	0.10	5.26	1	0.12	2.44	0.833	2.156	
UPDTE6	2	0.18	1.91	2	0.17	1.69	1.029	1.127	
UTILITY 1	5	0.11	3.96	5	0.14	2.23	0.794	1.779	

TOTAL	58	12.63	510.92	58	13.15	518.13	0.960	0.986	
MEAN	23	0.25	10.26	23	0.26	10.90	0.967	1.329	

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AMDAHL / IBM

*****				*****				*****			
STEPNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT		
*****				*****				*****			
ASM	52	0.27	4.15	52	0.29	4.74		0.920	0.875		
EDT	45	0.30	9.40	45	0.37	8.91		0.808	1.055		
FTG	17	1.49	1.92	17	1.90	1.81		0.782	1.057		
FTH	35	3.85	12.01	35	4.61	9.41		0.834	1.277		
GO	109	12.21	5.77	109	9.43	6.35		1.295	0.908		
IEBCOMPR	1	0.09	1.26	1	0.09	1.79		1.000	0.704		
IEBCOPY	2	0.78	44.43	2	0.82	60.85		0.951	0.730		
IEBGENER	12	0.16	11.80	12	0.16	15.95		0.979	0.740		
IEBPTPCH	3	0.14	2.56	3	0.15	2.03		0.977	1.257		
IEBUPDAT	4	0.20	3.20	4	0.19	4.44		1.038	0.720		
IEBUPDTE	11	0.21	3.33	11	0.22	2.36		0.975	1.411		
IEHLIST	13	0.26	10.98	13	0.27	8.54		0.957	1.286		
IEHMOVE	5	0.34	14.05	5	0.37	7.09		0.935	1.982		
IEHPRGM	7	0.06	1.30	7	0.07	1.00		0.827	1.310		
LOAD&GO	38	21.76	19.54	38	18.59	19.21		1.170	1.017		
PL1	8	2.22	7.85	8	2.85	9.05		0.777	0.867		
*****				*****				*****			
TOTAL	362	2375.43	3036.86	362	1995.79	3020.54		1.190	1.005		
MEAN	16	2.77	9.60	16	2.52	10.22		0.952	1.075		
*****				*****				*****			

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MODIFIED MODEL JOBSTREAM

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP MEANS

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
STEPNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT	CPU	WAIT	
ASM	5	0.47	7.53	5	0.52	8.51	0.909	0.876	
EDT	21	0.30	9.49	21	0.37	8.77	0.836	1.110	
FTG	10	2.16	1.82	10	2.76	1.74	0.779	1.173	
FTH	27	3.89	11.23	27	4.67	8.81	0.839	1.392	
GO	21	12.18	9.01	21	9.09	10.11	1.422	1.066	
IEBCOMPR	1	0.09	1.26	1	0.09	1.79	1.000	0.704	
IEBCOPY	2	0.78	44.43	2	0.82	60.85	1.021	0.801	
IEBGENER	2	0.17	12.92	2	0.17	17.89	0.964	0.830	
IEBPTPCH	2	0.15	2.69	2	0.15	1.87	0.981	1.593	
IEBUPDAT	2	0.22	3.53	2	0.20	5.95	1.124	0.722	
IEBUPDTE	7	0.18	3.12	7	0.19	2.17	0.933	1.553	
IEHLIST	5	0.28	12.57	5	0.29	9.77	0.964	1.287	
IEHMOVE	3	0.34	14.22	3	0.38	8.16	0.893	1.910	
IEHPROGM	2	0.06	1.26	2	0.07	0.99	0.826	1.264	
LOADEGO	18	41.11	20.42	18	33.67	20.10	1.046	0.889	
PL1	3	4.08	9.70	3	5.32	12.82	0.789	0.879	
TOTAL	131	1149.96	1402.51	131	983.68	1360.04	1.169	1.031	
MEAN	16	4.15	10.33	16	3.67	11.27	0.958	1.128	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
APPLICATIONS PROBLEMS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
JOBNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT	CPU	WAIT	
ANLTRIM	1	138.71	34.80	1	113.74	34.83	1.220	0.999	
DOT2	1	349.07	90.54	1	408.06	85.52	0.855	1.059	
DROPLET	1	489.70	5.06	1	283.43	5.21	1.728	0.971	
EIGEN	1	23.76	9.28	1	15.38	8.55	1.545	1.085	
EROS	1	154.55	145.78	1	171.95	145.33	0.899	1.003	
HEPCVT	1	78.99	54.11	1	99.41	84.12	0.795	0.643	
KTTFLCK	1	70.43	23.70	1	72.72	16.19	0.969	1.464	
LIFE1A	1	170.15	40.45	1	153.32	85.46	1.110	0.473	
LINDA	1	266.36	207.74	1	328.30	148.19	0.811	1.402	
MATRIX	3	75.06	22.68	3	45.11	13.61	1.664	1.666	
MONTE	1	210.30	16.17	1	169.67	7.71	1.239	2.097	
MULTC	1	100.59	60.74	1	81.16	34.55	1.239	1.758	
NVERTX	3	100.97	75.01	3	112.83	73.05	0.895	1.027	
OWL	1	116.93	47.88	1	127.70	22.50	0.916	2.128	
REXCO	1	196.46	19.18	1	156.20	16.92	1.258	1.134	
SDIAG	1	35.17	23.16	1	15.63	4.62	2.250	5.013	
SUMX	1	30.01	212.09*	1	109.03	184.55			
TOTAL	16	2577.20	876.28	16	2354.61	786.37	1.095	1.114	
MEAN	16	161.08	54.77	16	147.16	49.15	1.212	1.495	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
APPLICATIONS PROBLEMS

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = FTH									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

ANLTRIM	1	13.35	25.58	1	17.77	22.56	0.751	1.134	
DOT2	1	26.71	48.65	1	35.11	34.44	0.761	1.413	
DROPLET	1	1.70	3.12	1	2.14	2.15	0.794	1.451	
EIGEN	1	2.28	6.41	1	3.05	4.68	0.748	1.370	
EROS	1	19.51	58.71	1	25.92	49.86	0.753	1.177	
KTTFLCK	1	3.14	22.22	1	4.19	14.59	0.749	1.523	
LIFE1A	1	20.73	33.24	1	27.26	75.46	0.760	0.440	
LINDA	1	40.38	105.24	1	51.95	57.12	0.777	1.842	
MATRIX	3	7.04	19.64	3	8.84	11.69	0.796	1.680	
MONTE	1	6.01	14.35	1	7.25	5.49	0.829	2.614	
MULTC	1	10.36	58.18	1	12.47	15.86	0.831	3.668	
NVERTEX	3	15.39	71.61	3	19.95	51.78	0.772	1.383	
OWL	1	3.18	44.83	1	4.06	17.51	0.783	2.560	
REXCO	1	18.21	16.10	1	22.38	13.16	0.814	1.223	
SDIAG	1	1.87	16.75	1	2.31	3.18	0.810	5.267	
SUMX	1	28.95	204.10	1	35.81	148.22	0.808	1.377	

TOTAL	16	218.81	748.73	16	280.46	527.75	0.780	1.419	
MEAN	16	13.68	46.80	16	17.53	32.98	0.784	1.883	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
APPLICATIONS PROBLEMS

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = ASM									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

EROS	1	0.41	3.93	1	0.52	5.70	0.788	0.689	
SUMX	1	0.62	3.60	1	0.65	4.53	0.954	0.795	

TOTAL	2	1.03	7.53	2	1.17	10.23	0.880	0.736	
MEAN	2	0.51	3.76	2	0.58	5.11	0.871	0.742	

STEP = EDT&GO									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
LINDA	1	225.98	102.50	1	276.35	91.07	0.818	1.126	
SUMX	1	0.44	4.39*	1	72.57	31.80			
TOTAL	1	225.98	102.50	1	276.35	91.07	0.818	1.126	
MEAN	1	225.98	102.50	1	276.35	91.07	0.818	1.126	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
APPLICATIONS PROBLEMS

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = LOAD&GO									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

ANLTRIM	1	125.36	9.22	1	95.97	12.27	1.306	0.751	
DOT2	1	322.36	41.89	1	372.95	51.08	0.864	0.820	
DROPLET	1	488.00	1.94	1	281.29	3.06	1.735	0.634	
EIGEN	1	21.48	2.87	1	12.33	3.87	1.742	0.742	
EROS	1	134.63	83.14	1	145.51	89.77	0.925	0.926	
HEPCVT	1	61.64	10.64	1	74.68	12.21	0.825	0.871	
KTTFLCK	1	67.29	1.48	1	68.53	1.60	0.982	0.925	
LIFE1A	1	149.42	7.21	1	126.06	10.00	1.185	0.721	
MATRIX	3	68.02	3.04	3	36.27	1.92	1.875	1.583	
MONTE	1	204.29	1.82	1	162.42	2.22	1.258	0.820	
MULTC	1	90.23	2.56	1	68.69	18.69	1.314	0.137	
NVERTEX	3	85.58	3.40	3	92.88	21.28	0.921	0.160	
OWL	1	113.75	3.05	1	123.64	4.99	0.920	0.611	
REXCO	1	178.25	3.08	1	133.82	3.76	1.332	0.819	
SDIAG	1	33.30	6.41	1	13.32	1.44	2.500	4.451	

TOTAL	15	2143.60	181.75	15	1808.36	238.16	1.185	0.763	
MEAN	15	142.91	12.12	15	120.56	15.88	1.312	0.998	

STEP = PL1									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
HEPCVT	1	17.35	43.47	1	24.73	71.91	0.702	0.605	
TOTAL	1	17.35	43.47	1	24.73	71.91	0.702	0.605	
MEAN	1	17.35	43.47	1	24.73	71.91	0.702	0.605	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
APPLICATIONS PROBLEMS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP TIMES (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOB	CPU	WAIT	JOB	CPU	WAIT	CPU	WAIT
ASM	2	0.51	3.76	2	0.58	5.11	0.880	0.736
EDT&GO	1	225.98	102.50	1	276.35	91.07	0.818	1.126
PTH	16	13.68	46.80	16	17.53	32.98	0.780	1.419
LOAD&GO	15	142.91	12.12	15	120.56	15.88	1.185	0.763
PL1	1	17.35	43.47	1	24.73	71.91	0.702	0.605

SUMMARY OF STEP MEANS (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOB	CPU	WAIT	JOB	CPU	WAIT	CPU	WAIT
ASM	2	0.51	3.76	2	0.58	5.11	0.871	0.742
EDT&GO	1	225.98	102.50	1	276.35	91.07	0.818	1.126
PTH	16	13.68	46.80	16	17.53	32.98	0.784	1.883
LOAD&GO	15	142.91	12.12	15	120.56	15.88	1.312	0.998
PL1	1	17.35	43.47	1	24.73	71.91	0.702	0.605

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
SINGLE PRECISION APPLICATIONS PROBLEMS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

JOBNAME	JOBS	CPU	WAIT	JOBNAME	JOBS	CPU	WAIT	CPU	WAIT
DOT2	1	349.07	90.54	DOT2	1	408.06	85.52	0.855	1.059
EROS	1	154.55	145.78	EROS	1	171.95	145.33	0.899	1.003
KTTFLCK	1	70.43	23.70	KTTFLCK	1	72.72	16.19	0.969	1.464
LINDA	1	266.36	207.74	LINDA	1	328.30	148.19	0.811	1.402
NVERTEX	3	100.97	75.01	NVERTEX	3	112.83	73.05	0.895	1.027
OWL	1	116.93	47.88	OWL	1	127.70	22.50	0.916	2.128
TOTAL	6	1058.31	590.65	TOTAL	6	1221.56	490.78	0.866	1.203
MEAN	6	176.39	98.44	MEAN	6	203.59	81.80	0.891	1.347

STEP = EDT&GO

JOBNAME	STEPS	CPU	WAIT	JOBNAME	STEPS	CPU	WAIT	CPU	WAIT
LINDA	1	225.98	102.50	LINDA	1	276.35	91.07	0.818	1.126
TOTAL	1	225.98	102.50	TOTAL	1	276.35	91.07	0.818	1.126
MEAN	1	225.98	102.50	MEAN	1	276.35	91.07	0.818	1.126

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

STEP = LOAD&GO

JOBNAME	STEPS	CPU	WAIT	JOBNAME	STEPS	CPU	WAIT	CPU	WAIT
DOT2	1	322.36	41.89	DOT2	1	372.95	51.08	0.864	0.820
EROS	1	134.63	83.14	EROS	1	145.51	89.77	0.925	0.926
KTTFLCK	1	67.29	1.48	KTTFLCK	1	68.53	1.60	0.982	0.925
NVERTEX	3	85.58	3.40	NVERTEX	3	92.88	21.28	0.921	0.160
OWL	1	113.75	3.05	OWL	1	123.64	4.99	0.920	0.611
TOTAL	5	723.61	132.96	TOTAL	5	803.51	168.72	0.901	0.788
MEAN	5	144.72	26.59	MEAN	5	160.70	33.74	0.923	0.688

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
DOUBLE PRECISION APPLICATIONS PROBLEMS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

JOBNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT	CPU	WAIT
ANLTRIM	1	138.71	34.80	1	113.74	34.83	1.220	0.999
DROPLET	1	489.70	5.06	1	283.43	5.21	1.728	0.971
EIGEN	1	23.76	9.28	1	15.38	8.55	1.545	1.085
LIFE1A	1	170.15	40.45	1	153.32	85.46	1.110	0.473
MATRIX	3	75.06	22.68	3	45.11	13.61	1.664	1.666
MONTE	1	210.30	16.17	1	169.67	7.71	1.239	2.097
MULTC	1	100.59	60.74	1	81.16	34.55	1.239	1.758
REXCO	1	196.46	19.18	1	156.20	16.92	1.258	1.134
SDIAG	1	35.17	23.16	1	15.63	4.62	2.250	5.013
SUMX	1	30.01	212.09*	1	109.03	184.55		
TOTAL	9	1439.90	231.52	9	1033.64	211.46	1.393	1.095
MEAN	9	159.99	25.72	9	114.85	23.50	1.473	1.689

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

STEP = LOAD&GO

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
ANLTRIM	1	125.36	9.22	1	95.97	12.27	1.306	0.751
DROPLET	1	488.00	1.94	1	281.29	3.06	1.735	0.634
EIGEN	1	21.48	2.87	1	12.33	3.87	1.742	0.742
LIFE1A	1	149.42	7.21	1	126.06	10.00	1.185	0.721
MATRIX	3	68.02	3.04	3	36.27	1.92	1.875	1.583
MONTE	1	204.29	1.82	1	162.42	2.22	1.258	0.820
MULTC	1	90.23	2.56	1	68.69	18.69	1.314	0.137
REXCO	1	178.25	3.08	1	133.82	3.76	1.332	0.819
SDIAG	1	33.30	6.41	1	13.32	1.44	2.500	4.451
TOTAL	9	1358.35	38.15	9	930.17	57.23	1.460	0.667
MEAN	9	150.93	4.24	9	103.35	6.36	1.583	1.184

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
USER JOBS AND TUNED KERNELS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

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JOBNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT		CPU	WAIT		
-----				*-----*				*-----*			
BIGREBUS	1	506.52	382.78	1	279.36	335.52		1.813	1.141		
BISONINT	1	649.65	593.18	1	379.54	329.20		1.712	1.802		
BITSET	1	28.63	0.15	1	39.27	0.18		0.729	0.833		
DIF1DADJ	1	130.59	17.03	1	73.94	16.96		1.766	1.004		
DIF1DMOD	1	512.97	36.72	1	292.34	54.68		1.755	0.672		
DIF1DRL	1	35.51	17.51	1	21.70	16.37		1.636	1.070		
DMATMUL	1	244.10	10.52	1	89.49	9.58		2.728	1.098		
EMATMUL	1	140.50	9.83	1	90.03	12.79		1.561	0.769		
FORTLIBD	1	117.13	8.28	1	78.72	6.38		1.488	1.298		
FORTLIBE	1	72.03	8.87	1	83.42	9.31		0.863	0.953		
FSQRT	1	297.06	5.70	1	83.30	6.08		3.566	0.937		
FX2DEMO	1	453.98	281.06	1	321.12	290.55		1.414	0.967		
MINVERT	1	81.49	6.17	1	70.86	4.74		1.150	1.302		
MORETEST	2	33.39	0.25	2	40.56	0.44		0.823	0.562		
NATRAN	1	95.08	16.21	1	87.58	18.29		1.086	0.886		
OVCBENCH	1	621.05	133.81	1	278.66	104.60		2.229	1.279		
REBUSTST	1	113.64	151.79	1	77.86	159.68		1.460	0.951		
SASBENCH	1	193.59	4.33	1	171.03	7.05		1.132	0.614		
-----				*-----*				*-----*			
TOTAL	18	4326.91	1684.19	18	2558.78	1382.40		1.691	1.218		
MEAN	18	240.38	93.57	18	142.15	76.80		1.606	1.008		
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ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
USER JOBS AND TUNED KERNELS

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AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
STEP = FTH									

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	

DMATMUL	1	1.27	9.09	1	1.53	8.11	0.830	1.121	
EMATMUL	1	1.26	8.37	1	1.56	11.36	0.808	0.737	
FORTLIBD	1	0.56	5.70	1	0.67	2.63	0.836	2.167	
FORTLIBE	1	0.52	6.21	1	0.67	2.66	0.776	2.335	
FSQRT	1	0.45	4.35	1	0.64	4.00	0.703	1.087	
MINVERT	1	0.86	4.79	1	1.04	3.42	0.827	1.401	
NATRAN	1	6.10	14.10	1	7.89	13.87	0.773	1.017	

TOTAL	7	11.02	52.61	7	14.00	46.05	0.787	1.142	
MEAN	7	1.57	7.52	7	2.00	6.58	0.793	1.409	

STEP = GO									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
BIGREBUS	1	506.52	382.78	1	279.36	335.52	1.813	1.141	
BISONINT	1	649.65	593.18	1	379.54	329.20	1.712	1.802	
BITSET	1	28.63	0.15	1	39.27	0.18	0.729	0.833	
DIF1DADJ	1	130.59	17.03	1	73.94	16.96	1.766	1.004	
DIF1DMOD	1	512.97	36.72	1	292.34	54.68	1.755	0.672	
DIF1DRL	1	35.51	17.51	1	21.70	16.37	1.636	1.070	
FX2DEMO	1	453.98	281.06	1	321.12	290.55	1.414	0.967	
MORETEST	2	33.39	0.25	2	40.56	0.44	0.823	0.562	
OVCBENCH	1	621.05	133.81	1	278.66	104.60	2.229	1.279	
REBUSTST	1	113.64	151.79	1	77.86	159.68	1.460	0.951	
SASBENCH	1	193.59	4.33	1	171.03	7.05	1.132	0.614	
TOTAL	11	3279.52	1618.61	11	1975.38	1315.23	1.660	1.231	
MEAN	11	298.14	147.15	11	179.58	119.57	1.497	0.990	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
USER JOBS AND TUNED KERNELS

AMDAHL 470V/6					IBM 370/195			AMDAHL / IBM	
STEP = LOADGO									

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
USER JOBS AND TUNED KERNELS

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP TIMES (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOB	CPU	WAIT	JOB	CPU	WAIT	CPU	WAIT
FTH	7	1.57	7.52	7	2.00	6.58	0.787	1.142
GO	11	298.14	147.15	11	179.58	119.57	1.660	1.231
LOADGO	7	148.05	1.85	7	81.34	3.02	1.820	0.614

SUMMARY OF STEP MEANS (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOB	CPU	WAIT	JOB	CPU	WAIT	CPU	WAIT
FTH	7	1.57	7.52	7	2.00	6.58	0.793	1.409
GO	11	298.14	147.15	11	179.58	119.57	1.497	0.990
LOADGO	7	148.05	1.85	7	81.34	3.02	1.793	0.751

AMDAHL / IBM

FUNCTION	JOBS	REAL4	REAL8	JOBS	REAL4	REAL8	REAL4	REAL8
EXP	1	12.60	14.12	1	12.06	10.32	1.044	1.369
LOG	1	8.16	17.64	1	7.13	8.70	1.145	2.027
SIN	1	8.24	20.31	1	8.75	10.53	0.941	1.929
SQRT	1	7.39	12.39	1	6.66	7.32	1.110	1.693
X ** Y	1	24.35	39.74	1	32.84	26.28	0.742	1.512
TOTAL	5	60.74	104.20	5	67.45	63.15	0.901	1.650
MEAN	5	12.15	20.84	5	13.49	12.63	0.996	1.706

AMDAHL / IBM

DIMENSION	JOBS	REAL4	REAL8	JOBS	REAL4	REAL8	REAL4	REAL8
38X38	1	113.41	191.62	1	74.11	71.14	1.530	2.694
39X39	1	125.57	208.00	1	83.16	77.34	1.510	2.689
40X40	1	135.42	225.02	1	87.24	82.01	1.552	2.744
57X57	1	393.22	744.58	1	259.94	238.58	1.513	3.121
58X58	1	403.71	747.14	1	260.98	249.09	1.547	2.999
59X59	1	432.26	783.49	1	290.34	263.26	1.489	2.976
60X60	1	445.06	813.18	1	291.04	274.51	1.529	2.962
78X78	1	1047.94	1757.82	1	634.26	663.74	1.652	2.648
79X79	1	1099.26	1891.58	1	687.62	705.67	1.599	2.681
80X80	1	1112.20	1906.05	1	689.33	721.04	1.613	2.643
TOTAL	10	5308.04	9268.47	10	3358.02	3346.39	1.581	2.770
MEAN	10	530.80	926.85	10	335.80	334.64	1.553	2.816

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MATRIX MULTIPLY KERNELS

AMDAHL 470V/6					IBM 370/195			AMDAHL / IBM	
KERNEL = BRITH									

DIMENSION	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	RFAL8	

38X38	1	25.47	40.70	1	17.08	17.03	1.491	2.390	
39X39	1	27.90	43.78	1	18.45	18.39	1.513	2.381	
40X40	1	30.72	48.26	1	20.26	19.78	1.516	2.439	
57X57	1	88.83	157.18	1	58.47	57.10	1.519	2.753	
58X58	1	91.52	159.36	1	60.69	59.76	1.508	2.667	
59X59	1	97.02	167.04	1	64.75	62.84	1.498	2.658	
60X60	1	100.74	172.93	1	67.84	66.21	1.485	2.612	
78X78	1	235.26	374.27	1	148.50	155.43	1.584	2.408	
79X79	1	244.86	396.42	1	154.38	161.33	1.586	2.457	
80X80	1	250.11	409.47	1	162.35	174.27	1.541	2.350	

TOTAL	10	1192.45	1969.41	10	772.77	792.15	1.543	2.486	
MEAN	10	119.24	196.94	10	77.28	79.21	1.524	2.511	

KERNEL = CRITH									
DIMENSION	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	
38X38	1	30.34	49.92	1	24.84	24.81	1.221	2.012	
39X39	1	33.54	54.53	1	26.77	26.86	1.253	2.030	
40X40	1	36.48	58.75	1	29.33	28.89	1.244	2.034	
57X57	1	106.88	187.26	1	84.58	83.22	1.264	2.250	
58X58	1	108.29	193.54	1	88.23	87.14	1.227	2.221	
59X59	1	115.58	201.34	1	94.12	91.61	1.228	2.198	
60X60	1	120.19	212.22	1	98.91	96.09	1.215	2.209	
78X78	1	277.50	455.17	1	214.26	220.72	1.295	2.062	
79X79	1	289.02	480.00	1	223.53	228.43	1.293	2.101	
80X80	1	296.45	496.00	1	233.44	237.41	1.270	2.089	
TOTAL	10	1414.27	2388.73	10	1118.02	1125.18	1.265	2.123	
MEAN	10	141.43	238.87	10	111.80	112.52	1.251	2.121	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MATRIX MULTIPLY KERNELS

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

KERNEL = DRITH

DIMENSION	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8
38X38	1	17.28	31.49	1	9.82	7.57	1.760	4.161
39X39	1	18.94	34.18	1	10.76	8.44	1.761	4.047
40X40	1	20.10	36.61	1	11.24	8.14	1.789	4.500
57X57	1	57.47	122.62	1	32.46	24.00	1.770	5.109
58X58	1	59.65	121.98	1	34.02	25.79	1.753	4.730
59X59	1	64.38	129.28	1	37.48	28.17	1.718	4.589
60X60	1	64.51	134.91	1	37.00	27.50	1.744	4.906
78X78	1	160.13	291.97	1	82.84	79.08	1.933	3.692
79X79	1	170.37	323.46	1	87.26	95.41	1.953	3.390
80X80	1	164.48	310.66	1	88.47	79.72	1.859	3.897
TOTAL	10	797.31	1537.15	10	431.34	383.82	1.848	4.005
MEAN	10	79.73	153.72	10	43.13	38.38	1.904	4.302

KERNEL = ERITH

DIMENSION	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8
38X38	1	21.38	36.35	1	11.56	11.37	1.848	3.198
39X39	1	23.94	39.30	1	15.25	12.20	1.569	3.220
40X40	1	25.73	42.24	1	13.72	13.19	1.875	3.202
57X57	1	74.62	144.26	1	48.25	39.16	1.547	3.683
58X58	1	77.44	142.08	1	40.74	40.24	1.901	3.531
59X59	1	83.46	148.22	1	53.75	42.17	1.553	3.515
60X60	1	85.76	153.98	1	45.70	44.47	1.876	3.462
78X78	1	200.70	336.00	1	99.20	109.28	2.023	3.075
79X79	1	209.79	364.80	1	128.01	116.06	1.639	3.143
80X80	1	215.30	363.01	1	108.20	119.69	1.990	3.033
TOTAL	10	1018.11	1770.24	10	564.40	547.84	1.804	3.231
MEAN	10	101.81	177.02	10	56.44	54.78	1.782	3.306

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MATRIX MULTIPLY KERNELS

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
KERNEL = FRITH									

DIMENSION	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	

38X38	1	18.94	33.15	1	10.80	10.36	1.753	3.201	
39X39	1	21.25	36.22	1	11.94	11.44	1.780	3.166	
40X40	1	22.40	39.17	1	12.69	12.01	1.765	3.261	
57X57	1	65.41	133.25	1	36.18	35.09	1.808	3.797	
58X58	1	66.82	130.18	1	37.29	36.16	1.792	3.600	
59X59	1	71.81	137.60	1	40.24	38.47	1.784	3.577	
60X60	1	73.86	139.14	1	41.58	40.24	1.776	3.458	
78X78	1	174.34	300.42	1	89.46	99.23	1.949	3.027	
79X79	1	185.22	326.91	1	94.44	104.44	1.961	3.130	
80X80	1	185.86	326.91	1	96.86	109.96	1.919	2.973	

TOTAL	10	885.90	1602.94	10	471.48	497.40	1.879	3.223	
MEAN	10	88.59	160.29	10	47.15	49.74	1.829	3.319	

AMDAHL 470V/6					IBM 370/195			AMDAHL / IBM		
-	*	-	-	*	*-*	*	-	-	*	
	KERNEL		JOB	REAL4	REAL8		JOB	REAL4	REAL8	
*-	*	-	-	*	*-*	*	-	-	*	*-
	BRITH		1	1192.45	1969.41		1	772.77	792.15	
	CRITH		1	1414.27	2388.73		1	1118.02	1125.18	
	DRITH		1	797.31	1537.15		1	431.34	383.82	
	ERITH		1	1018.11	1770.24		1	564.40	547.84	
	FRITH		1	885.90	1602.94		1	471.48	497.40	
*-	*	-	-	*	*-*	*	-	-	*	*-
	TOTAL		5	5308.04	9268.47		5	3358.02	3346.39	
	MEAN		5	1061.61	1853.69		5	671.60	669.28	
*-	*	-	-	*	*-*	*	-	-	*	*-

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MATRIX MULTIPLY KERNELS

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
DIMENSION = 38X38									

KERNEL	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	

BRITH	1	25.47	40.70	1	17.08	17.03	1.491	2.390	
CRITH	1	30.34	49.92	1	24.84	24.81	1.221	2.012	
DRITH	1	17.28	31.49	1	9.82	7.57	1.760	4.161	
ERITH	1	21.38	36.35	1	11.56	11.37	1.848	3.198	
FRITH	1	18.94	33.15	1	10.80	10.36	1.753	3.201	

TOTAL	5	113.41	191.62	5	74.11	71.14	1.530	2.694	
MEAN	5	22.68	38.32	5	14.82	14.23	1.615	2.992	

DIMENSION = 39X39									
KERNEL	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	
BRITH	1	27.90	43.78	1	18.45	18.39	1.513	2.381	
CRITH	1	33.54	54.53	1	26.77	26.86	1.253	2.030	
DRITH	1	18.94	34.18	1	10.76	8.44	1.761	4.047	
ERITH	1	23.94	39.30	1	15.25	12.20	1.569	3.220	
FRITH	1	21.25	36.22	1	11.94	11.44	1.780	3.166	
TOTAL	5	125.57	208.00	5	83.16	77.34	1.510	2.689	
MEAN	5	25.11	41.60	5	16.63	15.47	1.575	2.969	

DIMENSION = 40X40									
KERNEL	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	
BRITH	1	30.72	48.26	1	20.26	19.78	1.516	2.439	
CRITH	1	36.48	58.75	1	29.33	28.89	1.244	2.034	
DRITH	1	20.10	36.61	1	11.24	8.14	1.789	4.500	
ERITH	1	25.73	42.24	1	13.72	13.19	1.875	3.202	
FRITH	1	22.40	39.17	1	12.69	12.01	1.765	3.261	
TOTAL	5	135.42	225.02	5	87.24	82.01	1.552	2.744	
MEAN	5	27.08	45.00	5	17.45	16.40	1.638	3.087	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MATRIX MULTIPLY KERNELS

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AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
DIMENSION = 57X57									

KERNEL	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	

BRITH	1	88.83	157.18	1	58.47	57.10	1.519	2.753	
CRITH	1	106.88	187.26	1	84.58	83.22	1.264	2.250	
DRITH	1	57.47	122.62	1	32.46	24.00	1.770	5.109	
ERITH	1	74.62	144.26	1	48.25	39.16	1.547	3.683	
FRITH	1	65.41	133.25	1	36.18	35.09	1.808	3.797	

TOTAL	5	393.22	744.58	5	259.94	238.58	1.513	3.121	
MEAN	5	78.64	148.92	5	51.99	47.72	1.582	3.519	

DIMENSION = 58X58									
KERNEL	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	
BRITH	1	91.52	159.36	1	60.69	59.76	1.508	2.667	
CRITH	1	108.29	193.54	1	88.23	87.14	1.227	2.221	
DRITH	1	59.65	121.98	1	34.02	25.79	1.753	4.730	
ERITH	1	77.44	142.08	1	40.74	40.24	1.901	3.531	
FRITH	1	66.82	130.18	1	37.29	36.16	1.792	3.600	
TOTAL	5	403.71	747.14	5	260.98	249.09	1.547	2.999	
MEAN	5	80.74	149.43	5	52.20	49.82	1.636	3.350	

DIMENSION = 59X59									
KERNEL	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	
BRITH	1	97.02	167.04	1	64.75	62.84	1.498	2.658	
CRITH	1	115.58	201.34	1	94.12	91.61	1.228	2.198	
DRITH	1	64.38	129.28	1	37.48	28.17	1.718	4.589	
ERITH	1	83.46	148.22	1	53.75	42.17	1.553	3.515	
FRITH	1	71.81	137.60	1	40.24	38.47	1.784	3.577	
TOTAL	5	432.26	783.49	5	290.34	263.26	1.489	2.976	
MEAN	5	86.45	156.70	5	58.07	52.65	1.556	3.307	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MATRIX MULTIPLY KERNELS

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
DIMENSION = 60X60									

KERNEL	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	

BRITH	1	100.74	172.93	1	67.84	66.21	1.485	2.612	
CRITH	1	120.19	212.22	1	98.91	96.09	1.215	2.209	
DRITH	1	64.51	134.91	1	37.00	27.50	1.744	4.906	
ERITH	1	85.76	153.98	1	45.70	44.47	1.876	3.462	
FRITH	1	73.86	139.14	1	41.58	40.24	1.776	3.458	

TOTAL	5	445.06	813.18	5	291.04	274.51	1.529	2.962	
MEAN	5	89.01	162.64	5	58.21	54.90	1.619	3.329	

DIMENSION = 78X78									
KERNEL	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	
BRITH	1	235.26	374.27	1	148.50	155.43	1.584	2.408	
CRITH	1	277.50	455.17	1	214.26	220.72	1.295	2.062	
DRITH	1	160.13	291.97	1	82.84	79.08	1.933	3.692	
ERITH	1	200.70	336.00	1	99.20	109.28	2.023	3.075	
FRITH	1	174.34	300.42	1	89.46	99.23	1.949	3.027	
TOTAL	5	1047.94	1757.82	5	634.26	663.74	1.652	2.648	
MEAN	5	209.59	351.56	5	126.85	132.75	1.757	2.853	

DIMENSION = 79X79									
KERNEL	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	
BRITH	1	244.86	396.42	1	154.38	161.33	1.586	2.457	
CRITH	1	289.02	480.00	1	223.53	228.43	1.293	2.101	
DRITH	1	170.37	323.46	1	87.26	95.41	1.953	3.390	
ERITH	1	209.79	364.80	1	128.01	116.06	1.639	3.143	
FRITH	1	185.22	326.91	1	94.44	104.44	1.961	3.130	
TOTAL	5	1099.26	1891.58	5	687.62	705.67	1.599	2.681	
MEAN	5	219.85	378.32	5	137.52	141.13	1.686	2.844	

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
MATRIX MULTIPLY KERNELS

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AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM		
DIMENSION = 80X80									

KERNEL	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	

BRITH	1	250.11	409.47	1	162.35	174.27	1.541	2.350	
CRITH	1	296.45	496.00	1	233.44	237.41	1.270	2.089	
DRITH	1	164.48	310.66	1	88.47	79.72	1.859	3.897	
ERITH	1	215.30	363.01	1	108.20	119.69	1.990	3.033	
FRITH	1	185.86	326.91	1	96.86	109.96	1.919	2.973	

TOTAL	5	1112.20	1906.05	5	689.33	721.04	1.613	2.643	
MEAN	5	222.44	381.21	5	137.87	144.21	1.716	2.868	

ARGONNE NATIONAL LABORATORY
 AMDAHL 470V/6 VS. IBM 370/195
 NRL BENCHMARK KERNELS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

AMDAHL 470V/6				IBM 370/195			AMDAHL / IBM	
JOBNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT	CPU	WAIT
NRLICH01	1	163.54	21.77	1	157.47	6.98	1.039	3.119
NRLICH02	1	129.98	15.13	1	111.97	4.49	1.161	3.370
NRLICH04	1	127.92	20.89	1	110.59	8.69	1.157	2.404
NRLICH05	1	150.43	7.07	1	136.43	7.82	1.103	0.904
NRLICH06	1	154.67	5.94	1	124.94	5.25	1.238	1.131
NRLICH07	1	221.75	4.14	1	94.29	3.66	2.352	1.131
TOTAL	6	948.29	74.94	6	735.69	36.89	1.289	2.031
MEAN	6	158.05	12.49	6	122.61	6.15	1.341	2.010

ARGONNE NATIONAL LABORATORY
AMDAHL 470V/6 VS. IBM 370/195
NRL BENCHMARK KERNELS

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

STEP = EDT

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
NRLICH01	1	0.13	5.52	1	0.17	3.04	0.765	1.816
NRLICH02	1	0.12	5.76	1	0.15	2.02	0.800	2.851
NRLICH04	1	0.12	4.49	1	0.15	4.69	0.800	0.957
NRLICH05	1	0.16	2.92	1	0.16	3.68	1.000	0.793
NRLICH06	1	0.13	2.72	1	0.16	2.74	0.813	0.993
NRLICH07	1	0.16	2.21	1	0.16	2.14	1.000	1.033
TOTAL	6	0.82	23.62	6	0.95	18.31	0.863	1.290
MEAN	6	0.14	3.94	6	0.16	3.05	0.863	1.407

STEP = FTH

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
NRLICH01	1	1.03	15.99	1	1.25	3.36	0.824	4.759
NRLICH02	1	0.68	8.96	1	0.84	2.29	0.810	3.913
NRLICH04	1	0.70	16.12	1	0.83	3.70	0.843	4.357
NRLICH05	1	1.01	3.92	1	1.33	3.94	0.759	0.995
NRLICH06	1	0.96	3.01	1	1.16	2.29	0.828	1.314
NRLICH07	1	1.14	1.66	1	1.43	1.31	0.797	1.267
TOTAL	6	5.52	49.66	6	6.84	16.89	0.807	2.940
MEAN	6	0.92	8.28	6	1.14	2.81	0.810	2.767

STEP = GO

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
NRLICH01	1	162.38	0.26	1	156.05	0.58	1.041	0.448
NRLICH02	1	129.18	0.41	1	110.98	0.18	1.164	2.278
NRLICH04	1	127.10	0.28	1	109.61	0.30	1.160	0.933
NRLICH05	1	149.26	0.23	1	134.94	0.20	1.106	1.150
NRLICH06	1	153.58	0.21	1	123.62	0.22	1.242	0.955
NRLICH07	1	220.45	0.27	1	92.70	0.21	2.378	1.286
TOTAL	6	941.95	1.66	6	727.90	1.69	1.294	0.982
MEAN	6	156.99	0.28	6	121.32	0.28	1.348	1.175

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IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP TIMES (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT	CPU	WAIT
EDT	6	0.14	3.94	6	0.16	3.05	0.863	1.290
FTH	6	0.92	8.28	6	1.14	2.81	0.807	2.940
GO	6	156.99	0.28	6	121.32	0.28	1.294	0.982

SUMMARY OF STEP MEANS (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT	CPU	WAIT
EDT	6	0.14	3.94	6	0.16	3.05	0.863	1.407
FTH	6	0.92	8.28	6	1.14	2.81	0.810	2.767
GO	6	156.99	0.28	6	121.32	0.28	1.348	1.175