[redacted] 25X1A

Main Post Office
Washington, DC 20013

12 December 1975

R E G I S T E R E D

Ampex Corporation
Advanced Technology Division
Terabit Memory Systems
1020 Kifer Road
Sunnyvale, California 94086

Attention: Mr. W.M. Slingland

Reference: Cable to AMPEX Corporation from Contracting Officer dated 4 December 1975.

Gentlemen:

The error rate stated in section 1a of the referenced cable is wrong. The specification states an unrecoverable error rate of only 1 in 62.5 billion bytes. The specification also states there is a raw error rate, without rereads, of only 1 error in each .375 billion bytes.

The translation of error rates into file loss at 70 files each day stands.

Very truly yours,

[redacted] STAT

Contracting Officer

AMPEX CORPORATION

401 BROADWAY · REDWOOD CITY, CALIFORNIA 94063
AREA CODE 415 · 367-2011 · TWX 910-376-5920 · TELEX 34-8464

January 9, 1976
Serial No. TMS-2/071

EXECUTIVE OFFICES

STAT Mr. [redacted]
Contracting Officer
STAT Post Office Box [redacted]
Main Post Office
Washington, D.C. 20013

STAT Subject : Contracts [redacted] TMS-2 Mass Storage System

Reference: (a) Agency Contracting Officer's Cable/Letter to V.E. Ragosine dated 4 December 1975

(b) Agency Contracting Officer's Letter to W.M. Slingland dated 12 December 1975

(c) Ampex Letter TMS-2/070 dated 23 December 1975

Gentlemen:

Consistent with our Reference (c) letter, this will acknowledge receipt and understanding of the Agency's concern over Ampex progress in the performance of the subject contracts as expressed in the Reference (a) correspondence and at the 18 December 1975 Management Review Meeting at the Agency. It is Ampex position that the "items of concern" as stated by the Agency need to be discussed, understood, and resolved; however, they are not of sufficient magnitude to indicate that successful completion of the contracts might be impaired. Ampex is committed to the timely completion of the TMS-2 Mass Storage System.

This letter is Ampex formal response to the Reference (a) and (b) Agency correspondence. Our response to the issues raised in the same sequence as Reference (a) is as follows:

a. We believe that there were misunderstandings between us as to the testing approach and philosophy during the November 1975 Redwood City test. These must be resolved prior to scheduling a formal Redwood City Preshipment Acceptance

Test. Ampex entered the November 1975 test believing that we had agreed at the 30 October 1975 Management Review Meeting to proceed with the test on a "mutual discovery" basis to assess overall development progress and status, thus, removing the contractual "pass/fail" connotation indicated in Reference (a).

Consequently, Ampex did not insist on its prerogative under
STAT Contract [redacted] Exhibit II, for prior approval of Agency prepared test procedures. Neither did Ampex complete a full "wring out" of the individual tests provided by the Agency. It was our understanding that it would be possible to work out the details as testing proceeded. In the formal context in which the November 1975 tests were run and without prior agreement on test procedures, definition of test sessions, and accept/reject criteria, it was impossible for Ampex to pass the Redwood City tests.

Based on the above and prior to scheduling the Redwood City Preshipment Acceptance Test, a detailed agreement relating to conduct of the test should be worked out between us, considering the following elements:

1. Definition of all tests to be run.

2. Definition of test procedures, sequence of tests, and planned action in case of difficulty or failure during testing.

3. Definition of discrete test sessions and the accept/reject criteria for such testing.

From Ampex viewpoint, the November 1975 tests were successful in exposing problem areas and demonstrating Ampex capability to resolve them promptly.

During the first four days of testing (test sessions 1 through 8), an inordinate number of failures occurred in moving some files from disk to TBM tape (descend) and from TBM tape to disk (ascend). These failures were diagnosed and an in-process installation of Read Verify software as well as an adjustment of the data channel hardware dramatically reduced the failure occurrences.

Thereafter, in test sessions 9 through 20, following implementation of the corrective actions by Ampex, 95% of the attempted descends (112 out of 118) were successful and 100% of the attempted ascends were successful. On this basis, no files were lost following incorporation of Read Verify software and data channel adjustment. Five of the six unsuccessful descends attempted following corrective action relate to functions which Ampex had never planned to support during a TMS-2 Release 1 PSAT. The remaining item relating to automatic demarking was recovered on retry at a different tape location. Ampex was not permitted to remove a known bad cylinder on the staging disk from use during testing which resulted in repetitive descend failures. Detailed summary data on the ascend and descend success ratio by test sessions, indicating reasons for failure and corrective actions taken, is provided as Attachment I.

There were also eighteen failure occurrences during the tests relating to software. Ampex acknowledges twelve of these occurrences as functional deficiencies in Release 1 Software; eleven have already been corrected, installed, and tested successfully. Partial capability of the twelveth item (set segment size less than 10) was installed at that time and we will have full capability for Final Release Software. The remaining six occurrences are considered by Ampex to have recovery implications which were not planned to be tested but will be incorporated for Final Release Software.

Attachment II is provided to detail the software failure occurrences and corrective actions.

The unrecoverable error rate stated in the Reference (b) correction of Reference (a) is incorrect and should be one error occurrence in 2.5 billion bytes read in lieu of 62.5 billion bytes as stated by the Agency.

b. As a result of the discussions during the December Management Review Meeting relating to the four design/action items, Ampex has re-evaluated its position on these issues. This re-evaluation has confirmed that the specification applicability trail within Contract [redacted] is not clear and is subject to widely varying interpretation differences. STAT

Further research and analysis of these design issues, in accordance with our commitment at the December meeting, has been completed and the following are Ampex revised positions:

1. Regarding concurrent access to individual transport drivers from both SCP's, the Agency cited Section 3.3.2.1.3, Paragraph 2, of the MSS Design Spec of 19 March 1975 to support its position. Ampex cited Section 10, Paragraph 2, and the specific floor cabling diagram on Page 172 of the same specification as justification for a different position.

   In recognition of the desirability of separating one SCP and one or more transport drivers from the online production TMS-2 equipment, Ampex agrees to provide dual floor cabling and manual switching capability to enable the Agency to run one SCP and one or more transport drivers offline from the remaining equipment, which can be run concurrently.

   Ampex will provide the above capability as a hardware function. The Agency should recognize that there are other procedural requirements which it must be responsible for in order to ensure system integrity. These include the proper sequence of operator commands to vary offline remaining DSS and CCS hardware from the primary SCP before reconfiguring the system with the second SCP. As the requirement for a split/dual system has never been clearly stated, Ampex requests that the Agency state clearly the purpose, intended use, and example configuration of the system with concurrent SCP access to transport drivers.

2. The specific hardware already ordered by the Agency, second increment, and options are covered under the Fixed Price Contract [redacted] The Agency cited the STAT MSS General Specification, Exhibit I, to Contract XG 3766 as basis for the position that perfect switching of a maximum hardware configuration is a contract requirement. It is Ampex view that the preparation and incorporation of the Mass Storage System Design/ Specification of 19 March 1975 supersedes and cancels the MSS General Specification under the "Design and

Analysis" provision of Contract [redacted] Further, STAT
it is Ampex position that delivery of a maximum STAT
system capability was clearly not a requirement authorized, planned, or costed under Contract [redacted].

In addition, at the time Contract [redacted] was con- STAT
verted from a standard CPFF to a CPFF with a ceiling, no costs were included in our proposal of 20 March 1975 to cover any expansion or reconfiguration beyond the hardware ordered or covered by option in Contract
STAT [redacted]

Future expansion capability to the maximum configuration has always been planned for the TBM product line to be accomplished consistent with marketing/ operational needs. It will be offered to the Agency when available or when specifically required and contracted for.

The present TMS-2 system design provides for incremental module expansion with perfect switching capability to a maximum of six transport drivers, sixty-four tape transports, two data channels, and two external data channel processors (EDCP) within the currently structured contract ceiling. A design change currently being implemented will enable field retrofit modification expansion to four external data channel processors.

In reviewing the contract performance requirements, the hardware and software capability for the existing system, and the above stated maximum configuration, it is Ampex view that two data channels and two external data channel processors are sufficient to handle the workload of a full six transport driver and sixty-four tape transport system. This is based upon utilization of one data channel during second and third shift operations for dispersal functions involving preparation of PRODTAPES and SPECTAPES. Our detailed analysis supporting our position that two data channels and two EDCP's are sufficient to handle a maximum system workload is provided as Attachment III.

3. During the October Management Review Meeting, Ampex indicated that a dedicated disk controller was required to access the MSS private files. The Agency took exception to this, citing Figure 3 of the MSS Design/Specification of 19 March 1975. Ampex reviewed its earlier position and indicated during the December Management Review that TMS-2 can operate with two shared BSS/MSS controllers as shown in Figure 3. Our detailed analysis supporting a position that two disk controllers shared between the staging disks and MSS private files are sufficient to handle the maximum workload is provided as Attachment IV. If, after installation and acceptance of TMS-2 at the Agency, it becomes apparent that the two shared disk controllers shown in Figure 3 of the MSS Design/Specification are inadequate to meet the representative MSS activity shown in Table 12, then Ampex will reimburse the Agency for the cost of procurement of an additional CDC 38302 controller.

4. Ampex software for the TMS-2 Mass Storage System has been implemented in a single storage control processor which will meet the performance requirements of the subject contracts. Other factors such as TBM tape search time and data transfer rate are more critical to system performance than CPU cycles available in a single SCP. Splitting the software functions into two parts, a master and a slave, may in fact degrade performance due to the increased communication overhead. The entire system becomes more complex, more difficult to manage and operate, and more difficult to develop, integrate and test. We believe the single SCP implementation approach is beneficial to the Agency as it enables a single SCP to meet full system performance requirements while the second unit is available for redundancy/backup purposes, similar to the IBM 3850 Mass Storage System. Further, the off-line/stand-alone dual system mode, made possible by the additional cabling and switching being provided by Ampex in connection with Item 1 above, reinforces the desirability of TMS-2 system software resident in a single SCP.

The Ampex Cost to Complete Proposal of 20 March 1975, on which Contract [redacted] ceiling price was based, STAT was predicated on continuation and completion of the software approach then under development.

Ampex considers that the intent of the Master/Slave SCP capability is fullfilled by providing for a stand-by SCP "watch dog" program to insure that the slave unit is available for system redundancy/backup in the event of failure of the master.

It is our view that the overall TMS-2 software design approach has been dramatically changed since the Ampex Technical Proposal #TBMP73-1 dated 24 January 1973 and the split software was only a possible implementation approach and not a specification requirement.

c. The TMS-2 Mass Storage System under Contract [redacted] has STAT always been developmental in nature. As a result of the Agency's concern and Ampex confidence in the overall system as defined in MSS Design/Specification of 19 March 1975, Ampex accepted the responsibility to perform the remaining development effort within a cost ceiling. The type of program undertaken by Ampex and the Agency has never before been accomplished and there are no easy solutions to scheduling, planning, and organizing the work that remains to be done. We have, however, accepted the responsibility to perform the subject contracts and have entered into the work with diligence and believe that we understood the basic requirements. In view of the issues raised via Reference (a) and our own assessment of progress as a result of the November 1975 tests, a total reassessment of the completion schedule is in order following discussions and agreement with the Agency. We are presently planning a concentrated software system design/specification review to plan and schedule the remaining software development for the project. As we indicated during the 18 December 1975 Management Review Meeting, our target schedule for hardware shipment is July 1976 and for Final Acceptance Test at the Agency in November 1976; however, resolution of the outstanding issues must be accomplished in the very near term to make these dates possible.

Ampex fully intends to complete the TMS-2 Mass Storage System at the earliest possible time without requesting any further funding beyond the present ceiling under Contract [redacted], assuming satisfactory STAT resolution to the above issues. We do, however, believe that many of the issues raised in the referenced correspondence have developed as a result of a breakdown in communications and understanding with people at both Ampex and the Agency. To improve project communications, Ampex believes it would be helpful to reinstate a resident Agency representative for the remainder of the project. Since the completion of the renegotiation of the TMS-2 project with the Agency in May 1975, Ampex has doubled its software staff primarily to support this project. We have restructured and reorganized the software group and added a full-time TMS-2 software manager. In further recognition of the importance of the project to Ampex Corporation, key project and engineering personnel participate in regular bi-weekly management review sessions for Advanced Technology Division Management.

We trust the above provides a full response to the Agency's concern and look forward to meeting with you at the earliest possible date to resolve the PSAT ground rules and other open issues identified.

Sincerely yours,

V. E. Ragosine
Vice President-General Manager
Advanced Technology Division

VER:fp

AMPEX

TMS-2 MASS STORAGE SYSTEM

NOVEMBER 1975 REDWOOD CITY TEST

DESCEND SUMMARY

SESSION	# DESCEND	# FAILURES	% SUCCESSFUL	COMMENTS - See P.3
1	Ø	Ø	--	--
2	23	1	96%	(1) Reason I
3	31	Ø	1ØØ%	--
4	3	3	Ø%	(3) Reason I
5	Ø	Ø	--	--
Software Modification				READ VERIFY INSTALLED
6	3	3	Ø%	(2) Reason II
				(1) Reason I
7	1Ø	3	77%	(3) Reason I
8	41	1Ø	8Ø%	(4) Reason I
				(6) Reason II
Hardware Modification				DATA CHANNEL ADJUSTED
9	15	2	88%	(2) Reason I
1Ø	Ø	Ø	--	--
11	23	Ø	1ØØ%	--
12	Ø	Ø	--	--
13	2Ø	1	95%	(1) Reason IV
14	21	1	95%	(1) Reason I
15	Ø	Ø	--	--
16	18	2	89%	(2) Reason III
17-2Ø	21	Ø	1ØØ%	--
Total 1-20	229	26	89%	
Total 9-20 After Corrective Actions Implemented	118	6	95%	

P.2 - TMS-2 Mass Storage System - November 1975 Redwood City Test

ASCEND SUMMARY

SESSION	# ASCENDS	# FAILURES	% SUCCESSFUL	COMMENTS - See P.3
1-2	Ø	Ø	--	--
3	2Ø	1	95%	(1) Reason II or V
4	6	2	67%	(2) Reason II or V
5	Ø	Ø	--	--
Software Modification				READ VERIFY INSTALLED
6-7	Ø	Ø	--	--
8	23	7	77%	(1) Reason VII
				(5) Reason V
				(1) Reason VI
Hardware Modification				DATA CHANNEL ADJUSTED
9-2Ø	77	Ø	1ØØ%	No file loss after Read Verify installed and Data Channel alignment modification made.
Total				
1-20	126	1Ø	92%	

REASONS

(15) Reason I - Bad tracks existed at two locations on BSSØØ1. Handling of these tracks not planned for PSAT. (Recovery type item.) Specific tracks were: Cylinder 28, Track 8 & Cylinder 288, Track 5.

(11) Reason II - Data Channel Read electronics improperly set-up to handle dropouts. Found prototype unit requires separate set-up procedure. Adjusted R11 on Assembly 621154Ø to eliminate errors.

(2) Reason III - Overflow record which spanned cylinder boundary. Function not planned for PSAT. (Recovery type item.)

(1) Reason IV - Demarkable block found. Recovered on retry at different tape location.

(7) Reason V - Read Verify function required as part of each Descend operation. Installed for usage after Session #5.

(1) Reason VI - Data Channel wire found disconnected after PSAT at Pin 22, J2, of Assembly 621139. This file was recoverable after reconnecting this wire.

(1) Reason VII - Reserve failure. Not supported. (Recovery type item.)

OTHER HARDWARE FAILURES

DA11-B	Two failures attributed to malfunction of this device. Replaced first portion after Session #1, remainder after Session #4.
SA11/TDIF Interrupt Handling	Eight(8) failures attributed to inability of SA11 and TDIF hardware to properly handle simultaneous interrupts. Missing wire added to SA11. TDIF design modified. Solution implemented and fully tested.

TMS-2 MASS STORAGE SYSTEM

NOVEMBER 1975 REDWOOD CITY TEST

SUMMARY OF SOFTWARE ERRORS

Session #'s	Occurrences	Description	Fix Implemented
2	2	- Error messages & completion messages not printed on flush command.	Fixed during Test
4	1	• "Setup complete" message in error should have been "breakdown complete". Interpreter cancelled job.	Fixed during Test
4	1	- Segment time limit currently at 10 instead of 1. File transfer segmentation limit currently at 17 segments for descend-disallowing large files.	Final release (R1 limited)
4	1	◆ SRQ full - request queue filled with job stream $1803MBL - set up for Biggie 1,2,3, & 4. Messages prioritized during test to drop low priority information only when full. Final system will have sufficient space.	Partial fix during Test
7	1	◆ Flush failure - nothing happened. Software timeout to TDP after lost interrupt. Error recovery will correct this.	Final release
9	1	◆ MSS aborted - incorrect MFD entries due to manual restart procedures. Error recovery will correct this.	Final release
10	1	◆ MSS sent incorrect message to host then hung looping. Manual restart procedure and incorrect MFD entries. Error recovery will correct this.	Final release

Key: ◆ Hard failure - caused system abort or required IPL to continue
• Incorrect operation - system did not function to specification
- Interpretation of operation - no files lost, jobs ran ok

P.2 - TMS-2 Mass Storage System
Summary of Software Errors

Session #'s	Occurrences	Description	Fix Implemented
13	1	• File conflicts. WM logic erroneously treated DISP on file required for 3 steps of a job.	Fixed during Test
13,16	3	• Priority conflicts - LIFO instead of FIFO within priority.	Fixed after Test
13	1	• Non-recognition of change in BSS configuration unless MSGØ91 received at IPL time.	Fixed after Test
17,18,19	3	• Deallocation did not stop - min/max logic not functioning correctly.	Fixed after Test
17	1	◆ Allocation lockout, space de-allocated on disk without MSS notification, wait loop for space. Error recovery will handle this.	Final release
20	1	◆ Display file abort - allocation lockout, op command had conflicting information on aborted. Error recovery will handle this.	Final release
	18		

Key: ◆ Hard failure - caused system abort or required IPL to continue (6)
• Incorrect operation - system did not function to specification (9)
- Interpretation of operation - no files lost, jobs ran ok (3)

TMS-2 MASS STORAGE SYSTEM

DESIGN/ACTION ITEM 2

Perfect Switching - Expanded System

Position

Up to 6 Transport Drivers may be configured in a TBM system with perfect switching. Up to 32 Dual Transport Modules may be configured in a TBM system with perfect switching. Up to 2 Data Channels may be configured in a system with perfect switching. Adding a 3rd Data Channel will reduce data channel utilization by less than 5% (from 11% utilization with 2 data channels to 7% utilization with 3 data channels). Up to 4 EDCP's may be configured in a system with perfect switching to 2 Data Channels. A 5th or 6th EDCP requires a 3rd data channel.

Analysis

Based on the Representative MSS Activity in Chapter 11 of the 19 March 1975 design specification, the following tables indicate Data Channel and EDCP utilization.

Data Channel utilization (expressed in hours busy and percent of time available busy) is shown for One Data Channel (this is the degraded mode of the current contract configuration), for Two Data Channels (current contract and present capability), and for Three Data Channels (the disputed capability desired by the Agency). The Read half of any data channel is utilized much more than the Write half because read requests are more frequent than write requests by a factor of about four and because the read half is used after every write operation for verification.

During the daytime peak of 10 hours, a single Read Data Channel can service all file read requests and read verify functions in 2.19 hours or 22% of the available 10 hours. With both Data Channels operational, the utilization of the read half of each is only 11%. A third Data Channel would reduce the duty cycle of each read data channel by only 4% from 11% to 7%. During the daytime 10 hours, the present contract and current capability provides 8.9 hours on each data channel out of 10 hours available during which the read data channel is not being used. This excess capacity of 8.9 hours can be used to perform tape-to-tape copy operations or to absorb an increased workload above that specified for the present contract.

P.2 - TMS-2 Mass Storage System - Design/Action Item 2

The night time activity has been shown compressed into 10 hours instead of the available 14 hours. This presents a worse case in terms of percent utilization and more realistically provides for equipment downtime for maintenance or system testing.

The read half of the data channel is again the most utilized. The production night workload would use 9% of a single read data channel at night, 4% of each of the two data channels provided in the present contract, and 3% of each of the three data channels if three were installed.

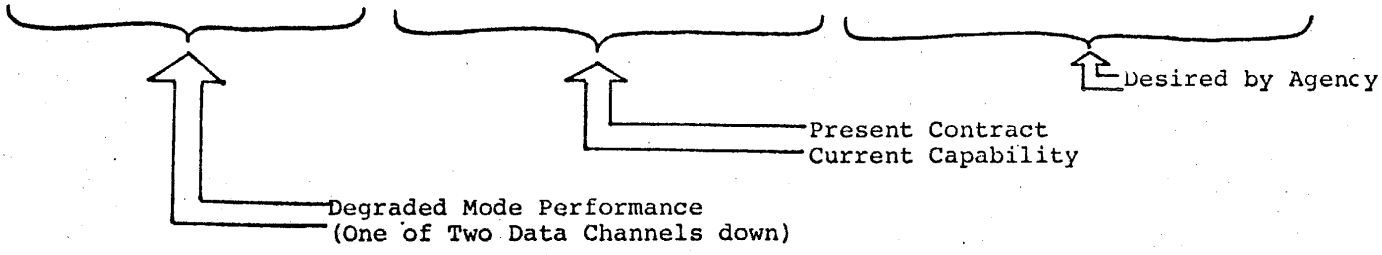
The log tape dispersal activity at night requires more read data channel utilization than the production workload. The dispersal function (elapsed time about 6 hours at night) requires only 1.76 hours of the 10 available hours of read data channel utilization. Even in a degraded mode of the present contract and current capability, a single read data channel can handle all night time production workload plus dispersal with an excess capability of 7.36 hours of 10 available hours. With both data channels operational (present contract and current capability), the data channel which is used for dispersal has an excess capacity of 7.8 hours and the other data channel has an excess capacity of 9.56 hours out of the 10 hours available. This excess capacity of 9.5 hours can be used to perform other tape-to-tape copy operations or to absorb an increased workload above that specified for the present contract. Adding a third data channel reduces the utilization of each data channel by about 1.5%.

EDCP utilization (expressed in hours busy and percent of time available busy) is shown for one through six EDCP's. The EDCP's are utilized most heavily during the day during which a single EDCP can service the production workload in 2.63 hours or about 26% utilization. The present contract and current capability with two EDCP's can support the representative MSS activity with a 13% utilization of each EDCP.

DATA CHAN[illegible] UTILIZATION

to Ampex Letter
TMS-2/071

	One Data Channel		Two Data Channels (Each)		IF Three Data Channels (Each)	
	Read	Write	Read	Write	Read	Write
Day (10 Hrs.)	2.19 hrs 22%	.44 hrs 4%	1.1 hrs 11%	.22 hrs 2%	.73 hrs 7%	.15 hrs 1.5%
Night (10 Hrs.)	.88 hrs 9%	.44 hrs 4%	.44 hrs 4%	.22 hrs 2%	.29 hrs 3%	.15 hrs 1.5%
Dispersal (10 Hrs.) (at night)	1.76 hrs 18%	.88 hrs 9%	1.76 hrs 18% 2nd DC not used for dispersal	.88 hrs 9% 2nd DC not used for dispersal	1.76 hrs 18% 2nd & 3rd DC not used for dispersal	.88 hrs 9% 2nd & 3rd DC not used for dispersal
Excess Capacity Day	7.81 hrs	9.56 hrs	8.90 hrs	9.78 hrs	9.27 hrs	9.85 hrs
Excess Capacity Night	7.36 hrs	8.68 hrs	7.80 hrs 1st DC 9.56 hrs 2nd DC	8.90 hrs 1st DC 9.78 hrs 2nd DC	7.95 hrs 1st DC 9.71 hrs 2nd & 3rd DC	8.97 hrs 1st DC 9.85 hrs 2nd & 3rd DC



EDCP UTILIZATION

	One EDCP	Two EDCP's (Each)	IF Three EDCP's (Each)	IF Four EDCP's (Each)	IF Five EDCP's (Each)	IF Six EDCP's (Each)
Day (10 Hrs.)	2.63 hrs 26%	1.32 hrs 13%	.88 hrs 9%	.66 hrs 7%	.53 hrs 5%	.44 hrs 4%
Night (10 Hrs.)	1.32 hrs 13%	.66 hrs 7%	.44 hrs 4%	.33 hrs 3%	.26 hrs 3%	.22 hrs 2%
Dispersal	0	0	0	0	0	0

Present Contract Current Capability

Current Capability with No Development Cost

Requires 3rd Data Channel

TMS-2 MASS STORAGE SYSTEM

DESIGN/ACTION ITEM 3

Shared Controller for MSS Private Disks

Position

Ampex does not require a dedicated control unit for the MSS private disks. All functions can be performed using a shared control unit configuration as illustrated in Figure 3 (Page 9) of the 19 March 1975 design specification. The system performance specified in Chapter 11 of the 19 March 1975 design specification can be met with the same shared control unit configuration.

Reservation

The Agency must be aware that there may be some infrequent times during which both EDCP's in Figure 3 (Page 9) are actively staging two large files through both of the shared control units. The duration of this busy condition could be as long as 153 seconds (two 403 cylinder files being staged in parallel). During the 153 seconds maximum busy time, neither SCP can access data on the private packs. This means that no new file request messages from the host computers may be received or processed. This is because the private packs are unavailable for message spooling or master file directory search operations.

During the busy time, the system does not fail because of the busy condition, no messages are lost, and no error conditions arise. The system simply must finish one of the two staging functions before it can begin any new work.

Analysis

Some recent measurements made on the system indicate the following statistics for private pack disk and controller utilization:

- One MVT Job requesting one TBM file causes

  100 program page disk accesses, and
  120 data base disk accesses, or

  220 total private pack disk accesses to service this job from beginning to end.

- o A disk access requires 2.5 milliseconds of SCP CPU time to set up and issue and 25 milliseconds of SA-11, control unit, and private pack disk busy time to execute.

- o The above numbers are worst case.

  - memory mapping and subtask work space swapping (both items planned for final release) will reduce the program page rate by a factor of three or four.

  - system tuning and some repackaging will reduce both data base accesses and program paging by a factor of two or three.

  - one file per job is not typical and the overhead per job is not a linear function of the number of files per day used below.

  - the LRU disk management scheme means that many files may not require staging and therefore will not require as many private pack disk accesses.

The peak daytime workload (0800-1800) from Figure 12 (Page 158) of the 19 March 1975 specification shows 2500 files ascended or descended. Assuming the worst case of one file per job, this represents:

	2500	files (jobs) in 10 hours
X	220	private pack disk accesses
=	550,000	disk accesses in 10 hours
X	25	millisec busy time per access
=	13,750	seconds (3.82 hours) out of 10 hours during which the SA-11, shared disk control unit, and private disk packs are busy supporting the SCP.

During this same 10 hour peak period, 7875 seconds (2.19 hours) are required to stage or destage 20,000 cylinders of data for 2500 files.

Therefore, if there were only one disk controller servicing both the private disk packs and the backfill storage disk packs, that control unit would be busy 6.01 hours (3.82 + 2.19) out of the 10 hour peak period or 60% utilization. This is the worst possible case and yet performance is easily met.

P.3 - TMS-2 Mass Storage System - Design/Action Item 3

With both control units functioning, one of the control units is busy 4.92 hours (3.82 + 1/2 X 2.19) and the other is busy 1.09 hours out of the 10 hours available. The representative MSS activity could double before the shared control unit is saturated.

Interpretation

All of the above is worst case. With memory mapping, system tuning, two or three files per job, and LRU management of the staging disks, the representative MSS activity could increase by a factor of five before the load on the shared private pack disk control unit became a critical factor. If and when the load does increase to this level, then the remedy is to add a third (non-shared) private pack disk control unit.