SOC-DR-1

DESIGN REQUIREMENTS FOR THE SCIENCE OPERATIONS CENTER FOR THE TETHERED SATELLITE SYSTEM

SOUTHWEST RESEARCH INSTITUTE

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LIST OF ACRONYMS	
Acronym	Description
AOS	Acquisition of Signal
ANSI	American National Standards Institute
ASI	Agenzia Spaziale Italiana
BFD	Block Formatted Data
BGJA	Bruce G. Jackson and Associates
CAS	Calibrated Ancillary System
CIP	Customer Interface Panel
DCORE	Deployer Core Equipment
DRB	Deployable/Retractable Boom
EGSE	Electrical Ground Support Equipment
EMET	Investigation of Electromagnetic Emissions in TSS
FO	Functional Objective
FOSA	Flight Operations Support Annex
GMT	Greenwich Mean Time
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
IDFS	Instrument Data File Set
IMDN	Investigation and Measurement of Dynamic Noise
IWG	Instrumentation Working Group
JSC	Johnson Space Center
KSC	Kennedy Space Center
LAN	Local Area Network
LOS	Loss of Signal
MMAG	Martin Marietta Astronautics Group
MSFC	Marshall Space Flight Center
MSID	Measurement/Stimuli Identification
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications Network
NRZ-L	Non-Return to Zero – Level
OESEE	Observations at Earth's Surface of EM Emissions
PDI	Payload Data Interleaver
PDR	Preliminary Requirements Review
PI	Principal Investigator

LIST OF ACRONYMS	
Acronym	**Description**
PIP	Payload Integration Plan
POCC	Payload Operations Control Center
RETE	Research on Electrodynamic Tether Effects
RGB	Red Green Blue
ROPE	Research on Orbital Plasma Electrodynamics
RPA	Retarding Potential Analyzer
SCORE	Satellite Core Equipment
SETS	Shuttle Electrodynamic Tether System
SFDU	Standard Format Data Units
SFMDM	Smart Flex Multiplexer Demultiplexer
SOC	Science Operations Center
SOD	Science Operations Director
SPCDS	Spacelab Payload Command and Data System
SPREE	Shuttle Potential and Return Electron Experiment
SwRI	Southwest Research Institute
TEID	Theoretical and Experimental Investigations of TSS Dynamics
TEMAG	Tether Magnetometer
TLM	Telemetry
TMST	Theory and Modeling in Support of Tether
TOP	Tether Optical Phenomenon
TSS	Tethered Satellite System
TSSPO	Tethered Satellite System Project Office

1. Scope

This document specifies the requirements for the TSS-1 Science Operations Center as they have been developed from the original system concept through completion of the Preliminary Requirements Review and pre-baseline review. The requirements are presented in a series of tables and figures and include all hardware, software, and support activities identified during the review process.

This document is intended to serve as a statement of work for the TSS-1 Science Operations Center independent of all requirements for flight hardware and ground support equipment specified in Contract NAS8-36840.

2. Applicable Documents

The following documents are cited for reference, except where specific sections are incorporated into or define a SOC requirement. Unless specified otherwise herein, the revision in effect at the date of original issue of this document is the applicable revision.

2.1. General Facilities

- POCC Capabilities Document, JSC-NSTS-21063.
- Calibrated Ancillary System (CAS) JSC-GSFC NASCOM Block ICD, JSC-10081, Vol. 11 (8.18-H), Nov. 1984.
- Calibrated Ancillary System (CAS) JSC-GSFC Mission Planning ICD, JSC-10081, Vol. 11 (9.18), Mar. 1985.
- Calibrated Ancillary System User Accommodation Handbook, GSFC 510-101.28, May 1989.
- Standard Orbiter Ancillary Data Parameter Definitions, JSC, Draft Mar. 8, 1989.
- Data Link Layer and Physical Layer Specifications, Version 2.0, Nov. 1982. Digital Equipment Corporation, Intel Corporation, and Xerox Corporation. The Ethernet: A Local Area Network.

2.2. Operation and Integration Agreements

- TSS-SRD-01.
- TSS-1 Payload Integration Plan (PIP) 18411.
- TSS-OIA-01 Tethered Satellite System to Shuttle Electrodynamic Tether System (SETS) Operations and Integration Agreement.
- TSS-OIA-03 Tethered Satellite System to Shuttle Potential and Return Electron Experiment (SPREE) Operations and Integration Agreement.
- TSS-OIA-04, TSS to Satellite Operation and Interface Agreement.
- TSS-OIA-05, TSS to Deployer CORE Operation and Interface Agreement.
- TSS-OIA-06 Tethered Satellite System to Deployer Operations and Integration Agreement

- TSS-OIA-07 Tethered Satellite System to Investigation and Measurement of Dynamics Noise (IMDN) Operations and Integration Agreement.
- TSS-OIA-08Tethered Satellite System to Investigation EM Electrodynamic Tether (EMET) Operations and Integration Agreement.
- TSS-OIA-09Tethered Satellite System to Theory and Modeling in Support of Tether (TMST) Operations and Agreement Agreement.
- TSS-OIA-10Tethered Satellite System to Observations at the Earth's Surface of EM Emissions by TSS (OESEE) Operations and Integrations Agreement.
- TSS-OIA-11Tethered Satellite System to Theoretical and Experimental Investigation on TSS Dynamic Noise (TEID) Operations and Integration Agreement.

2.3. Interface Documents

- ASI EID-04, RETE.
- ASI EID-06, ROPE.
- ASI EID-07, TEMAG.
- Aeritalia TS-SR-AI-019, CORE.
- Aeritalia TS-SR-AI-004, CORE.
- Aeritalia TS-SR-AI-003, CORE.

3. Requirements

- Requirements for the SOC are listed in Table I. The following codes are used in the table to indicate the source and classification of the requirements:

Source	Code
Project (MSFC)	PR
ROPE	RO
RETE	RE
TEMAG	MA
SETS	SE
SPREE	SP
DCORE	DC
SCORE	SC
DRB	DR
MMAG	MM
IWG	IW
System Concept	SY

Class	Code
Functional	F
General	G
Interface	I
Resource	R
Validation	V

- The mission phases, phase duration, and data rates to be accommodated during each mission phase are shown in Table II. Each mission phase will be archived separately. Inactive sections will

be dumped to tape to provide disk storage space of the current mission phase. At no time will the on-line data span a period greater than 36 hours.

- Joint science displays are shown in Figures 1a – 1d.
- Joint POCC displays are shown in Figures 2a – 2d.
- The SOC configuration is shown in Figure 3. SwRI will provide all PC Decom, archive, joint display, and project-provided workstation hardware.
- Detail configurations of each station type are shown in Figures 4a – 4d.
- The baseline SOC schedule is shown in Figure 5.

TABLE I. SOC REQUIREMENTS			
ID	Source	Class	Description
1	PR	G	The SOC shall provide equal resources to each PI group for Joint Science purposes, for Joint POCC purposes, and for evaluation of FO success criteria.
2	PR	G	Within the SOC all data is available to each PI group.
3	PR	R	All required data needed for both real-time (during mission) operations and post-mission data analysis will be archived. The on-line archive (kept on disk) will consist of three separate mission phases: pre-deployed, deployed, and post-deployed. Inactive sections will be dumped to tape to provide disk storage space for the current mission phase. At no time will the on-line data span a period greater than 36 hours. See Table II for mission phase durations and data rate.
4	IW,PR	F,R	The displays shown in Figures 1a–d, called the Joint Science Displays, will be available for evaluating the progress towards achieving the FOs. Display configurations will be finalized at the PDR.
5	IW, PR	F	As only two Joint Sciences Displays are simultaneously displayed, the SOC operator will select the appropriate displays from those shown in Figures 1a–d.
6	PR	G,R	The SOC system operation must be immune to single point failures of SOC hardware or software which will affect upstream operations.
7	PR	F,R	The Joint POCC displays 1, 2, 3, and 4 will be available at all times (See Figures 2a through 2d).
8	PR	F,I	The data integrity within and through the SOC must be assured. During mission operation, all data received at System Level II will be archived. It shall be possible to note the times when the CIP output ceases, has format errors, or is rejected for other reasons. These data can then be requested after mission termination.
9	PR	F,I	The operational integrity of the SOC must not be compromised by operational errors on a Project-provided workstation.
10	SY	F	The SOC must ingest PDI data in serial form (NRZ-L and/or Manchester biphase) at RS-422 levels from either the SPCDS at KSC or from a CIP at JSC. Separate interfaces will be provided for PDI from the SFMDM and from the satellite. The SOC-to-JSC interfaces are explicitly defined in the TSS-1 Payload Integration Plan (PIP) 18411, FOSA Annex 3.
11	SY	F	A burst data rate of up to 64 kbps must be accommodated for the PDI.
12	SY	F	The SOC must ingest CAS data in NASCOM blocks from a JSC-provided CIP. The SOC-to-JSC interfaces are explicitly defined in the TSS-1 Payload Integration Plan (PIP) 18411, FOSA Annex 3.
13	SY	F	A data rate of up to 19.2 kbps must be accommodated for the CAS.

TABLE I. SOC REQUIREMENTS (Continued)			
ID	Source	Class	Description
14	SY	F	PDI and CAS data streams will be decommutated into distinct data streams at Data Level C for each of the following: CAS, ROPE, RETE, SETS, SPREE, TEMAG, DCORE, SCORE, DRB, Deployer general parameters, Deployer critical parameters, and satellite parameters. Synchronization and transition words will be discarded from the IDFSs.
15	PR,SY	F	The SOC must handle PDI and CAS dump conditions. (Dump means the JSC playback of recorder data after the end of the mission.)
16	PR	F	There will be a display showing the real-time status of the PC Decom ingest and packetizing operations. The following parameters will be displayed: A. Number of CAS NASCOM blocks received B. Number of SFMDM minor frames received C. Number of satellite minor frames received D. Number of rejected NASCOM blocks E. GMT at which the last NASCOM block was rejected F. Number of synchrnization losses for serial input G. GMT at which either serial or BFD input was lost H. Number of packets placed on the Level B LAN by CAS, SFMDM, and satellite
17	PR	F	The PC Decom subsystem will keep a status log (on disk) of the parameters listed in ID 16. Parameters A, B, C, and H will be recorded at 5-minute intervals. Parameters D, E, F, and G will be recorded as they occur.
18	SY	F, I	The ingested PDI and CAS data will be verified for format correctness.
19	SY, PR	F	The Data Level B data blocks will be time-tagged with GMT to 1/100 second resolution. Satellite time will be correlated to GMT and, thus, satellite data blocks will be time-tagged as just stated.
20	SR	F	The failure of a flight instrument shall not affect the SOC operation, with the exception of those displays directly dependent on data from the instrument.
21	PR	R	Decommutation and archive functions will occur concurrently in two physically distinct computer groups for failsafe operation. The primary and secondary decommutation and archive subsystem groups must be powered by independent circuits so that a single circuit breaker cannot shut down both. These power circuits should come from an uninterruptible power supply. Both subsystem groups will be located in the SOC room.
22	SY	V, R	For SOC test and development purposes, the decommutation subsystem must be capable of providing data blocks derived from previously recorded data.

TABLE I. SOC REQUIREMENTS (Continued)			
ID	Source	Class	Description
23	SY	I, F	The operational characteristics of the SOC must not depend on a fixed configuration (i.e., the archive subsystem should not need knowledge of the number of user workstations or their network addresses).
24	PR	I	The SOC LANs will use standardized, off-the-shelf technology. Specifically, the SOC LANs are Ethernet V.2 compatible, using the 10 BASE 2 [3.1.F] wiring method. These LANs will support a 10mbps bandwidth with station taps spaced at 0.5 meter increments. Multiport transceivers are specifically excluded because a failure of one of these units could affect multiple stations. All transceivers, including spares, will be connected before SOC operations begin. Transceivers may be replaced during the SOC mission operation period, if necessary.
25	IW	F	The Joint Science Displays will have 4 possible time scales, selectable by operator command. The time scales will be determined by the IWG.
26	SY	F	The archival data shall be organized in an experiment-independent manner (e.g., the software must handle each type of data without special customization). The data will be recorded in a canonical format called the Instrument Data File Set (IDFS).
27	PR	F,R	The archive subsystem shall be able to produce copies of the data on magnetic tape after the mission operation is complete. These data tapes will be in 1/4 inch QIC-150 format, per ANSI DC-600XTD. Each cartridge tape will hold up to 150mB of data, including label and volume identification data. ANSI labeled tape format will be used for volume identification and data recording.
28	PR	F	The archive subsystem must accept IDFS playback requests during LOS periods.
29	SY	F	The archive subsystem must handle AOS during an archive playback in progress.
30	PR	F	The archive subsystem will maintain a disk file log of the amount and quality of the data archived.
31	PR	F	Software utilities will be provided to package the IDFS archive data using Standard Format Data Units (SFDU).
32	PR	F	Software will be provided to allow post-mission meta-data to be added to the archive and packaged within SFDUs.

TABLE I. SOC REQUIREMENTS (Continued)

ID	Source	Class	Description
33	PR	G	The software used to access and display the data will be made available on each workstation. The software provided by SwRI, exclusive of the SUN-provided software, is listed below: A. GraphIII graphics library, which includes source code and documentation. B. SOC Joint Science Display System, including source code and documentation. C. SOC Data Access Library for accessing data on the Level C LAN and from the archive system, and for retrieving IDFS fields and data from disk or QIC-150 format tapes. D. SOC SFDU library, including documentation. E. Makefiles, test, and verification routines will be included where applicable.
34	PR	F	The Joint Science and POCC Displays will use a traversing, vertical scroll bar to indicate the current time.
35	SY	F	Each workstation at System Level III must acquire the lookup tables used for logical instrument calibration upon boot-up.
36	SY	F	The lookup tables must also be downloaded from the archive system when commanded by the operator.
37	DC	F	The archive subsystem must handle the asychronous DCORE data so that it can be processed, displayed, and archived in the same manner as the frame-synchronous data. A maximum of 15 minor frames of DCORE data can be lost before synchronization occurs.
38	SE	F	The Joint Display subsystem must generate the correct step voltage for the production of the SETS Langmuir Probe and RPA spectrograms from the asynchronous sweeps.
39	SY	F	All SOC workstations must reboot in less than 30 secs. In order to stay within this limit, each SOC workstation will disable the *fsck* program during the mission operations.
40	SY	F	Logical instrument definitions must be created for each experiment.
41	PR	R	Color hardcopies must be easily and quickly made of any display at System Level III. These hardcopies will be produced on Tektronix 4693 RGB raster printers by loading the RGB display output. The 4693 RGB will produce an "A" size color print in 43 seconds, with a capture time of 4 seconds. Three sets of four workstations will share a printer via a 4-channel multiplexer. The IWG will determine which 12 workstations will have direct access to the printers.
42	MM	F	All TSS CAS parameters available at the CIP will be archived and made available to the workstations at System Level III. These parameters and their sampling rates are defined in PIP Annex 5.

TABLE I. SOC REQUIREMENTS (Continued)

ID	Source	Class	Description
43	MM	R	The project-furnished SOC system components will have the following configuration (see Figures 3, and 4a-d): A. Decommutation Subsystem 1) 80386 PC running at 25 MHz 2) 2-mbyte memory 3) 40-mbyte and 180-mbyte hard disks 4) Special quad-port high-speed serial interface 5) Ethernet V.2 10 Base 2 interface card 6) CGA video adaptor and monitor 7) BGJA PC Decom software This subsystem is duplicated for failsafe operation. B. Archival Subsystem 1) SUN 4/370-S-32-P14 SPARCserver 370 2) SUN 450A second ethernet controller 3) HDS 3200 Model 10 15" B/W CRT 4) SUN X660H 150-mbyte 1/4" desktop cartridge tape unit This subsystem is duplicated for failsafe operation. C. Joint Display Subsystem 1) SUN 4/60C-8-P3 SPARCstation 1 (with 19" color monitor) 2) SUN X551H 104-mbyte internal disk 3) GraphOn 470HR 16" Color CRT 4) NDS GP220Z 15" B/W CRT There are two of these systems. D. Project-provided Workstations. 1) SUN 4/60FC-8-P3 SPARCstation 1 (with 16" color monitor) 2) SUN X551H 104-mbyte internal disk 3) SUN X660H 150-mbyte 1/4" desktop cartridge tape unit 4) Sun X450H second ethernet controller There are seven of these systems, plus two spare systems E. LANs Ethernet V.2 10 Base 2, with ISOLAN 1114 transceivers
44	PR	V	A system test and verification procedure will be implemented. This procedure will be approved by the TSSPO.
45	SE	F	The SOC must be a real-time system, e.g., the data flow through the SOC must occur at the highest rate that does not interfere with the archiving task. The SOC system processing shall not add more than 5 seconds of delay time to data packets before they are made available on the Level C LAN.

TABLE I. SOC REQUIREMENTS (Continued)			
ID	Source	Class	Description
46	PR	G	Training on the SOC functions will be provided to each PI at SwRI. The training plan and schedule will be determined at the preliminary design review.
47	PR	I	User EGSEs will be accommodated at Data Level C or System Level III only.
48	PR	F	Common decommutation and archival databases will be provided for use at both KSC and JSC.
49	PR	F	Each experiment group is responsible for all experiment-specific software.
50	PR	I,F	Software will be provided for the SETS workstation to build the same SETS TLM page that is input to the SFMDM.
51	PR	F	The Joint Displays shall be updated in real-time.
52	PR	I	Software will be provided to receive data from the Level C LAN. The users must provide software to send and receive data on their secondary Ethernet ports.
53	PR	G	A SOC System Manager will be provided for each shift for Level IV testing at KSC and for pre-mission simulations and mission operations at JSC.
54	PR	G	One PC Decom station, one archive station, two user workstations, and one printer station will be provided at KSC to support Level IV testing. Reusable shipping containers will be provided for this equipment.
55	PR	G	SOC activities will be performed in accordance with the schedule shown in Figure 5.
56	PR	R	Maintenance will be provided through June 1991 for all project-furnished equipment. Maintenance of SUN equipment will be on a next-day, on-site basis with an uplift to 24-hour coverage, 7 days a week, with 2-hour response for the month of May 1991.
57	SY	V	Documentation for existing software which is used for the SOC without modification will be used as-is. Documentation for existing software which is modified for use with the SOC will be changed to clearly show the modification. Documentation for software developed specifically for the SOC will be in accordance with MSFC-PLAN-1554, Paragraph 3.2. Generic documentation will be used to the extent possible for logical instrument software.
58	SY	V	The TSSPO will delegate responsibility for review and approval of software documentation to TSS project personnel.
59	SY	V	The TSSPO will delegate responsibility for witness and approval of software/system verification test to TSS project personnel.
60	SY	R	SwRI will provide all cabling necessary for the SOC up to the CIP. JSC is responsible for installation of the cables in the SOC and satellite support rooms.
61	SY	R	One copy of all archive data will be furnished to each user within 30 days after completion of the mission.

TABLE I. SOC REQUIREMENTS (Continued)			
ID	Source	Class	Description
62	SY	G	NASA is responsible for disposition of all SOC equipment after completion of the mission.
63	RO	G	Raw telemetry may be recorded at System Level II for possible post-mission use. This is a SwRI option only and is not a SOC design requirement. Any such recording shall not interfere with successful processing or archiving of IDFS files.

TABLE II. ARCHIVE REQUIREMENTS				
Mission Phase	Duration (Hours)	Data Rate (kbps)		
		Satellite	SFMDM	CAS
Pre-Deployed	26	16	33.333	19.2
Deployed	36	16	33.333	19.2
Post-Deployed	24	—	33.333	19.2

Each mission phase will be archived separately. Inactive sections will be dumped to tape to provide disk storage space for the current mission phase. At no time will the on-line data span a period greater than 36 hours.

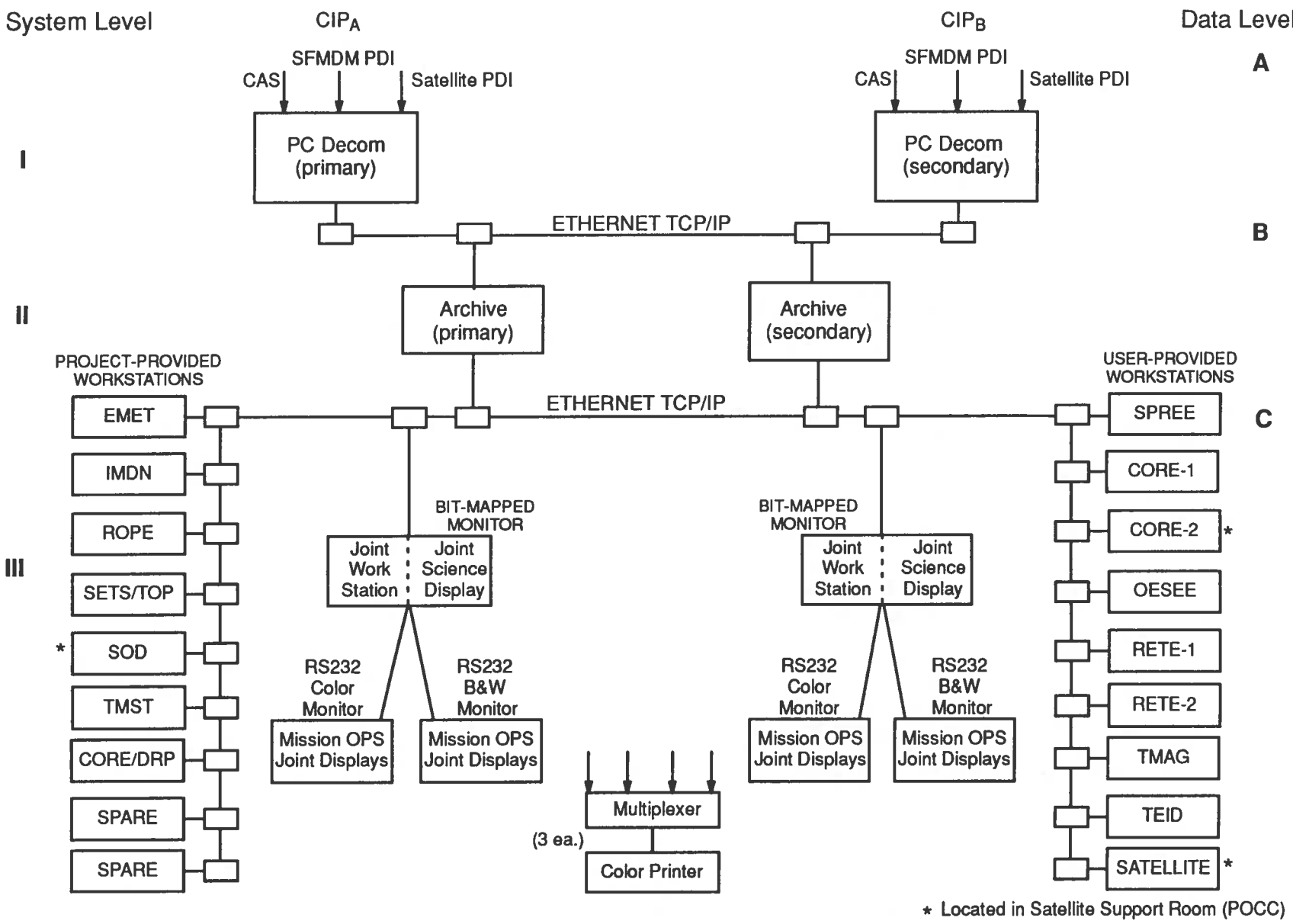

Figure 3. SOC Configuration

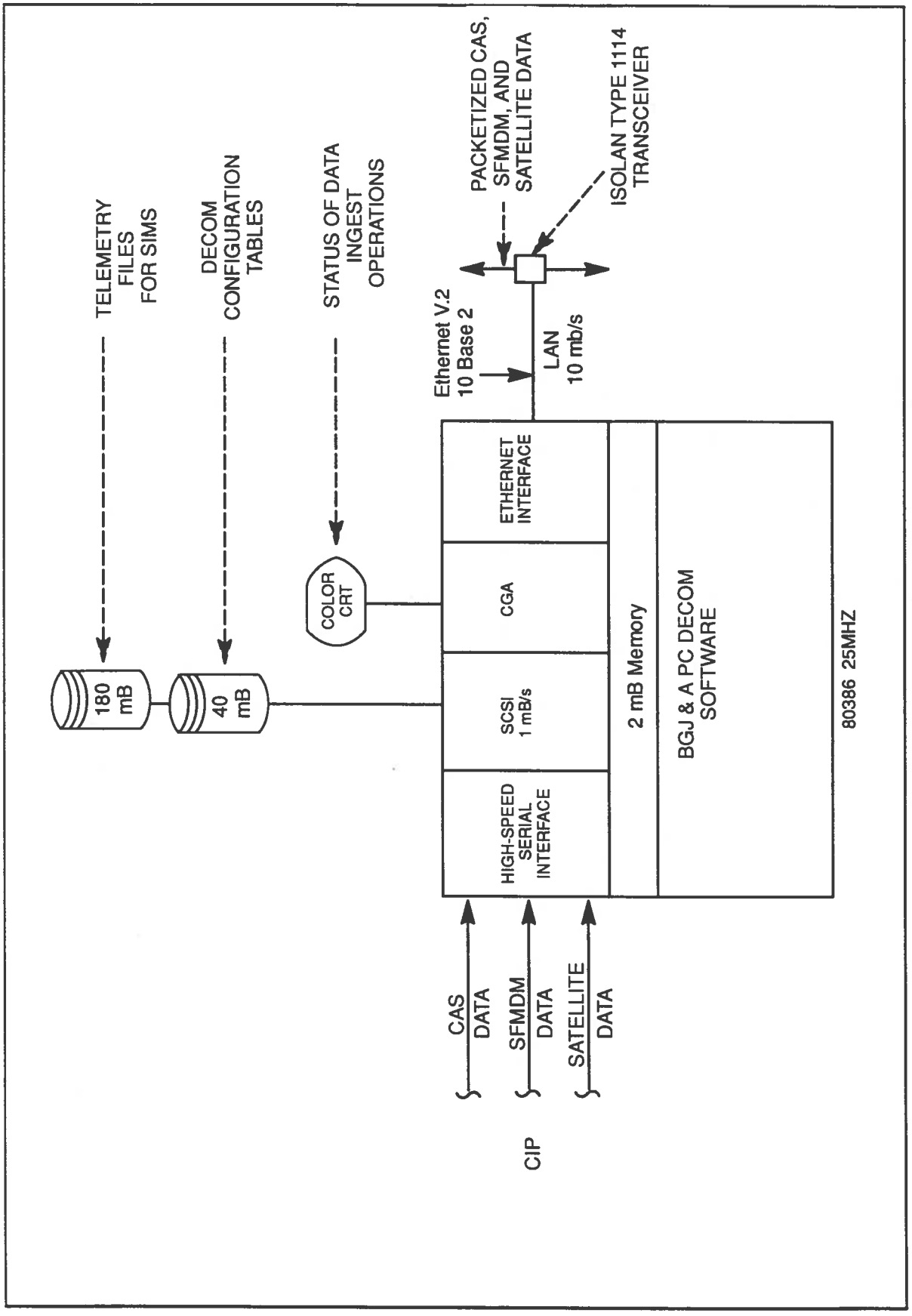

Figure 4a. SOC System Level I PC DECOM

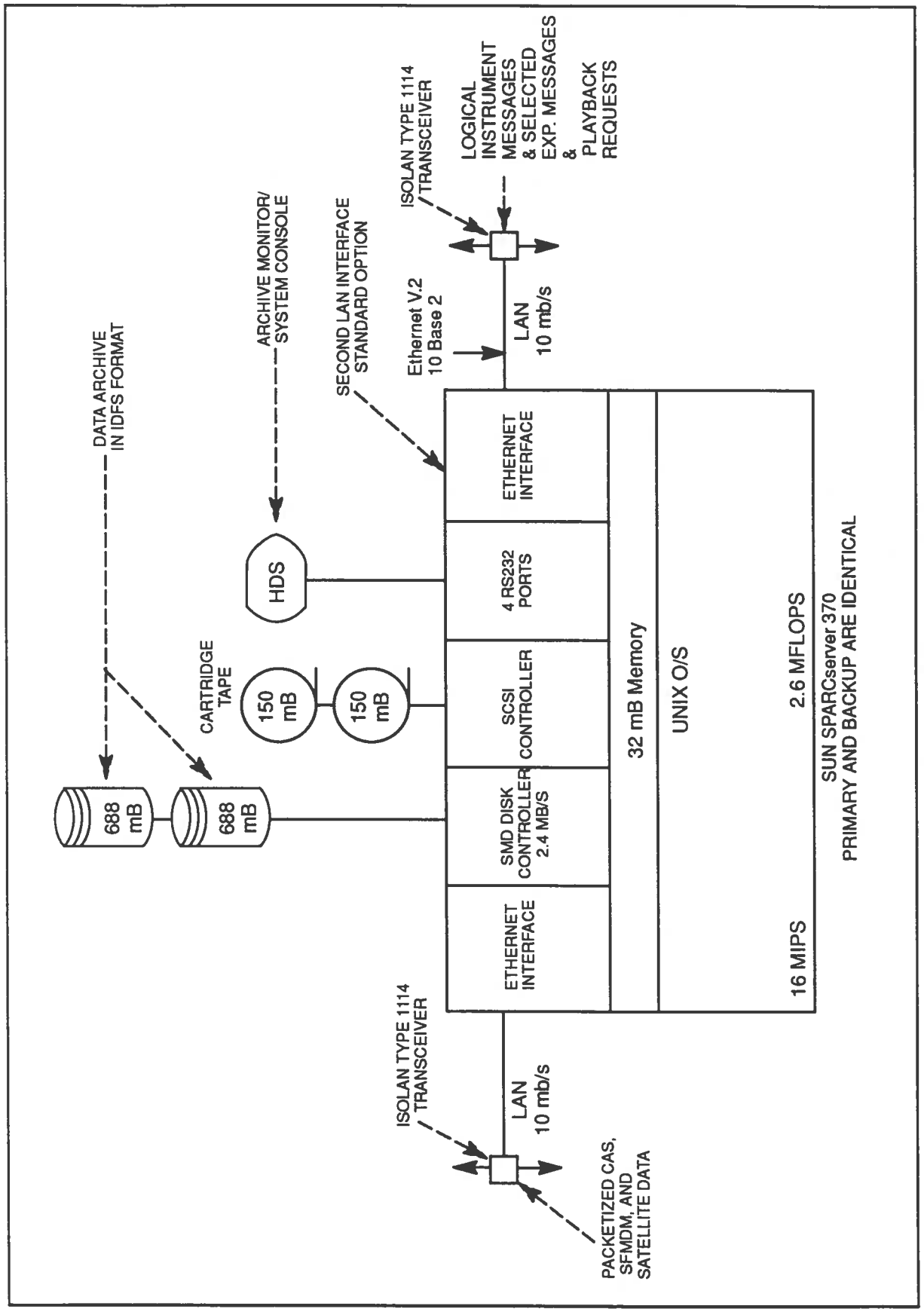

Figure 4b. SOC System Level II Archive

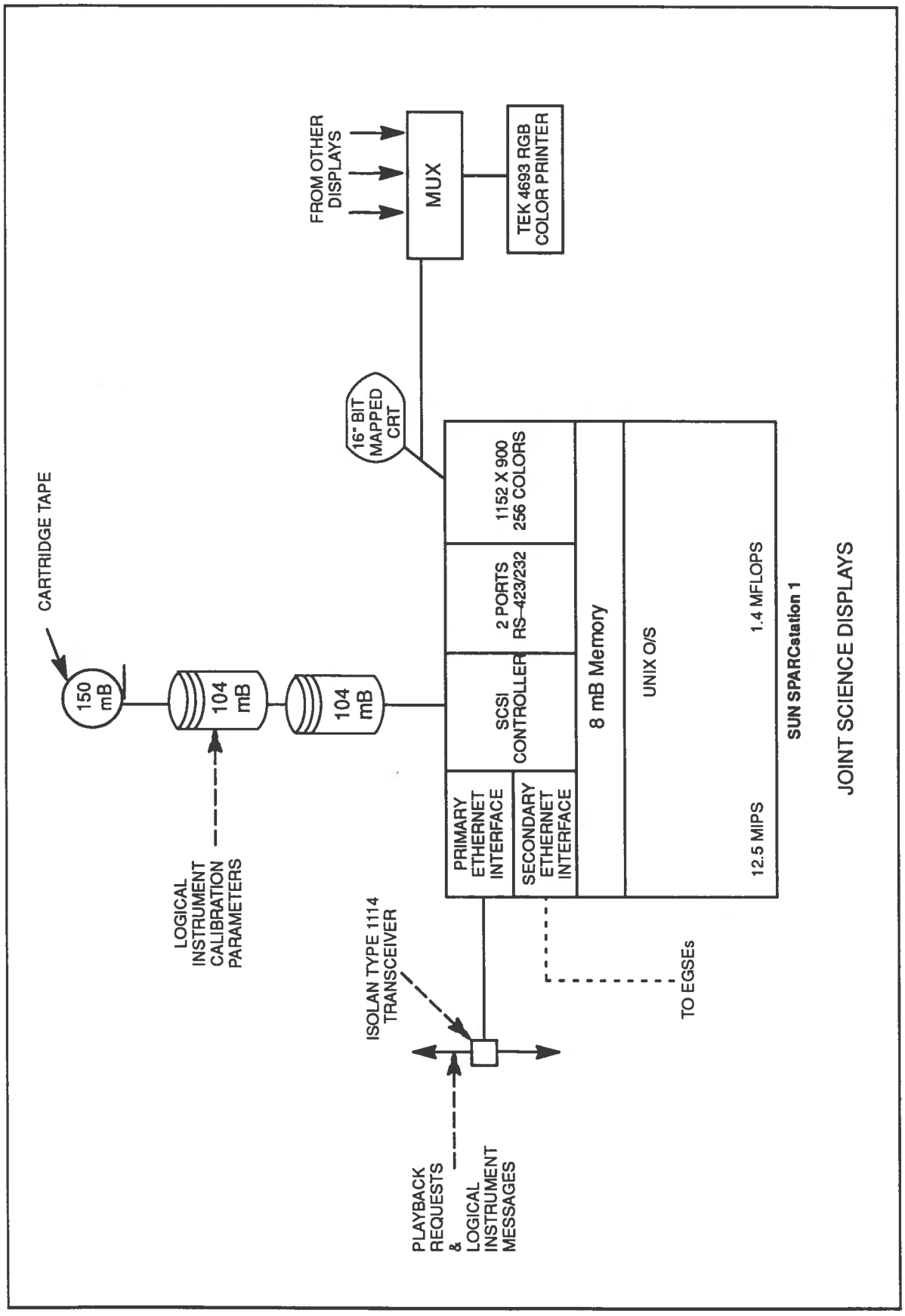

Figure 4c. SOC System Level III User W/S

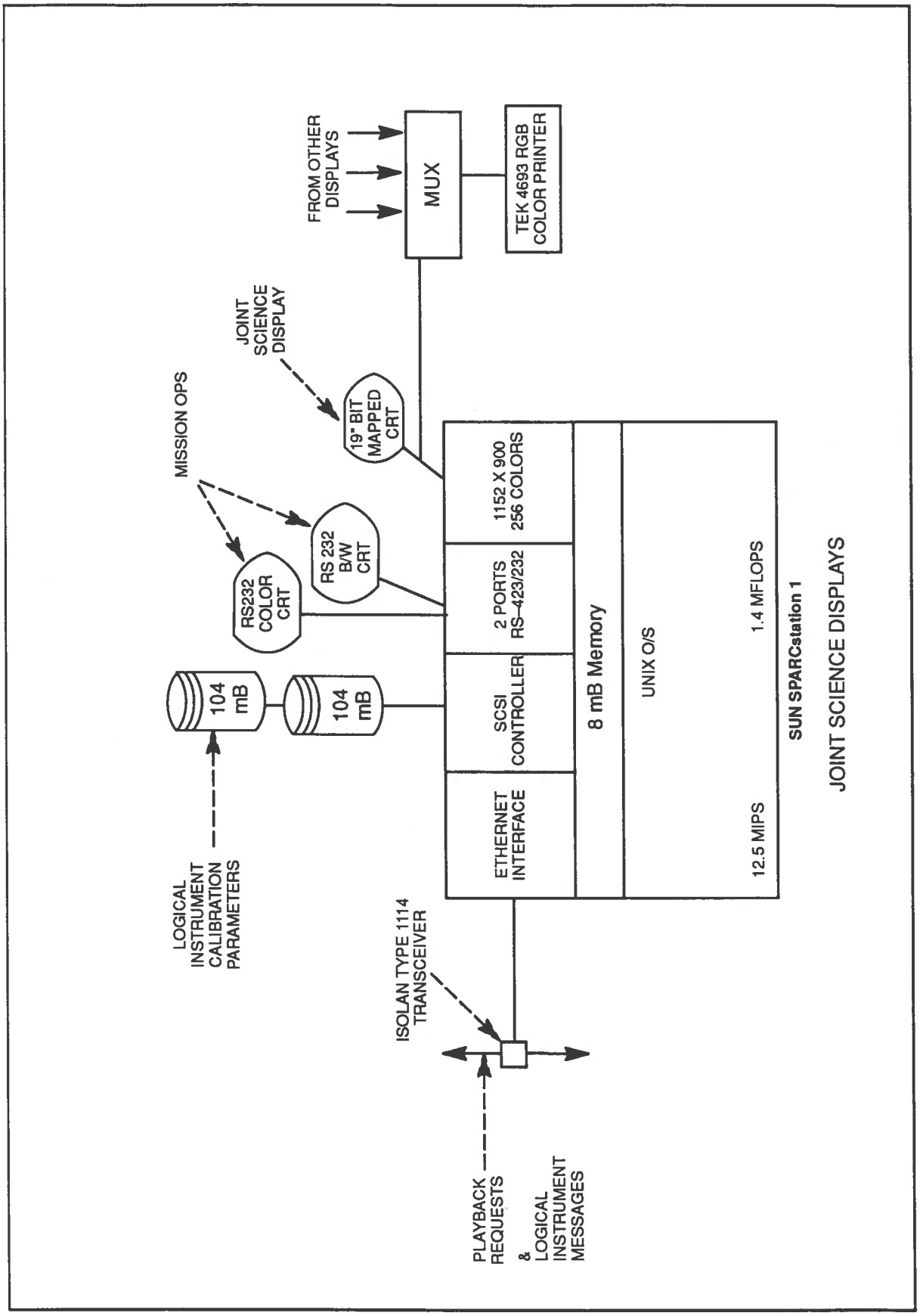

Figure 4d. SOC System Level III Joint W/S

Figure 5. SOC Schedule

TABLE III. SOC CAS PARAMETERS		
MSID	**Parameter**	**Format**
Water Dumps		
V62X0455E	Supply H20 Dump ISLN VLV (Closed)	BD
V62X0465E	Supply H20 Dump VLV (Open)	BD
V62X0533E	Waste H20 Dump ISLN VLV (Closed)	BD
V62X0538E	Waste H20 Dump VLV (Open)	BD
V62Q0540A	Waste H20 Tank QTY	AMU
V62Q0410A	Potable H20 Tank QTY A	AMU
V62Q0420A	Potable H20 Tank QTY B	AMU
V62Q0548A	Potable H20 Tank QTY C	AMU
V62Q0544A	Potable H20 Tank QTY D	AMU
Fuel Cell Purging		
V45X0804E	Fuel Cell Auto Purge (on)	BD
Orbiter Vernier Control System		
V79X2615X	Vernier Jet F5L Driver	BD
V79X2616X	Vernier Jet F5R Driver	BD
V79X2629X	Vernier Jet L5D Driver	BD
V79X2630X	Vernier Jet L5L Driver	BD
V79X2643X	Vernier Jet R5R Driver	BD
V79X2644X	Vernier Jet R5D Driver	BD
V79X2601X	RCS Jet F1F Driver	BD
V79X2602X	RCS Jet F1L Driver	BD
V79X2603X	RCS Jet F1U Driver	BD
V79X2604X	RCS Jet R1D Driver	BD
V79X2605X	RCS Jet F2F Driver	BD
V79X2606X	RCS Jet F2R Driver	BD
V79X2607X	RCS Jet F2U Driver	BD
V79X2608X	RCS Jet F2D Driver	BD
V79X2609X	RCS Jet F3F Driver	BD
V79X26010X	RCS Jet F3L Driver	BD
V79X2611X	RCS Jet F3U Driver	BD
V79X2612X	RCS Jet F3D Driver	BD
V79X2613X	RCS Jet F4R Driver	BD
V79X2614X	RCS Jet F4D Driver	BD
V79X2617X	RCS Jet L1A Driver	BD
V79X2618X	RCS Jet L1L Driver	BD

TABLE III. SOC CAS PARAMETERS (Continued)		
MSID	**Parameter**	**Format**
V79X2619X	RCS Jet L1U Driver	BD
V79X2620X	RCS Jet L2L Driver	BD
V79X2621X	RCS Jet L2U Driver	BD
V79X2622X	RCS Jet L2D Driver	BD
V79X2623X	RCS Jet L3A Driver	BD
V79X2624X	RCS Jet L3L Driver	BD
V79X2625X	RCS Jet L3D Driver	BD
V79X2626X	RCS Jet L4L Driver	BD
V79X2627X	RCS Jet L4U Driver	BD
V79X2628X	RCS Jet L4D Driver	BD
V79X2631X	RCS Jet R1A Driver	BD
V79X2632X	RCS Jet R1R Driver	BD
V79X2633X	RCS Jet R1U Driver	BD
V79X2634X	RCS Jet R2R Driver	BD
V79X2635X	RCS Jet R2U Driver	BD
V79X2636X	RCS Jet R2D Driver	BD
V79X2637X	RCS Jet R3A Driver	BD
V79X2638X	RCS Jet R3R Driver	BD
V79X2639X	RCS Jet R3D Driver	BD
V79X2640X	RCS Jet R4R Driver	BD
V79X2642X	RCS Jet R4U Driver	BD
V79X2644X	RCS Jet R4D Driver	BD
V41X1388E	MPS-LH2 OUTBOARD FILL VZV (OPEN)	BD
V41X1389X	MPS-LH2 OUTBOARD FILL VLV (CLOSED)	BD
V41X14096	MPS–LH2 INBOARD FILL VLV (OPEN)	BD
V41X1410X	MPS-LH2 INBOARD FILL VLV (CLOSED)	BD
V41X1509X	MPS-LOX INBD FILL VLV (CLOSED)	BD
V41X15106	MPS-LOX INBD FILL VLV (OPEN)	BD
V41X15136	MPS-LOX OUTBD FILL VLV (OPEN)	BD
V41X1514X	MPS-LOX OUTBD FILL VLV (CLOSED)	BD
Orbiter Electrical Power		
V45V0100A	FC 1 Volts	AMU
V45C0101A	FC 1 Amps	AMU
V76V0100A	Main BUS A Volts	AMU
V45V0200A	FC 2 Volts	AMU

TABLE III. SOC CAS PARAMETERS (Continued)		
MSID	**Parameter**	**Format**
V45C0201A	FC 2 Amps	AMU
V76V0200A	Main BUS B Volts	AMU
V76X2833E	PL PRI MNB ON	BD
V45V0300A	FC 3 Volts	AMU
V45C0301A	FC 3 Amps	AMU
V76V0300A	Main BUS C Volts	AMU
V76V2843E	PL PRI FC 3 ON	BD
V76X2838E	PL PRI MNC ON	BD
V76X2810E	PL AFT MNB PWR ON (STA 1307)	BD
V76C2811A	PL AFT MNB AMPS	AMU
V76X2821E	PL AFT MNC PWR ON (STA 1307)	BD
V76C2822A	PL AFT MNC AMPS	AMU
V76X2845E	MAIN C GND	BD
V76X2868E	PL AUX MAIN A ON	BD
V76X2869E	PL AUX MAIN B ON	BD
V76S2851E	PL CABIN MAIN A ON	BD
V76S2853E	PL CABIN MAIN B ON	BD
V76V1500A	AC1 OA VOLTS	AMU
V76V1501A	AC1 OB VOLTS	AMU
V76V1502A	AC1 OC VOLTS	AMU
V76V1600A	AC2 OA VOLTS	AMU
V76V1601A	AC2 OB VOLTS	AMU
V76V1602A	AC2 OC VOLTS	AMU
V76V1700A	AC3 OA VOLTS	AMU
V76V1701A	AC3 OB VOLTS	AMU
V76V1702A	AC3 OC VOLTS	AMU
Orbiter Time		
V75W3504D	MTU-PCM VOTED GMT TOTAL TIME	EMD
V75W3514D	MTU-PCM VOTED MET TOTAL TIME	EMD
V75W3604D	MTU-NON-VOTED GMT TOTAL TIME	EMD
V75W3614D	MTU-NON-VOTED MET TOTAL TIME	EMD
Orbiter State Vector (M-50 Reference System)		
V95H0178C	X-COMP of Current Shuttle POS Vector	DPL
V95H0186C	Y-COMP of Current Shuttle POS Vector	DPL
V95H0187C	Z-COMP of Current Shuttle POS Vector	DPL

TABLE III. SOC CAS PARAMETERS (Continued)		
MSID	**Parameter**	**Format**
V95L0190C	X-COMP of Current Shuttle VEL Vector	SPL
V95L0191C	Y-COMP of Current Shuttle VEL Vector	SPL
Orbiter Aft ADI		
V72R1116C	AFT ADI Roll Rate	BSS
V72R1117C	AFT ADI Pitch Rate	BSS
V72R1118C	AFT ADI Yaw Rate	BSS
V72H1125C	AFT ADI Roll Attitude Error	BSS
V72H1127C	AFT ADI Pitch Attitude Error	BSS
V72H1129C	AFT ADI Yaw Attitude Error	BSS
V72K2093X	AFT ADI Rate Scale (HIGH) (10 DEG/SEC)	BD
V72K2094X	AFT ADI Rate Scale (MEDIUM) (5 DEG/SEC)	BD
V72K2095X	AFT ADI Rate Scale (Low) (1 DEG/SEC)	BD
V72K2097X	AFT ADI Errors Scale (HIGH) (10 DEG)	BD
V72K2098X	AFT ADI Errors Scale (MEDIUM) (5 DEG)	BD
V72K2099X	AFT ADI Errors Scale (LOW) (1 DEG)	BD
Orbiter Left ADI		
V72H0910C	Roll SINE POS	BSS
V72H0912C	Pitch SINE POS	BSS
V72H0914C	Yaw SINE POS	BSS
V72H0911C	Roll COSINE POS	BSS
V72H0913C	Pitch COSINE POS	BSS
V72H0915C	Yaw COSINE POS	BSS
V72K2015X	ADI L ATT SEL (INRT)	BD
V72K2017X	ADI L ATT SEL (REF)	BD
V72K2016X	ADI L ATT SEL (LVLH)	BD
V72R0916C	ADI L RATE (RTE) Roll	BSS
V72R0917C	ADI L RTE Pitch	BSS
V72R0918C	ADI L RTE Yaw	BSS
V72K2008X	ADI L RTE SCL (HIGH)	BD
V72K2009X	ADI L RTE SCL (MEDIUM)	BD
V72K2011X	ADI L RTE SCL (LOW)	BD
V72H0925C	ADI L ERR ROLL	BSS
V72H0927C	ADI L ERR PITCH	BSS
V72H0929C	ADI L ERR YAW	BSS
V72K8504X	ADI L ERR SCL (HIGH)	BD

TABLE III. SOC CAS PARAMETERS (Continued)		
MSID	**Parameter**	**Format**
V72K8505X	ADI L ERR SCL (MEDIUM)	BD
V72K8506X	ADI L ERR SCL (LOW)	BD
Orbiter Body Attitude Error		
V90H2141C	Body Attitude Error (PITCH)	SPL
V90H2142C	Body Attitude Error (YAW)	SPL
V90H2143C	Body Attitude Error (ROLL)	SPL
Body Attitude with Response to M50 Coord. Systems		
V90U2240C	M50-TO-Measured Body QUAT ELE 1	SPL
V90U2241C	M50-TO-Measured Body QUAT ELE 2	SPL
V90U2242C	M50-TO-Measured Body QUAT ELE 3	SPL
V90U2243C	M50-TO-Measured Body QUAT ELE 4	SPL
LVLH Attitude with Respect to M50 Coord. Systems		
V90U2641C	M50-WRT LVLH QUAT 1	SPL
V90U2642C	M50-WRT LVLH QUAT 2	SPL
V90U2643C	M50-WRT LVLH QUAT 3	SPL
V90U2644C	M50-WRT LVLH QUAT 4	SPL
COMM/INST		
V75X2723E	P/L Recorder Tape Motion	BD
V74E2511A	KU RF Power Out	AMU
Orbiter Rendezvous Radar		
V74X2915B	Range Data Good Discrete	BD
V74U2623J	KU-A CH1 Radar Range	TBD
V74X2916B	Range Rate Data Good Discrete	BD
V74H2922B	Range Rate (.01 to 819.2 FT/SEC)	TBD
V74H2618J	Antenna Azimuth Angle (Roll RT From -Z) (+X Out Tail)	TBD
V74H2920B	Antenna Elevation Angle (Pitch POS From –Z) (+Z Out Tail)	TBD
Position Referenced to Orbiter Structure		
V92H3417C	POR X Position	SPL
V92H3418C	POR Y Position	SPL
V92H3419C	POR Z Position	SPL
Target State Vector		
V95H0862S	X-COMP OF CURRENT TARGET POS VECTOR	DPL
V95H0863C	Y-COMP OF CURRENT TARGET POS VECTOR	DPL
V95H0864C	Z-COMP OF CURRENT TARGET POS VECTOR	DPL
V95H0867C	X-COMP OF CURRENT TARGET VEL VECTOR	TBD

TABLE III. SOC CAS PARAMETERS (Continued)		
MSID	**Parameter**	**Format**
V95H0868C	Y-COMP OF CURRENT TARGET VEL VECTOR	TBD
V95H0869C	Z-COMP OF CURRENT TARGET VEL VECTOR	TBD
Evaporator Venting		
V63T1207A	FCL 1 EVAP OUTLET Temp	AMU
V63T1208A	FCL 1 RAD OUTLET Temp	AMU
V63T1407A	FCL 2 EVAP OUTLET Temp	AMU
V63T1408A	FCL 2 RAD OUTLET Temp	AMU