SPACE ACCELERATION MEASUREMENT SYSTEM II

System Requirements Document

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Table of Contents

1.0 INTRODUCTION

The Space Acceleration Measurement System-II project (SAMS-II) will provide a microgravity acceleration measurement system to support the NASA Office of Life and Microgravity Sciences and Application (OLMSA) Microgravity Research Division (MRD) science experiments onboard the International Space Station (ISS).

The purpose of this document is to establish the system requirements to be met by the SAMS-II project for the design, fabrication, verification, and operation of a microgravity accelerometer system for the International Space Station in support of microgravity science experiments.

2.0 BACKGROUND

Documented requirements for SAMS-II are consolidated and derived from Principal Investigators, ISS and facility rack developers, quality assurance and the MRD program office. In addition, operational requirements that have been generated from the system analysis process will be used to provide the SAMS-II project with a core set of capabilities for the operations phase. Appropriate performance indices have been added to some requirements to create verifiable requirements.

A complete SAMS-II system will consist of initially: one Interim Control Unit (ICU) and four to ten Remote Triaxial Sensor - Electronic Enclosures (RTS-EE) and eight to twenty Remote Triaxial Sensor - Sensor Enclosures (RTS-SE). SAMS-II will be built up in two phases, the ICU phase and then the CU Phase. A Control Unit (CU) is planned for SAMS-II operations starting with ISS utilization flight #5 (UF-5).

The ICU will be a laptop computer and peripherals located in an ISIS (International Subrack Interface Standards) drawer in an EXPRESS Rack. The ICU will be used until the CU design is completed and built. The ICU will have limited capabilities compared to the CU. The ICU will transmit RTS data to the EXPRESS RIC and then downlinked via 1553 Bus. Also, RTS commands will be uplinked via the 1553 Bus and sent to the EXPRESS RIC that forwards the commands to the ICU and then to the appropriate RTS. The ICU/CU provides the basic communications, data storage and data processing capability. The data storage capacity is to be primarily devoted to raw and processed acceleration data. Data display and crew control of SAMS-II will be possible via the ICU.

Each RTS-SE will include three analog accelerometers and three temperature sensors. The RTS-SE will sense acceleration and provide a digital signal to the RTS-EE. The RTS-EE will provide the power and data interfaces for the RTS-SE, provide network data flow control and will also perform data processing for temperature compensation and axial misalignment of the data. RTS data is then sent to the ICU/CU. Control signals from the ICU/CU to the various RTS units will take place over the reverse path, using the corresponding protocols.

Ground data processing and display capabilities will exist for a Principal Investigator (PI). The software implemented for these ground capabilities will be similar to that implemented for the onboard capabilities. It is anticipated that data will be made available remotely to a PI over a ground network.

Software will be designed in an object-oriented style and generally be capable of execution on the GOE, ICU/CU or RTS processors. The software will provide the necessary communications between devices; as well as such functions as command generation, status monitoring and data processing. The software will also be providing diagnostic capabilities, resource allocation, data input, and archiving functions. Security is expected to be provided by ISS facilities.

3.0 REQUIREMENTS

The requirements listed in this section originate from the references noted in brackets. The referenced information is not necessarily the basis for the content of the requirement. In order to make these requirements measurable and verifiable, in some cases; specific numerical values were added based on input from knowledgeable parties. If a certain requirement is not referenced to a document, an explanation of the requirement will be provided in the back of the document in Appendix A. Requirements with the reference "See Appendix A" are derived requirements from lessons learned, good workmanship practices in design, programming or data handling.

A requirement marked "*CU Phase*" indicates that the requirement is deferred and will be implemented when the CU (Control Unit) is designed and integrated into the SAMS-II system. The *CU Phase* requirements are of a tentative nature and are therefore subject to modification as the ISS microgravity measurement program further develops.

3.1 Data Acquisition

3.1.1 System Noise Floor

The system shall provide measurements in three axes of the microgravity acceleration where the noise level for each axis is 10dB below the curve defined by: 1.8 ug_{rms} for data from 0.01 Hz to 0.1 Hz, 18 ug_{rms} x frequency for data from 0.1 to 100 Hz, 1.8mg_{rms} for data from 100Hz to 300 Hz.. [ESRD 2.1.1, SSP-41000]

3.1.2 Accuracy

The system shall provide acceleration measurements in which the maximum error is less than 10% of the measured value for measurements that exceed the system noise floor requirement (reference 3.1.1) across the frequency range of 0.01Hz to 300 Hz. The system shall provide the capability for on orbit calibration prior to each experiment and for on-line temperature compensation. [ESRD 2.1.1, 4.5.7.2, 4.5.7.6, SSP 41000]

3.1.3 Acquisition Frequency Range

3.1.3.1 Acquisition Frequency Range - Vibratory

The magnitude of the system's frequency response shall be within 1dB of 1 (output/input) over the frequency range of 0.01 Hz to 300 Hz. [ESRD 2.1.1, 2.1.3]

3.1.3.2 Acquisition Frequency Range – Quasi-Steady

The magnitude of the system's frequency response shall be within 1dB of 1 (output/input) over the frequency range of 0.00018 Hz to 0.01 Hz. [ESRD 2.1.1, 2.1.3]

3.1.4 Sensor Axes Orthogonality

The acceleration measurement system shall produce measurement data from the accelerometers with measurement axes mutually orthogonal within plus or minus 0.1 degree. This is independent of mounting accuracy. [ESRD 4.5.7.4]

3.1.5 Measurement Location

The accleration measurement shall be taken as close as practical to the desired location. [ESRD 2.1.4]

3.1.6 Requirement Deleted

3.1.7 Time Correlation

The system shall timetag data using facility time it is provided. [ESRD 2.1.2, Project Plan 3.9]

3.1.8 Health Status Data

Housekeeping data shall be produced at a once/second rate monitoring temperature, voltage, and airflow (on/off). [See Appendix A]

3.1.9 Event Trigger - *CU Phase*

The system shall detect and notify the PI at the PI ground location when the measured value becomes more, or less than a threshold value defined by the Principal Investigator. [ESRD 3.4].

3.1.10 Selectable Frequency Range and Control

The project shall provide the PI with their desired frequency range Quasi-Steady to 300 Hz. Per a PI's request, the project shall be able to change the frequency scale for which acceleration data is acquired, within 1 minute after the command is received onboard. [ESRD 2.1.3; 2.2.1]

3.1.11 Measurement Number - *CU Phase*

The acceleration system shall be designed to support up to 20 active RTS-SE's simultaneously. [See Appendix A]

3.1.12 Simultaneous Axis Changes

Changes affecting the accelerometer data are to be made on all accelerometer axes simultaneously. [See Appendix A]

3.1.13 Frequency Resolution

The system shall provide frequency resolution of acquired acceleration data up to 300 Hz. at +/-0.2% of the actual measured frequency. [ESRD 4.5.7.7]

3.1.14 Independent Sensor Head Control

A PI shall be able to have independent control over each sensor head associated with an experiment; changes made to one head should not interrupt data collection on any other sensor head. [ESRD 2.2, 2.2.1, Project Plan 2.1.4]

3.1.15 Start & Stop Time - *CU Phase*

The acceleration measurement system shall start and stop taking acceleration data at the time that a PI has established, or when a request is received. [ESRD 2.2.1]

3.1.16 Sensor Head Orientation & Alignment

The project shall know the mounting coordinates of the RTS-SE and its orientation relative to a known ISS coordinate system. If the user is also an RTS-EE Integrator, they shall provide the project office the RTS-SE mounting coordinates. The RTS-SE shall be aligned to one of the sensor axis to some known reference axis with accuracy within +/-0.5 degrees. The coordinates shall be provided to the user prior to data being obtained from new location. [ESRD 3.11, 4.5.7.5]

3.1.17 Pre-operations Data

The acceleration measurement system shall be capable of providing data describing the microgravity environment prior to initiating experiment operation. [Project Plan 3.8, ESRD 2.3.2.2]

3.1.18 Requirement Deleted

3.2 Data Processing

3.2.1 Update Interval - *CU Phase*

The acceleration measurement system shall be able to have a data calculation be repeated continuously at a specified time interval. [ESRD 2.2.1]

3.2.2 Data Identification

The acceleration measurement system shall identify data with the processing performed on it. [See Appendix A]

3.2.3 Analysis Functions

The acceleration measurement system shall provide analysis functions for acceleration including acceleration magnitude versus time, acceleration magnitude versus frequency, power spectral density in a specified frequency range, and magnitude versus time versus frequency. [ESRD 2.3.1]

3.2.4 Requirement Deleted

3.2.5 Requirement Deleted

3.2.6 Coordinate System

The acceleration measurement system shall be able to provide data in coordinate systems other than that of the accelerometer. [ESRD 2.1.4, PIMS-ISS-001]

3.2.7 Requirement Deleted

3.2.8 Principal Investigator Control

The project shall be able to change its onboard data processing for a PI at a time designated by the PI. If the PI is onboard, the PI will be authorized by the project to make any changes. [ESRD 2.2.1, Project Plan 3.8]

3.2.9 Off-line Processing - *CU Phase*

It shall be possible to perform data processing on data stored onboard the International Space Station. [PIMS-ISS-001]

3.2.10 Requirement Deleted

3.2.11 Requirement Deleted

3.2.12 Digital Data Pass Through

The acceleration measurement system shall provide, at an output register of the RTS-EE, the same Digital Data signal that was sent to the input of the RTS-EE from the RTS-SE. [See Appendix A]

3.3 Data Storage – *CU Phase*

3.3.1 Onboard Science Data Storage - *CU Phase*

The acceleration measurement system shall be capable of storing Principal Investigator acceleration data onboard. [ESRD 2.3.1.2, Project Plan 3.8]

3.3.2 Control Of Onboard Data Storage - *CU Phase*

A PI shall be able to store data onboard either starting at a time chosen by the PI, or at a defined time interval prior to the event trigger indication. [ESRD 3.4]

3.3.3 Onboard Storage Access - *CU Phase*

A PI shall be able to display stored acceleration data, either onboard the ISS or at their home site(s). [ESRD 2.3.1.2, Project Plan 3.8]

3.3.4 Requirement Deleted

3.3.5 Data Processing Response - *CU Phase*

A PI shall be able to change the function (acceleration time history, spectrum, etc.) of data recorded onboard within a minute. [ESRD 2.2.1]

3.3.6 Requirement Deleted

3.3.7 Onboard Data Management - *CU Phase*

A PI shall be able to selectively delete microgravity data they have stored Onboard the International Space Station. [Project Plan 2.1.5 a]

3.4 Data Distribution

3.4.1 Requirement Deleted

3.4.2 Data Distribution

The project shall make data available to Principal Investigators, system operators, and the ISS crew. [ESRD 2.3, Project Plan 3.8]

3.4.3 Experiment Apparatus Access To SAMS-II - *CU Phase*

The acceleration measurement system shall be capable of providing acceleration data to space station payloads utilizing the ISS onboard network. [Project Plan 3.2]

3.4.4 Requested Data Format - *CU Phase*

A Principal Investigator shall be able to receive acceleration data in the requested format. [ESRD 2.3.2.3, Project Plan 3.9]

3.4.5 Crew Interface - *CU Phase*

The acceleration measurement system shall be able to accept commands and display data with an onboard system interface. [ESRD 2.2.2]

3.4.6 Data Identification

Transmitted experiment data records shall include time stamp, accelerometer identifier, sensor axis, coordinate system, frequency range, and type of data processing. [See Appendix A]

3.4.7 Distribution

The acceleration measurement system shall have the capability to send the acceleration data from a particular experiment to multiple PIs. [Project Plan 3.9, ESRD 2.3]

3.4.8 Requirement Deleted

3.4.9 Requirement Deleted

3.4.10 Discontinuous Link

The acceleration measurement system shall be able to operate with a space station to ground communications link availability of 50%. [Project Plan 3.9]

3.4.11 Requirement Deleted

3.4.12 Requirement Deleted

3.5 Data Display

3.5.1 Data Display

The acceleration measurement system shall be capable of providing graphical and/or tabular displays for Principal Investigators with data presented in the individual axes chosen. [ESRD 2.3.1, PIMS-ISS-001]

3.5.2 Frequency Selection

The acceleration measurement system shall provide a choice of display frequency ranges up to the full-scale acquisition frequency range. [Project Plan 3.1, PIMS-ISS-001]

3.5.3 Operating Status Display

The project shall make the current acceleration measurement system operating status data available to the operator and the space station crew. [ESRD 2.2.2]

3.5.4 Parameter Display

The acceleration measurement system shall be capable of displaying the values for a Principal Investigator's current system data acquisition parameters at the Principal Investigator's site. [Project Plan 3.8, PIMS-ISS-001]

3.5.5 Notification of Principal Investigator-Defined Acceleration Events

The acceleration measurement system shall be capable of notifying Principal Investigators if the measured acceleration matches a Principal Investigator-defined level (event trigger). [ESRD 2.3.2.1, PIMS-ISS-001]

3.6 Quality

3.6.1 Availability

The project shall produce an availability of at least 0.9 for use by Principal Investigators, system operators and the space station crew. (See Appendix A)

3.6.2 Control Unit Lifetime

3.6.2.1 Control Unit Lifetime – *CU Phase*

On-orbit design lifetime for the acceleration measurement system control unit shall have a 90% reliability that the unit will last for at least ten years. Operational duty cycles of at least 80% are to be supported. [Project Plan 3.5]

3.6.2.2 Control Unit Lifetime – *ICU Phase*

On-orbit design lifetime for the acceleration measurement system interim control unit shall have a 90% reliability that the unit will last for at least 3 years. Operational duty cycles of at least 80% are to be supported. [Project Plan 3.5]

3.6.3 RTS Unit Lifetime

On-orbit design lifetime for the acceleration measurement system RTS unit shall have a 90% probability that the unit will last for at least two years with a operational duty cycle of 30%. [See Appendix A]

3.6.4 Requirement Deleted

3.6.5 Modularity

The acceleration measurement system shall be designed to operate with its individual hardware and software elements capable of being replaced by redesigned elements. [Project Plan 3.7]

3.6.6 Hardware Burn-In

All acceleration measurement system electronic hardware will log at least 100 hours of failure free operation before hardware turnover to assure no infant mortalities of the system's electronics. [SAMS-II-005]

3.6.7 Thermal Cycling

All acceleration measurement system electronic hardware will undergo Thermal Cycling testing consisting of 8 thermal cycles (2 power on/off, 6 powered on) between 5°C and 45°C before hardware turnover to assure no infant mortalities of the system's electronics. [SAMS-II-005]

3.6.8 Outgassing

All hardware shall be subjected to Outgas testing. [SAMS-II-005, NHB 8060.1C]

3.6.9 Random Vibration

All flight acceleration measurement system hardware (except for RTS-SE's) will undergo Random Vibration testing to levels of $6.8 g_{rms}$ for one minute. [NASA-STD-7001]. Flight RTS-SE's will undergo Random Vibration testing to $5.55 g_{rms}$ per Table 1. This test has been modified in the upper frequencies to prevent hardware damage.

Table 1 SE Random Vibration Acceptance Levels

Frequency (Hz)	PSD level (g^2/Hz)
20	0.01
20 – 70	+3.3 dB/octave
70 – 340	0.04
340 – 2000	-3.9 dB/octave
2000	0.004
composite	**5.55 g_{rms}**

All qualification acceleration measurement system hardware (except for RTS-SE's) will undergo Random Vibration testing to levels of $9.61 g_{rms}$ per Table 2. Increasing the workmanship levels defined in NASA-STD-7001 by 3 db derives the test levels. Qualification RTS-SE's will undergo Random Vibration testing to $7.24 g_{rms}$ per Table 3. This test has been modified in the upper frequencies to prevent hardware damage. Durations for qualification level random vibration testing will be per NASA-STD-7001.

Table 2 Random Vibration Qualification Levels

Frequency (Hz)	PSD level (g^2/Hz)
20	0.02
20 – 70	+3.3 dB/octave
70 – 500	0.08
500 – 2000	-3.0 dB/octave
2000	0.02
composite	**9.61 g_{rms}**

Table 3 SE Random Vibration Qualification Levels

Frequency (Hz)	PSD level (g^2/Hz)
20	0.02
20 – 70	+3.3 dB/octave
70 – 340	0.08
340 – 600	-3.9 dB/octave
600	0.0384
600 – 1000	-8.0 dB/octave
1000	0.0098
1000 – 2000	-3.9 dB/octave
2000	0.004
composite	**7.24 g_{rms}**

3.6.10 Wire Derating

Electrical wires shall be derated in accordance with TM 102179. [SSP 52000-IDD-ERP 6.2.3]

3.6.11 EMI

Perform EMI Emissions testing (conducted and radiated) per carrier requirements to verify workmanship of each RTS-SE and RTS-EE (See Appendix A).

3.7 Resource Management

3.7.1 Onboard Resources

The project office shall control the amount of data storage, downlink throughput, and data processing available to Principal Investigators. [ESRD 2.2.1]

3.7.2 Operator Control

Only system operators shall be able to change the system resource allocations. [ESRD 2.2.1]

3.7.3 Requirement Deleted

3.7.4 Downlink Throughput At Allocation - *CU Phase*

The acceleration measurement system shall produce an indication if the expected network throughput from user requests will exceed the allocated throughput. [See Appendix A]

3.7.5 Need To Disable Principal Investigator Usage – *CU Phase*

The acceleration measurement system shall provide system operators the capability of disabling a specific Principal Investigator's overall usage of system. [ESRD 2.2]

3.8 Programmatic

3.8.1 Multiple Sensor Heads

The acceleration measurement system shall have the capability of supporting more than one sensor head in a given experiment apparatus and/or rack. [ESRD 2.1.4]

3.8.2 User Support

The project will be responsible for all operational documentation. PIMS will be responsible for providing input to the acceleration measurement project for operational documentation of their system. [ESRD 2.2.1, Project Plan 2.1.4]

3.8.3 Full Activity Test

3.8.3.1 Full Activity Test - *CU Phase*

The acceleration measurement system shall be able to operate successfully with a simulated full experiment activity of 1) ten active RTS-EE's, 2) experiment frequency ranges set to the maximum acquisition frequency, 3) command sent to change one RTS's frequency range, 4) two requests for RTS status are made. Given these conditions, system should be able to 1) record five sets of acceleration data recorded as acceleration vs. time, 2) record one set of acceleration data recorded as energy vs. time, 3) display three vector amplitude and direction calculations, and 4) service all requests within a minute. Constraints include 1) not allowing any impact to other accelerometer's data, 2) all data processed into compensated engineering unit data. When changing settings on a particular head, a brief gap (0.5 to 1 second) in that head's data flow may occur. [Project Plan 3.3]

3.8.3.2 Full Activity Test - *ICU Phase*

The The acceleration measurement system ICU Laptop shall be able to reliably control up to 6 RTS-EE units running up to 10 RTS-SEs operating concurrently at their maximum acquisition frequency rate. "Control" in this context includes acquisition, and downlinking of data (both accelerometry data and EE health-and-status data), as well as routing of commands and acknowledgments to and from the units and ground station.

The unit will be commanded to deliver any desired units (counts, volts, or micro-g) containing any desired adjustments (gain, axial alignment, and/or temperature compensation). When changing settings on a particular head, a brief gap (0.5 to 1 second) in that head's data flow may occur. (See Appendix A)

3.8.4 Software Portability

The project shall produce acceleration measurement system unique software for use by Principal Investigators with commonly available workstations. [ESRD 2.2.1] This requirement does not pertain to PIMS ground display software.

3.8.5 Mission Simulation

The mission simulation test shall demonstrate the capability of the flight hardware and flight software to perform its intended on-orbit operations. [SAMS-II-005 Table 7 (SARGE 3.7)]

3.9 Operations

3.9.1 Command Log

The acceleration measurement system shall store attempted and implemented operator commands. [See Appendix A]

3.9.2 Log Request

The command log shall be provided to system operators upon their request. [See Appendix A]

3.9.3 Requirement Deleted

3.9.4 Command Verification

The project shall provide users the capability to verify that a command has been implemented. [Project Plan 3.9]

3.9.5 Status Data Storage

The acceleration measurement system shall store records of the system status data for use by system operators. [Project Plan 3.9]

3.9.6 Recorded Data Handling - CU Phase

Recorded onboard data shall be brought down on mass storage data devices via logistics missions, stored in archives and made available to Principal Investigators for post-operations analysis. [ESRD 3.9]

3.9.7 Flight Unit Replacement

The project shall have the capability of on-orbit maintenance to the functional orbital replacement unit (ORU) level. [Project Plan 3.6]

3.9.8 Failed RTS Thermal Sensor

The acceleration measurement system shall verify that the thermal sensors, used for thermal compensation, are functioning correctly to provide high resolution and accurate acceleration data. [ESRD 4.5.7.2, 4.5.7.3]

3.9.9 Temperature Sensor Failure - *CU Phase*

Accelerometer compensation for temperature shall allow for the use of another accelerometer's temperature data in the event of a temperature sensor failure. [See Appendix A]

3.9.10 Operations Database

The acceleration measurement system shall be able to maintain databases of the following as a function of experiment and time: a. system status data, b. PI and experiment parameters. [Project Plan 3.9]

3.9.11 Response Time

The acceleration measurement system shall be able to execute commands within one minute of their arrival at the flight subsystem. [See Appendix A]

3.9.12 Software Uploads -- CU phase

The acceleration measurement system shall have the capability to upload new software to the CU from the system ground operations. The CU shall be able to accept the new software and be able to execute it. [See Appendix A]

3.9.13 Control Unit Power Requirement

3.9.13.1 Control Unit Power Requirement - *CU Phase*

In the EXPRESS rack, the acceleration measurement system control unit shall require no more than 500 watts. [SSP 52000-IDD-ERP 6.2]

3.9.13.2 Control Unit Power Requirement – *ICU Phase*

In the EXPRESS rack, the acceleration measurement system control unit shall require no more than 75 watts. [SSP 52000-IDD-ERP 6.2]

Sections 3.10 – 3.18 have been deleted from this document.

4.0 REFERENCES

1. NASA-STD-7001, Payload Vibroacoustic Test Criteria, MSFC, June 21,1996
2. ESRD, PIMS-001, Experiment Support Requirements Document, Glenn Research Center, February 28, 1996.
3. PIMS-ISS-001, PIMS Software Requirements for Processing Microgravity Acceleration Data from the ISS, Glenn Research Center, Draft #1
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6. SSP 52000-IDD-ERP, EXPRESS Rack Payloads Interface Definition Document, May 1998.
7. SSP 52000-PVP-ERP, EXPRESS Rack Payloads Payload Verification Requirements/Plan, June 23, 1999
8. Space Experiments Division Operating Instruction 6700-4, Lewis Research Center; Electrical, Electronic, and Electromechanical Parts Policy; August 1994.
9. Standard Assurance Requirements and Guidelines for Experiments (SARGE), NASA Glenn Research Center, Revision 0, April 1996

APPENDIX A - REQUIREMENT REFERENCES

This section will explain the references to the requirements in this document that are not a reference to a Space Station or SAMS-II document.

3.1.8 Health Status Data

This requirement is in place to monitor the system for the system operators and the project's use.

3.1.11 Measurement Number

The number of Sensor Heads being supported is based off the available downlink that is allocated to the systems capabilities. This number may be lower than 20 at any given time due to downlink traffic and the RTS-SE's sampling at higher rates.

3.1.12 Simultaneous Axis Changes

The acceleration measurement system is intended to be a 3-D acceleration measurement system. A data point is a collection of readings from the 3 orthogonal axes taken at the same time. Individual axis control and adjustments are not the scope of acceleration measurement system. Each axis of a SE needs to be read at the same frequency, with the same gain, put into the same units and compensated the same way so that the "data point" is always homogenous. Therefore, it is a requirement that any changes affecting the accelerometer data be made to all axes simultaneously.

3.2.2 Data Identification

The project feels that any piece of the system's data that is transmitted to the ground for archiving needs to be able to stand-alone. The purpose of archiving is to look at the data again at a later time. The data needs to be identified with key pieces of information like time stamp, accelerometer ID, axis, frequency range and any other processing done to the data for it to make sense at a later time. Therefore, the project requires transmitted experiment data records shall include time stamp, accelerometer identifier, sensor axis, coordinate system, frequency range, and type of data processing.

Digital Data Pass Through

This is to verify the actual bit stream of the Data signal is transferred through the RTS-EE accurately.

3.4.6 Data Identification

The project feels that any piece of the system's data that is transmitted to the ground for archiving needs to be able to stand-alone. The purpose of archiving is to look at the data again at a later time. The data needs to be identified with key pieces of information like time stamp, accelerometer ID, axis, frequency range and any other processing done to the data for it to make sense at a later time. Therefore, the project requires transmitted experiment data records shall include time stamp, accelerometer identifier, sensor axis, coordinate system, frequency range, and type of data processing.

3.6.1 Availability

The mean time to repair should be assumed to be no greater than 5 days, using SAMS-II Reliability Prediction Analysis and recommended procedures, and the average available crew time to be 1 hour, and the time to service to be 2 days.

3.6.3 RTS Unit Lifetime

The SAMS-II Project Plan has a requirement for the ICU/CU but not for the RTS. It was determined that the lifetime of the RTS will be 2 years based off the RTS-SE. The RTS-SE will be used on orbit for 2 years before being sent to the ground for recalibration.

3.6.11 EMI

This requirement was derived from the lessons learned from the SAMS Engineering team.

3.7.4 Downlink Throughput At Allocation - *CU Phase*

The ISS network is a limited resource that must be shared by all experiments. Each experiment will be given a throughput allocation that can change throughout the mission. It is necessary to keep track of the project's use of the network to make sure the system does not exceed the project's allocation. Notifying the ground operators when the allocation is exceeded will allow them to correct the situation by reducing the sampling rates of sensors or turning various sensors off.

3.8.3.2 Full Activity Test - *ICU Phase*

This requirement was derived from the lessons learned from the SAMS-II Software Engineering team.

3.9.1 Command Log

The project wants this requirement to have records of all operations.

3.9.2 Log Request

The project wants this requirement to have records of all operations.

3.9.9 Temperature Sensor Failure

The independent temperature readings for each axis on a SE are all taken within very close proximity to each other. The accelerometers that the Project has chosen to use vary with temperature and therefore the readings are compensated for temperature. If the project feels a temperature sensor has gone bad, the project feels that it would be more accurate to use a neighboring temperature sensor's reading and compensate the acceleration data than to use the bad temperature or no temperature at all in compensations. Therefore, the project requires that the system allow neighboring temperature sensors to be used in compensation.

3.9.11 Response Time

The system needs to be able to respond to commanding as soon as it can. The acceleration measurement project feels that to serve the science community, the acceleration measurement system needs to implement received commands within a minute of receipt of that command on the control unit. One minute is short enough for the science community and long enough for the acceleration measurement system to implement.

3.9.12 Software Uploads -- CU phase

The SAMS-II ICU version will not have the capability of uploading a replacement set of software to the ICU and RTS. If there are problems with the SAMS-II operations, waiting for the next Shuttle flight may be too long to suspend operations.