National Aeronautics and
Space Administration

**Lyndon B. Johnson Space Center**

**Houston, Texas 77058**

**JULY 1996**

# Hardware Development Plan
# for the
# Workstation
# Human Research Facility

LS-71042

# PROJECT DOCUMENT APPROVAL SHEET

| DOCUMENT NUMBER | DATE | NO. OF PAGES |
|---|---|---|
| LS-71042 | September 26, 1996 | 16 |

**TITLE:**

Hardware Development Plan
for the
Workstation
Human Research Facility

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| APPROVED: | PROJECT ENGINEER | Signature on File | 8/26/96 |
| APPROVED: | TECHNICAL MONITOR | Signature on File | 8/14/96 |
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| DATE | PREPARED BY | CHANGE APPROVALS | CHANGE NUMBER |
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**Report Number** LS-71042 **Date** 8/5/96

# Hardware Development Plan for the Human Research Facility Workstation

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| DOCUMENT NUMBER | DOCUMENT CHANGE/ REVISION LOG | PAGE 1 OF 1 |
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| LS-71042 | | |

| CHANGE/ REVISION | DATE | DESCRIPTION OF CHANGE | PAGES AFFECTED |
|---|---|---|---|
| BASIC | 9/19/96 | BASELINE ISSUE | |

Altered pages must be typed and distributed for insertion.

CONTENTS

# FIGURES

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| 3D | Three Dimensional |
| AAA | Avionics Air Assembly |
| A/D | Analog to Digital |
| COTS | Commercial Off The Shelf |
| DOS | Disk Operating System |
| EMI | Electromagnetic Interference |
| EXPRESS | |
| GB | Giga Byte |
| HDP | Hardware Development Plan |
| HRF | Human Research Facility |
| IDE | Integrated Drive Assembly |
| I/O | Input/Output |
| ISS | International Space Station |
| LSLE | Life Science Laboratory Equipment |
| MB | Mega Byte |
| NASA | National Aeronautics and Space Administration |
| NTSC | |
| OS | Operating System |
| OS/2 | Operating System 2 |
| PCMCIA | Personal Computer Memory Card Industry Association |
| PI | Principle Investigator |
| PRD | Program Requirements Document |
| PU | Panel Unit |
| RAM | Random Access Memory |
| RFI | Request For Information, Radio Frequency Interference |
| RFP | Request For Proposal |
| RGB | Red, Green, Blue |
| SAMMI | |
| SCSI | Small Computer System Interface |
| SSP | Space Station Program |
| VDC | Volts, Direct Current |
| VEG | Virtual Environment Generator |
| VGA | |

# 1.0 INTRODUCTION

The purpose of this document is to define the development plan of the Human Research Facility (HRF) Workstation. This document will outline the steps required to prototype, design, fabricate, test and certify the hardware, as well as define the major programmatic and developmental milestones in the project.

# 2.0 HARDWARE DESCRIPTION

The HRF Workstation consists of a single 4 Panel Unit (PU) EXPRESS rack drawer (Workstation Computer Drawer), keyboard and display. It will provide data collection, archive, downlink, display, video processing, graphics accelerator, user interface and EXPRESS Rack interface.

## 2.1 FLIGHT HARDWARE DELIVERABLES

Three flight units will be built (Flight, Flight Backup and Qualification Unit). Delivery dates are 2/97 for Qualification Unit, 6/97 for Flight and Flight Backup.

## 2.2 TRAINING HARDWARE DELIVERABLES

One specific training unit will be built. It will be flight like (fit, form and function). Delivery will be 2/97. The qualification unit can be used as a trainer after qualification has been passed.

## 2.3 PROTOTYPE HARDWARE

4 prototype units will be built. The first two units will began integration 2/96. The second two units (flight prototype, one science and one engineering, one flight like) will start integration 6/96. One set will be used for hardware integration. After the hardware configuration is defined and working, the second set (one science and one engineering) will be put in that configuration for software development. Both sets of units will be prototype units of the same function as the flight units.

## 2.4 BASELINE DATA COLLECTION HARDWARE REQUIREMENTS

Baseline data collection will be done using two of the prototype units.

## 2.5 GROUND SUPPORT EQUIPMENT REQUIREMENTS

A Ground Support Plan will be delivered in May, 1996. A rack and International Space Station (ISS) data system simulator with ground support equipment will be required. The rack simulator will include flight equivalent thermal, electrical, mechanical and data interfaces. A data systems simulator that emulates the data system from rack to ground will also be required (including command and upload capability). EXPRESS rack test software, test data (input and output files), test tools and detailed functionals are required for testing of the HRF Workstation. Specific interface test equipment (PCI bus, ISA bus, Small Computer System Interface (SCSI), Integrated Drive Assembly (IDE), etc.) will also be required for the Workstation.

At least one test will have to be done with the prototype prior to the delivery at JSC of the EXPRESS Rack GSE unit.

## 2.6 ONBOARD SUPPORT EQUIPMENT

Onboard support equipment shall include a vacuum cleaner (ISS supplied) to clean the air intake screens and TBD test and checkout hardware (HRF supplied).

## 2.7 UPGRADES

The Science Working Group has specified a need for a wireless communication interface for the Workstation. Development work for this interface will parallel the development of the Workstation to minimize the impact to the Workstation for addition of this interface. Other upgrades will be evaluated on a case by case basis.

## 3.0 JUSTIFICATION

HRF Workstation is being designed and developed to meet the requirements defined in the Level II Functional Requirements Document for the HRF, LS-71001, in accordance with the Program Requirements Document (PRD) for the HRF, LS-71000.

## 4.0 DEVELOPMENT METHOD AND STATUS

The HRF Workstation Computer Drawer will be built from the design of a system (Virtual Environment Generator (VEG) Computer Drawer) that will fly on the Neurolab Spacelab (1998). Basic capability that will need to be added to the VEG system is a video frame grabber board, a video converter board, an Analog to Digital (A/D) board for additional data collection and a time card. The actual part selection for these additional capabilities is still being done. The Workstation will be built “in house” with extensive use of Commercial Off The Shelf (COTS) parts. This approach makes the project meet the schedule with less risk and cost. Informal studies have been done on the existing pieces of the VEG for the proper selection (Life Science Laboratory Equipment (LSLE) Microcomputer 2 parts, parts already flown in another system, only COTS parts available that meet the specifications, vender surveys through Radio Frequency Interference (RFI)/Request for Proposal (RFP) process, etc.). Human factors KC-135 and DTO research will be evaluated for inputs to selection of keyboard, display and cursor control. The display and keyboard of the Portable Computer System will be investigated for use as the display and keyboard for the Workstation.

The Keyboard/display will be a repackaged COTS product. Vender research will be done to determine what level of repackaging is necessary. The display is not a common COTS item.

## 4.1 SCIENCE ENGINEERING PLAN

Testing 11/97. A report will be delivered to NASA documenting the end results and whether the system meet or failed the requirements. Science team personnel will be part of the development team so that conformance to space station conventions will be met. Testing will be performed on the HRF Workstation prototype hardware and software to ensure that specific requirements are met.

In all phases of the HRF Workstation development, Science team engineers will help to ensure that the Workstation is properly designed and configured for effective and efficient use to meet science objectives. Science team engineers will understand that the time to impact design is Specification and Assembly Drawing (S&AD)/End Item

Specification (EIS) review, Preliminary Design Review (PDR) and Critical Design Review (CDR). Design changes will be harder and more costly to incorporate the later in the design phase that they are proposed. For instance, typically design changes accepted at CDR are ones that the system will not operate without, not minor changes.

Science team engineers will review the Workstation requirements and make sure that the hardware development plan, S&AD or EIS comply with the requirements related to science objectives. They will prepare review item discrepancies (RID) as required during the hardware requirements review documenting the requirements that are not met, examine all other RIDs for issues related to science objectives and verify the resolution of science objective related RIDs.

Science team engineers will provide science criteria for design engineers to include in evaluating commercial Workstation hardware under consideration for purchase and modification to meet HRF requirements. They will review the Statement of Work (SOW) and assist with source evaluation board activities as required.

Prior to the PDR project design engineers and Science team engineers will discuss the ideas for configuring the Workstation according to the functional requirements and compare them to its use in the HRF. This discussion will include sketches of the designs under consideration and literature and data from manufacturers who's devices are under consideration. Prior to the PDR Science team engineers will compare the proposed design to the EIS or S&AD and evaluate any differences they find between the two. They will prepare RIDs, if necessary, during the PDR, examine all other RIDs for issues related to science objectives and verify the resolution of science related RIDs. They will present rationale and documented requirements for the science objective features they required in the design and for the RIDs they prepared.

During the prototype development, Science team engineers will prepare a test plan and approval criteria for evaluating the prototype. When the prototype is complete they will deliver the test plan to the Project Engineer one month prior to the science team test for evaluation against documented requirements (the prototype will be ready June, 1996). They will then test the prototype in a simulated flight environment to evaluate its operation and to ensure that it meets the science criteria. The Science team engineers will then deliver to the project engineer, one month prior to CDR, a paper outlining conclusions. Specific problems and fixes will be specified in the paper for discussion during the CDR, if applicable.

Prior to the CDR Science team engineers will review several items in the CDR package. Among these will be the hardware overview and operations, acceptance and certification plan, engineering analysis, schematics, sketches and drawings. They will prepare review item discrepancies (RID) if necessary, during the CDR, examine all other RIDs for issues related to science objectives and verify the resolution of science objective related RIDs. They will present rationale for the science objective features they required in the design and for the RIDs they prepared. After the CDR Science team engineers will verify that the design includes any modifications agreed upon in the CDR/PDR to satisfy science objective requirements.

During Workstation fabrication, project engineers will inform Science team engineers of any science objective related changes to the Workstation.

After the qualification unit is complete, Science team engineers will test it in a simulated flight environment to evaluate its operation and any changes from the prototype evaluated at an earlier development phase. After the flight unit is complete, Science team engineers will evaluate any changes made after evaluating the qualification unit.

The Science Verification Test (SVT) will include full ground uplink and downlink simulators. The start of the SVT is scheduled for Nov., 1997. Two months prior to the SVT, the Science team Engineers will submit an SVT to the Project Engineer. The Science team engineers will be involved with the SVT. After the SVT, the Science team engineers will submit to the Project Engineer an evaluation of the test objectives and how they were met.

They will prepare a final report on the usability and maintainability of the Workstation, its conformance to the EIS or SOW, science objective effectiveness and methods of incorporating science objective requirements into future designs.

## 4.2 HUMAN FACTORS ENGINEERING PLAN

Human Factors personnel will be part of the development team so that conformance to space station conventions will be met. Testing will be performed on the HRF Workstation prototype hardware and software to ensure that specific requirements are met.

In all phases of the HRF Workstation development, human factors engineers will help to ensure that the Workstation is properly designed and configured for effective and efficient crew use. Human factors engineers will understand that the time to impact design is S&AD/EIS review, PDR and CDR. Design changes will be harder and more costly to incorporate the later in the design phase that they are proposed. For instance, typically design changes accepted at CDR are ones that the system will not operate without, not minor changes.

Human factors engineers will review the Workstation requirements and make sure that the hardware development plan, S&AD or EIS comply with the requirements related to human factors. They will prepare review item discrepancies (RID) as required during the hardware requirements review documenting the requirements that are not met, examine all other RIDs for issues related to human factors and verify the resolution of human factors related RIDs.

Human factors engineers will provide human factors criteria for design engineers to include in evaluating commercial Workstation hardware under consideration for purchase and modification to meet HRF requirements. They will review the SOW and assist with source evaluation board activities as required.

Prior to the PDR project design engineers and human factors engineers will discuss the ideas for configuring the Workstation according to the functional requirements and compare them to its use in the HRF. This discussion will include sketches of the designs under consideration and literature and data from manufacturers who’s devices are under consideration. Prior to the PDR human factors engineers will compare the proposed design to the EIS or S&AD and evaluate any differences they find between the two. They will prepare RIDs, if necessary, during the PDR, examine all other RIDs for issues related to human factors and verify the resolution of human factors related RIDs. They will present rationale and documented requirements for the human factors features they required in the design and for the RIDs they prepared.

During the prototype development, human factors engineers will prepare a test plan and approval criteria for evaluating the prototype. When the prototype is complete they will deliver the test plan to the Project Engineer one month prior to the test for evaluation against documented requirements. They will then test the prototype in a simulated flight environment to evaluate its operation and to ensure that it meets the human factors criteria. The human factors engineers will then deliver to the project engineer, one month prior to CDR, a paper outlining conclusions. Specific problems and fixes will be specified in the paper for discussion during the CDR.

Prior to the CDR human factors engineers will review several items in the CDR package. Among these will be the hardware overview and operations, acceptance and certification plan, engineering analysis, schematics, sketches and drawings. They will prepare review item discrepancies (RID) if necessary, during the CDR, examine all other RIDs for issues related to human factors and verify the resolution of human factors related RIDs. They will present rationale for the human factors features they required in the design and for the RIDs they prepared. After the CDR human factors engineers will verify that the design includes any modifications agreed upon in the CDR/PDR to satisfy human factors requirements.

During Workstation fabrication, project engineers will inform human factors engineers of any human factors related changes to the Workstation.

After the training unit is complete human factors engineers will attend crew training sessions to evaluate how convenient and efficient the device is for the crew to use, noting crew comments about its operation. They will also evaluate device operations during any pre-flight experiments that use the Workstation and recommend any modifications to either the device software or its use.

After the qualification unit is complete, human factors engineers will test it in a simulated flight environment to evaluate its operation and any changes from the prototype evaluated at an earlier development phase. After the flight unit is complete, human factors engineers will evaluate any changes make after evaluating the qualification unit. They will prepare a final report on the usability and maintainability of the Workstation, its conformance to the EIS or SOW, human factors effectiveness and methods of incorporating human factors requirements into future designs.

## 4.3 QUALIFICATION TEST PLAN

The HRF Workstation will be built to the S, R & QA requirements as stated in the HRF PRD. Detailed testing requirements and a test matrix will be included in the S&AD or EIS for the HRF workstation. The workstation will go through the standard suite of environmental tests for a 4PU electronics drawer plus keyboard and display (including (Electromagnetic Interference (EMI)/RFI, Conducted, Thermal, Humidity, Vibration, Shock, Offgassing, etc.). A full suit of evaluation and test equipment is needed to verify the operational capability and troubleshoot problems that arise during development and testing. These evaluation and testing capabilities include, but are not limited to, testers for SCSI interface, PCI interface, Personal Computer Memory Card Industry Association (PCMCIA) interface, A/D drivers, D/A drivers, digital Input/Output (I/O) drivers, IDE interface, RS-422 interface, RS-232 interface, Ethernet interface, NTSC interface, Red, Green, Blue (RGB) interface and RS-170 interface.

5.0 GENERAL SPECIFICATIONS

5.1 FUNCTIONAL SPECIFICATIONS

The HRF Computer Workstation shall be capable of:

5.1.1 Providing high-capacity mass storage devices.

5.1.2 Uploading and downloading software and data from and to the ground.

5.1.3 Displaying high-resolution graphics.

5.1.4 Having sufficient back plane space to support the use of digital signal processing cards and dual 3-D graphics accelerators.

5.1.5 Being rapidly reconfigured and reprogrammed.

5.1.6 Supporting multitasking and event-driven, real-time processing.

5.1.7 Supporting multichannel equal-interval sampling and precise reaction-time measurement.

5.1.8 Supporting a variety of operating systems, such as Disk Operating System (DOS)/Windows, UNIX/X-windows, OS/2, Windows NT, and Mac Operating System (OS) capability.

5.1.9 Accepting pre-developed software or standard off-the-shelf applications for specific experiment needs (LabViews, SAMMI).

5.1.10 Being compatible with investigators ground versions of the same computer for software/experiment development activities for preflight science verification testing and baseline data collection activities.

5.1.11 Providing simulations of tasks similar to those used in training to measure performance retention/degradation over time and the effect of in-flight training on productivity.

5.1.12 Being upgraded. Capability to expand to include virtual environment is desirable.

5.1.13 Accommodating video frame grabbing and NTSC generator card and video disk storage capability.

5.1.14 Providing voice input and sound output.

5.1.15 Accepting and utilizing graphics software.

5.1.16 Accommodating video capture and analysis software.

5.1.17 Providing multiple serial interfaces.

5.1.18 Providing Ethernet and Payload Bus connectivity

5.1.19 Accommodating the fastest processor clock speed available.

5.1.20 Providing an A/D Card - 16 bit resolution (standard).

5.1.21 Providing an option to support head mounted display.

5.1.22 Providing a voice Recognition System (software interface required).

5.1.23 Providing digital Sound recording and playing capability.

5.1.24 Accommodating station connectivity.

5.1..25 Providing the necessary interfaces to support a printer.

## 5.2 TECHNICAL SPECIFICATIONS

The HRF Computer Workstation shall have:

5.2.1 A large (17”) rack-mounted high-solution, 24 bit color display (standard option) and separate keyboard. Display should have minimum lag, so that dynamic graphics and motion video can be displayed. (Display compatible with RGB, NTSC, and VGA inputs).

5.2.2 Non-fixed workstation components adjustable and able to connect to seat track attachments.

5.2.3 Attachments to allow the components to be placed in various orientations or combinations for different test situations.

5.2.4 Minimum restrictions on the type or quality of software that may be loaded on the computer.

5.2.5 128 Mega Byte (MB) Random Access Memory (RAM); 8 Giga Byte (GB) hard disk + (SCSI and/or IDE); removable mass storage for backup, data distribution.

5.2.6 Graphics capability for Three Dimensional (3D) with Z buffering of surfaces at a minimum of 60,000 triangle per second. 24 bit color, RGB output 1280 x 1024.

5.2.7 Ability to accept wide range of input devices, including trackball, joystick, hand controller, eye-tracker, etc. (Gameport, serial port, and Analog input support).

5.2.8 A PCMCIA slot to access data from other devices stored on PCMCIA cards.

5.2.9 A file compressor utility program.

5.2.10 Voice input and sound output and front panel headphone output.

5.2.11 Nominal power requirements of 28 Volts, Direct Current (VDC), 15 amps.

## 5.3 LAUNCH AND DEPLOYED CONFIGURATION

The HRF Workstation computer drawer will fit in one, 4 PU active EXPRESS Rack drawer location. The keyboard and display will be stowed. This is the same configuration for launch as it is for non-operating.

The operating configuration is display and keyboard are unstowed, attached to the "seat" rails at the side of the rack, cables are unstowed and connected. Any experiment specific cable are then unstowed and connected.

## 6.0 INTERFACE REQUIREMENTS

### 6.1 DATA

The rear drawer data connections will be the EXPRESS Rack Ethernet, video (out from drawer to RIC only) and RS-422 connections.

The front panel data connections will be two serial interfaces, floppy drive interface, video interface in and out, IRIG-B interface, display/keyboard interface, audio interface, A/D and digital I/O interfaces, Digital Signal Processing A/D and Digital I/O interfaces, joystick and parallel interface and Fast SCSI-2 interface.

The Access Door to the PCMCIA drives will be removable in flight to accommodate possible connector and interface changes due to the PCMCIA card slot capabilities.

The HRF Workstation will be capable of utilizing the full capabilities of the ISS and EXPRESS Rack interfaces as they are provided by Space Station Program (SSP).

### 6.2 POWER

The HRF Workstation will require 28 VDC from the EXPRESS Rack Drawer connector power interface. The Workstation will use approximately 350 Watts (Maximum). Maximum use possible will be made of current "green" technologies to reduce power.

### 6.3 SERVICES

Thermal cooling will be accomplished via the EXPRESS Rack Avionics Air Assembly (AAA) system. The Workstation will use internal fans for cooling and exhaust. Structural support launch and reentry will be provided the EXPRESS Rack.

### 6.4 OPERATIONAL SCENARIOS

The HRF Workstation is designed to provide generic data collection, display, downlink and archive for systems that need the capability. The Workstation can also take a controller role in overseeing/controlling different experiment hardware.

## 7.0 SCHEDULE

See Appendix A.

## 8.0 DESIGN LIFE AND MAINTAINABILITY

The design life for the HRF Workstation is 10 years with replacement parts. A Mean Time Between Failure study will be done to estimate the parts most likely to fail. Maintainability will consist of battery replacement, software upgrades, possible board changeouts, possible fan replacement, vacuuming of the vent covers and other scheduled maintenance events. Logistics will include parts for maintenance and replacement parts. All parts that are sensitive to obsolescence will be procured up front at a 10% spares rate.

## 9.0 COST ESTIMATE

This estimate is based on 3 flight units (Flight, Flight Backup, Qualification), 2 Trainer (Flight Like) and 3 Ground Development Units (prototype). Due to the nature of the equipment (computer systems), spares must be purchased as an up front cost. Costs are carried out to the year 2002 for flight support.

Costs include ground development systems, software development, modifications, Flight systems, testing, documentation, flight support (software and hardware) and hardware development costs. No Principle Investigator (PI) specific units are included in the costs.

This cost estimate assumes no development, hardware or software is received from the Neurolab VEG project. No funding for the VEG or it's development in included in the HRF Workstation budget. Experience and designs used in the VEG project up to this date will be used in the HRF Workstation design. The VEG, if it is not canceled, will reduce risk by completing testing approximately 6 months before the HRF Workstation. This will allow design changes to be incorporated into the Workstation based on lessons learned during the VEG testing. If VEG is canceled 9 months from 12/95, there will be no impact as the HRF Workstation design will be complete and work will have already have started on the Workstation qualification unit.

## 10.0 RISK ASSESSMENT

The most significant risk will be the risk that all HRF hardware must face. This risk is one of ISS/SSP requirements that have not been documented being levied on the hardware late in the design cycle or just prior to flight. For the HRF Workstation, the hardware will be built on the best known and documented requirements. If additional requirements are levied on the hardware (testing, functional, verification, etc.) above the initial "build/test to" requirements, they will be evaluated as they are levied on the hardware and developer. If this scenario (additional requirements) occurs, the evaluation will include cost and schedule impacts which will be delivered to NASA.

A secondary risk that is no HRF Program documentation has been officially released or signed. This includes the PRD. This Hardware Development Plan (HDP) and cost estimate are based on requirements needed to meet the LSPD PRD for Class C flight hardware for Space Shuttle flight. The HRF PRD has many TBDs and new requirements that current LSPD Hardware does not do to certify hardware. It is not clear how this will impact test cost, time and location. There are also some requirements currently in the HRF PRD that can not be met by the HRF Workstation. They will be addressed in detail at the HRF WS PDR and CDR.

A third risk is available manpower. Manpower for this project must be delivered immediately due to the very compressed schedule. If manpower is not delivered on time, this will increase cost due to a more compressed schedule and it will not allow schedule milestones to be meet. Manpower needed is included in the costs estimate.

A fourth risk is the possible requirements for ISO 9000 quality. Currently, for the LSPD PRD, we do not meet and do not have the requirements to meet ISO 9000. As this is a "build on site" and not a purchase or "build off site", the ISO 9000 is not applicable to this piece of hardware.

## 10.1 TECHNICAL RISK

Technical Risk is Medium. The display requirement for 17", high resolution color is currently beyond present technology. A phased approach will be used to meet this requirement.

## 10.2 COST RISK

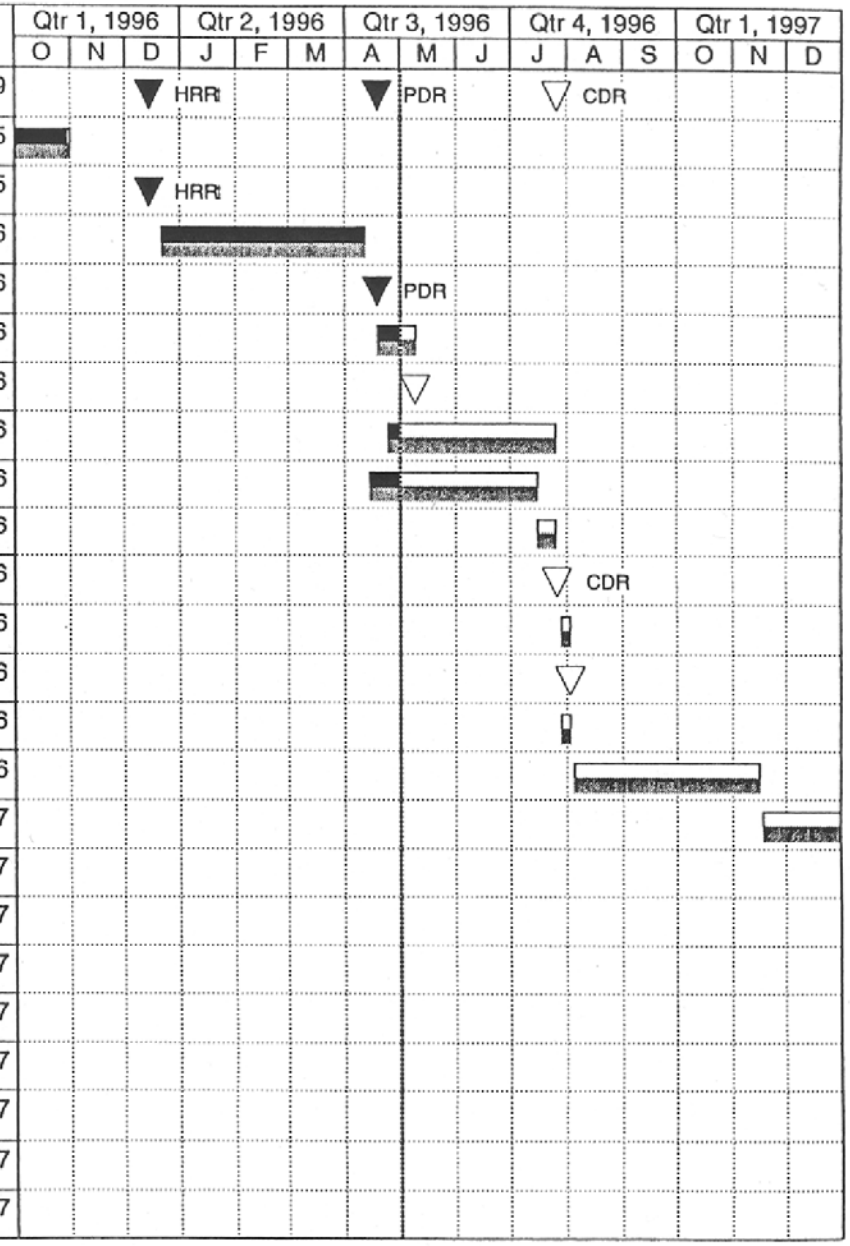
The Cost Risk is Medium. The VEG Computer Drawer flight units should drive out most of the unknowns. Corporate knowledge gained in the delivery of the VEG Computer can be passed on for the development of the HRF Workstation, thus reducing the "learning curve" and lowering some manpower costs.

## 10.3 SCHEDULE RISK

Schedule Risk is Medium. There is sufficient time to deliver this hardware on time and on schedule. The cost and schedule in this HDP are based on a manpower and cost projection. If manpower and budget are not made available at the projected levels and skills January 1996, then schedule becomes further compressed which will increase cost and schedule risk (i.e. schedule slips may arise due to unavailable manpower or budget).

# Appendix A

| Itm# | Task Name | Start | Finish |
|---|---|---|---|
| 1 | **HRF COMPUTER WORKSTATION** | 9/1/95 | 8/2/99 |
| 2 | Prepare Hardware Dev Plan | 9/1/95 | 10/31/95 |
| 3 | Hardware Requirements Review (HRR) | 12/15/95 | 12/15/95 |
| 4 | Preliminary Design | 12/22/95 | 4/11/96 |
| 5 | Preliminary Design Review (PDR) | 4/18/96 | 4/18/96 |
| 6 | Incorporate RIDs Into Safety Data | 4/19/96 | 5/9/96 |
| 7 | Deliver Phase I Safety Review Data | 5/9/96 | 5/9/96 |
| 8 | Detail Design | 4/25/96 | 7/25/96 |
| 9 | Build Prototype | 4/15/96 | 7/15/96 |
| 10 | Test Prototype and Modify Design as Required | 7/16/96 | 7/25/96 |
| 11 | Critical Design Review (CDR) | 7/26/96 | 7/26/96 |
| 12 | Incorporate RIDs Into Safety Data | 7/29/96 | 8/2/96 |
| 13 | Deliver Phase II Safety Review Data | 8/2/96 | 8/2/96 |
| 14 | Finalize Design Release Drawings | 7/29/96 | 8/2/96 |
| 15 | Fabricate and Assemble Qual Unit | 8/5/96 | 11/15/96 |
| 16 | Conduct Acceptance Test on Qual Unit | 11/18/96 | 1/16/97 |
| 17 | Verify Interfaces with Rack In Ground Rack | 1/17/97 | 1/17/97 |
| 18 | Qual Readiness Review | 1/17/97 | 1/17/97 |
| 19 | Conduct Qualification Tests | 1/20/97 | 3/19/97 |
| 20 | Resolve Anomalies and Modify Design | 3/20/97 | 4/11/97 |
| 21 | Design Certification Review (DCR) | 4/11/97 | 4/11/97 |
| 22 | Deliver Phase III Safety Review Data | 4/11/97 | 4/11/97 |
| 23 | Fabricate and Assemble First Flight Unit | 4/14/97 | 6/13/97 |
| 24 | Conduct Acceptance Test on Flight Unit | 6/16/97 | 8/11/97 |




Status Date: 5/1/96

| Itm# | Task Name | Start | Finish | Qtr 1, 1996 | | | Qtr 2, 1996 | | | Qtr 3, 1996 | | | Qtr 4, 1996 | | | Qtr 1, 1997 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D |
| 25 | First Article Configuration Inspection (FACI) | 8/11/97 | 8/11/97 | | | | | | | | | | | | | | | |
| 26 | Verify Interfaces with Rack in Ground Rack | 8/12/97 | 9/11/97 | | | | | | | | | | | | | | | |
| 27 | Integration Readiness Review | 9/11/97 | 9/11/97 | | | | | | | | | | | | | | | |
| 28 | Deliver Flight Unit(s) to Bond | 9/12/97 | 9/18/97 | | | | | | | | | | | | | | | |
| 29 | Support Rack Level Integration and Verification | 1/22/98 | 3/18/98 | | | | | | | | | | | | | | | |
| 30 | Fabricate and Assemble Balance of Flight Units | 8/12/97 | 1/15/98 | | | | | | | | | | | | | | | |
| 31 | Refurbish Qual Unit as Necessary | 4/14/97 | 5/23/97 | | | | | | | | | | | | | | | |
| 32 | Deliver Qual Unit to High Fidelity Mockup | 5/23/97 | 5/23/97 | | | | | | | | | | | | | | | |
| 33 | Develop Trainers and Simulators | 8/5/96 | 11/25/96 | | | | | | | | | | | | | | | |
| 34 | Conduct Acceptance Tests on Balance of Flight Unit: | 1/16/98 | 2/5/98 | | | | | | | | | | | | | | | |
| 35 | Deliver Trainers and Simulators | 11/26/96 | 12/2/96 | | | | | | | | | | | | | | | |
| 36 | Close All Open Paper | 3/19/98 | 4/15/98 | | | | | | | | | | | | | | | |
| 37 | Launch Package Acceptance Review | 6/23/98 | 6/23/98 | | | | | | | | | | | | | | | |
| 38 | Payload Acceptance Review | 2/5/98 | 2/5/98 | | | | | | | | | | | | | | | |
| 39 | Close All Open Paper | 2/6/98 | 3/5/98 | | | | | | | | | | | | | | | |
| 40 | Deliver Balance of Flight Units to Bond | 3/6/98 | 3/19/98 | | | | | | | | | | | | | | | |
| 41 | Ship Launch Package to Launch Site | 6/23/98 | 6/23/98 | | | | | | | | | | | | | | | |
| 42 | Support Payload Training | 12/3/96 | 2/24/97 | | | | | | | | | | | | | | | |
| 43 | Sustaining Engineering | 6/23/98 | 8/2/99 | | | | | | | | | | | | | | | |

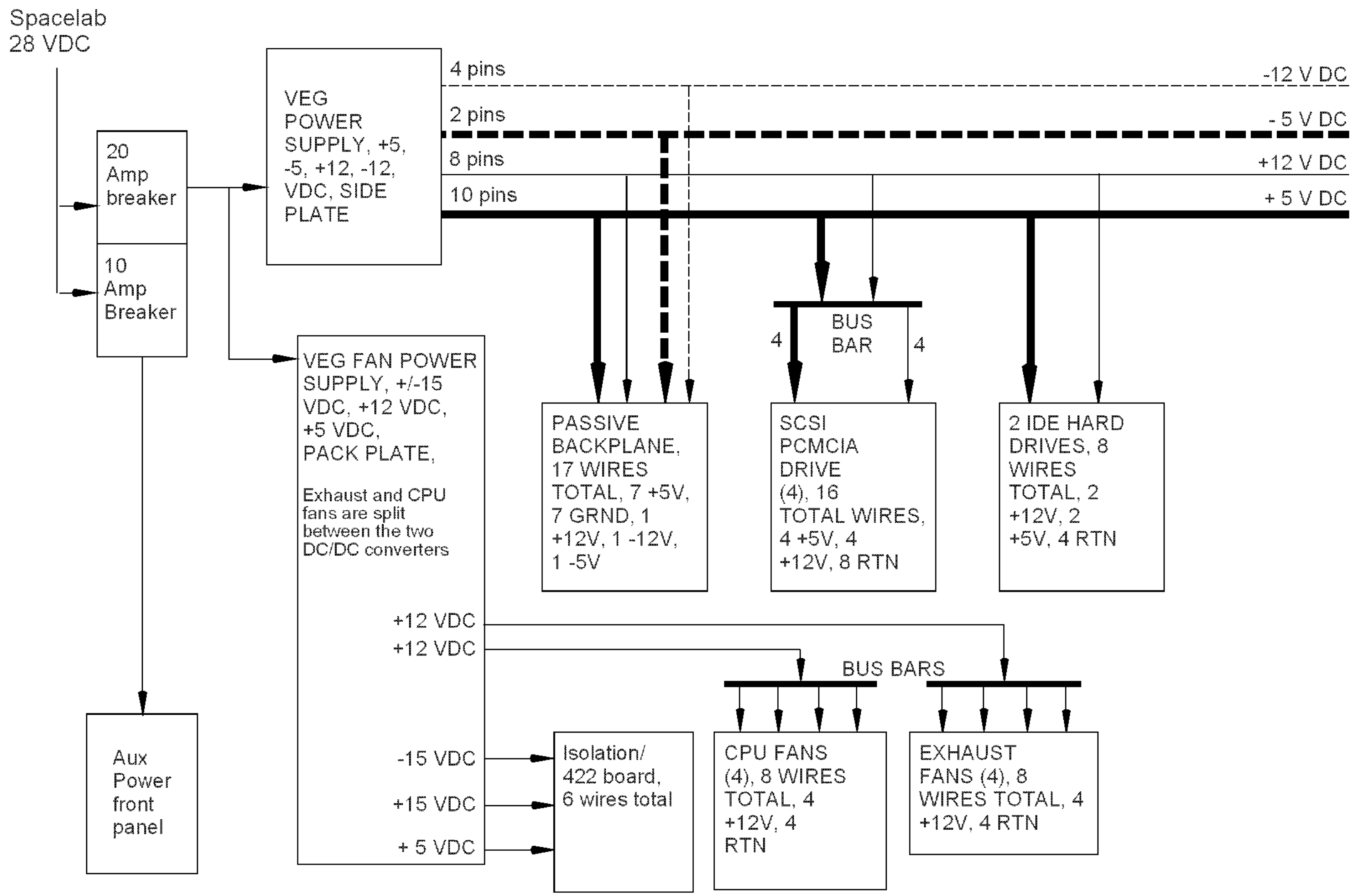
Status Date: 5/1/96

# Appendix B

Appendix C

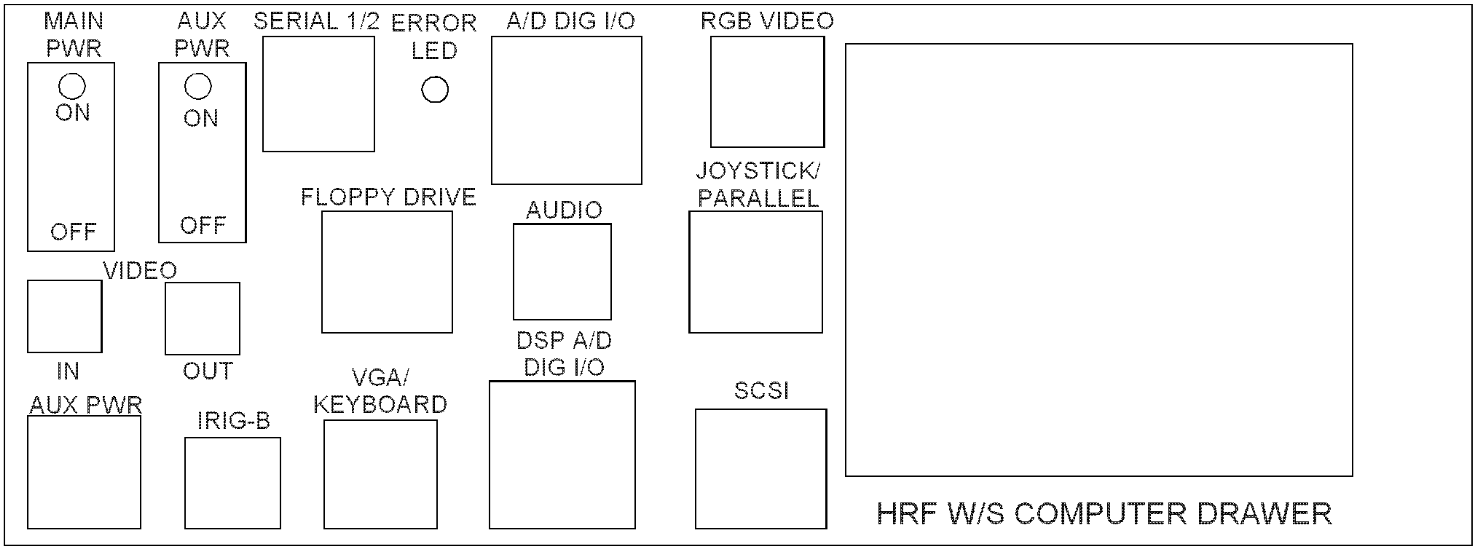
Appendix D

Appendix E




Bus bars split 1 +5 VDC or 1 +12 VDC into 4 or more wires of same size, the main wire is fused at its maximum current.

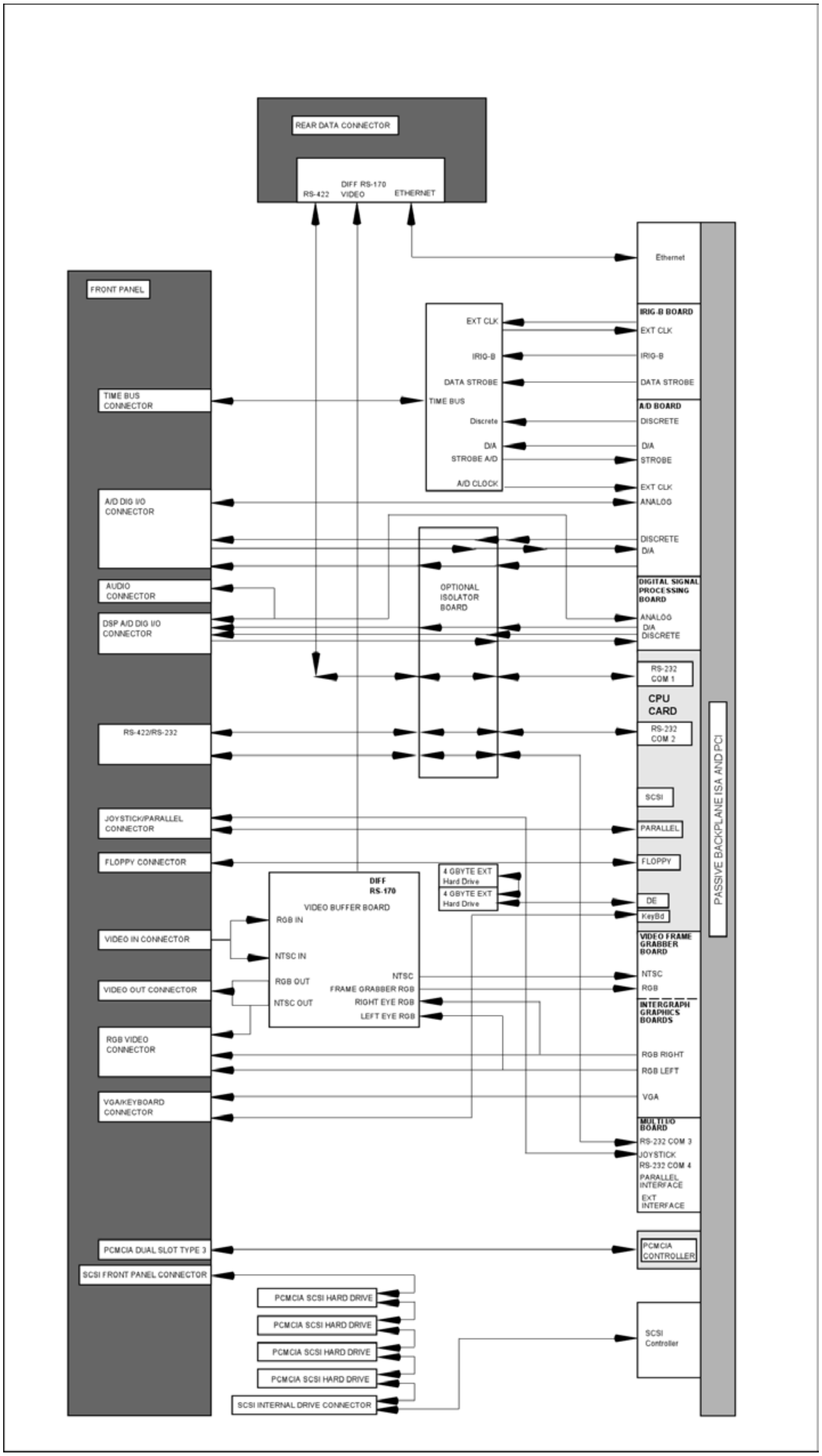
Preliminary Power Block Diagram



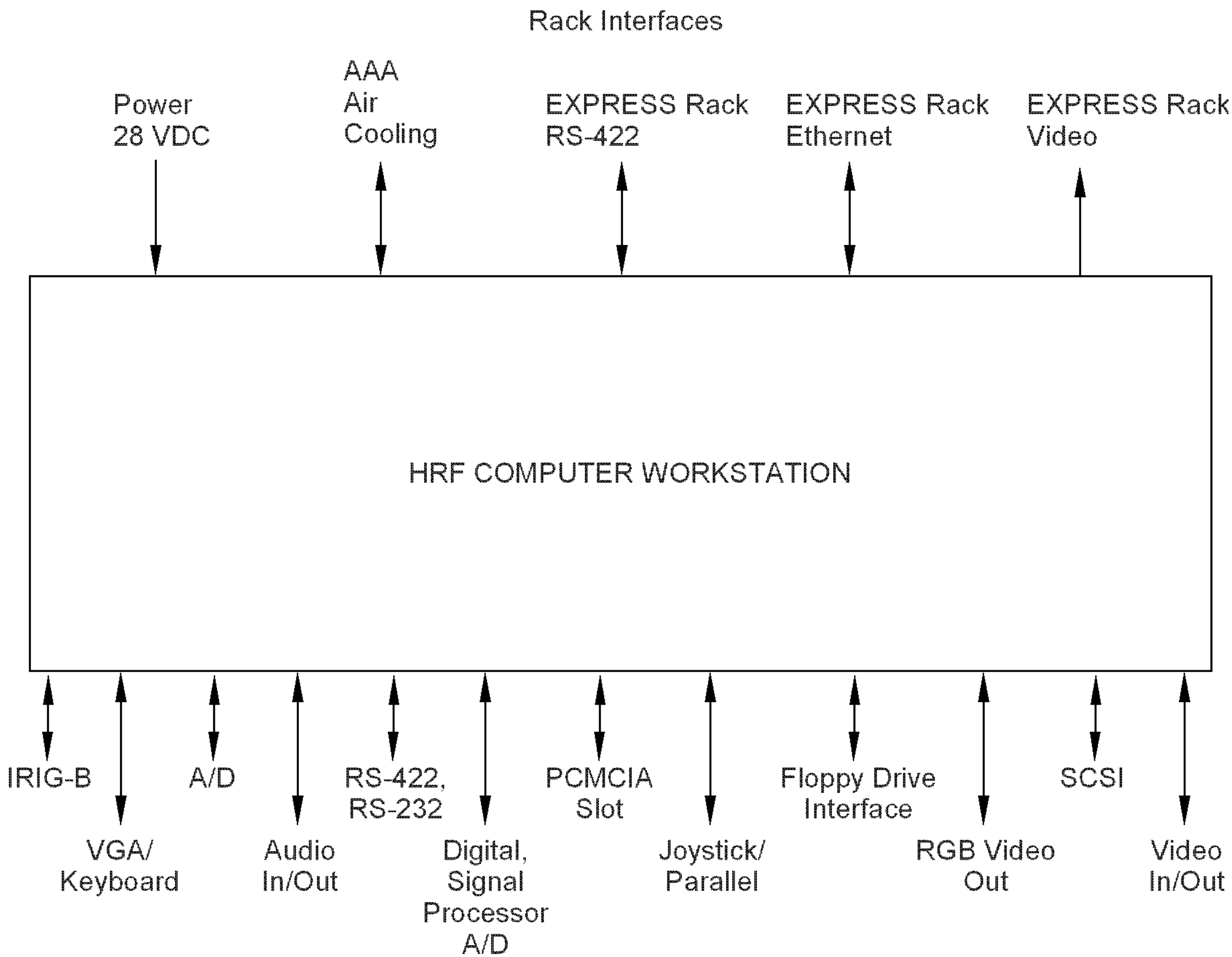

VGA/Keyboard is a MS27497T14F35SC, same as LM2
Joystick/parallel is a MS 27497T16F42SC
AUX PWR is a MS3470L14-12S 10 Amp connector
A/D DIG I/O is a MS27497T20F35SC, 79 # 22 pins
Video in, Video out are BNC connectors
DSP A/D I/O is a MS27497T20F35SC, 79 # 22 pins
FLOPPY DRIVE is a MS27497T16F42SC
IRIG-B is a MS27497E10F35SA
RGB VIDEO is a MS27497T14F35SC
SCSI is a MS27497T16F35SC shell size 16 (50 pins)

This drawing is half size, connector sizes are to scale, maximum diameter. NASA-STD-3000 Guidelines are 1" between connectors.

HRF Workstation Front Panel (DRAFT)




Rack Mounted HRF Workstation Internal Block Diagram




Preliminary HRF Computer Workstation Block Diagram

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