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SPACE STATION TASK FORCE

HUMAN PRODUCTIVITY
PROGRAM DEFINITION

D.B. CRAMER

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HUMAN PRODUCTIVITY: WHAT IS IT?

**THE USE OF MAN TO ATTAIN UTILITARIAN
OBJECTIVES IN THE SPACE STATION SYSTEM**

WHY SPACE STATION? WHY NOW?

- o EARLIER ATTEMPTS TO START A SPACE STATION PROGRAM HAD NO SUCH THRUST
- o PRESENT SPACE STATION PLANNING IS CHARACTERIZED BY:
 - TECHNICAL ACTIVITIES TIED CLOSELY TO MISSION REQUIREMENTS -- USER NEEDS ACKNOWLEDGED
 - COMMERCIAL THEME MORE PROMINENT
 - COMMERCIAL USERS HAVE MORE DETAILED REQUIREMENTS
 - CUSTOMER DEMAND FOR HIGH EFFICIENCY AND AFFORDABILITY
- o CURRENT NATIONAL CONCERN OVER U.S. PRODUCTIVITY
- o NASA'S GOAL TO BECOME "A LEADER IN THE DEVELOPMENT AND APPLICATION OF ADVANCED TECHNOLOGY AND MANAGEMENT PRACTICES WHICH CONTRIBUTE TO SIGNIFICANT INCREASE IN BOTH AGENCY AND NATIONAL PRODUCTIVITY"

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HUMAN PRODUCTIVE PROGRAM GOAL

**TO OPTIMIZE HUMAN PRODUCTIVITY ON THE
SPACE STATION WITHIN THE EXISTING RESOURCES
AND OPERATIONAL CONSTRAINTS**

HUMAN PRODUCTIVITY FLIGHT OBJECTIVES

- DEVELOP HABITABILITY WHICH:
 - SUSTAINS HUMAN PRODUCTIVITY ABOVE 90% OF INITIAL PERFORMANCE THROUGHOUT A TOUR OF 90 DAYS
- MAXIMIZE IVA CREW TIME:
 - CURRENT GOAL: 9 HOURS/DAY EXCLUDING WEEKENDS
- ESTABLISH EVA WHICH IS:
 - ROUTINE
 - RELIABLE
 - CONVENIENT
 - AND ABOVE ALL - CAPABLE
 - CURRENT GOAL: 8 HOURS/DAY FOR 4 CREW MEMBERS
- MAXIMIZE USE OF SHUTTLE TO VALIDATE NEW SYSTEMS

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HUMAN PRODUCTIVITY PROGRAM STRATEGY (I)

- INTEGRATE CREW-RELATED ACTIVITIES AND FACILITIES INTO A SINGLE, WELL INTEGRATED, AND COORDINATED PROGRAM
- CONDUCT ITERATIVE COST/TRADE STUDIES
- IDENTIFY COST EFFECTIVE PROGRAM ELEMENTS
- INCREASE SAFETY AND PRODUCTIVITY OF HUMAN OPERATIONS
- MATCH RESOURCES

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HUMAN PRODUCTIVITY: PROGRAM STRATEGY (A)

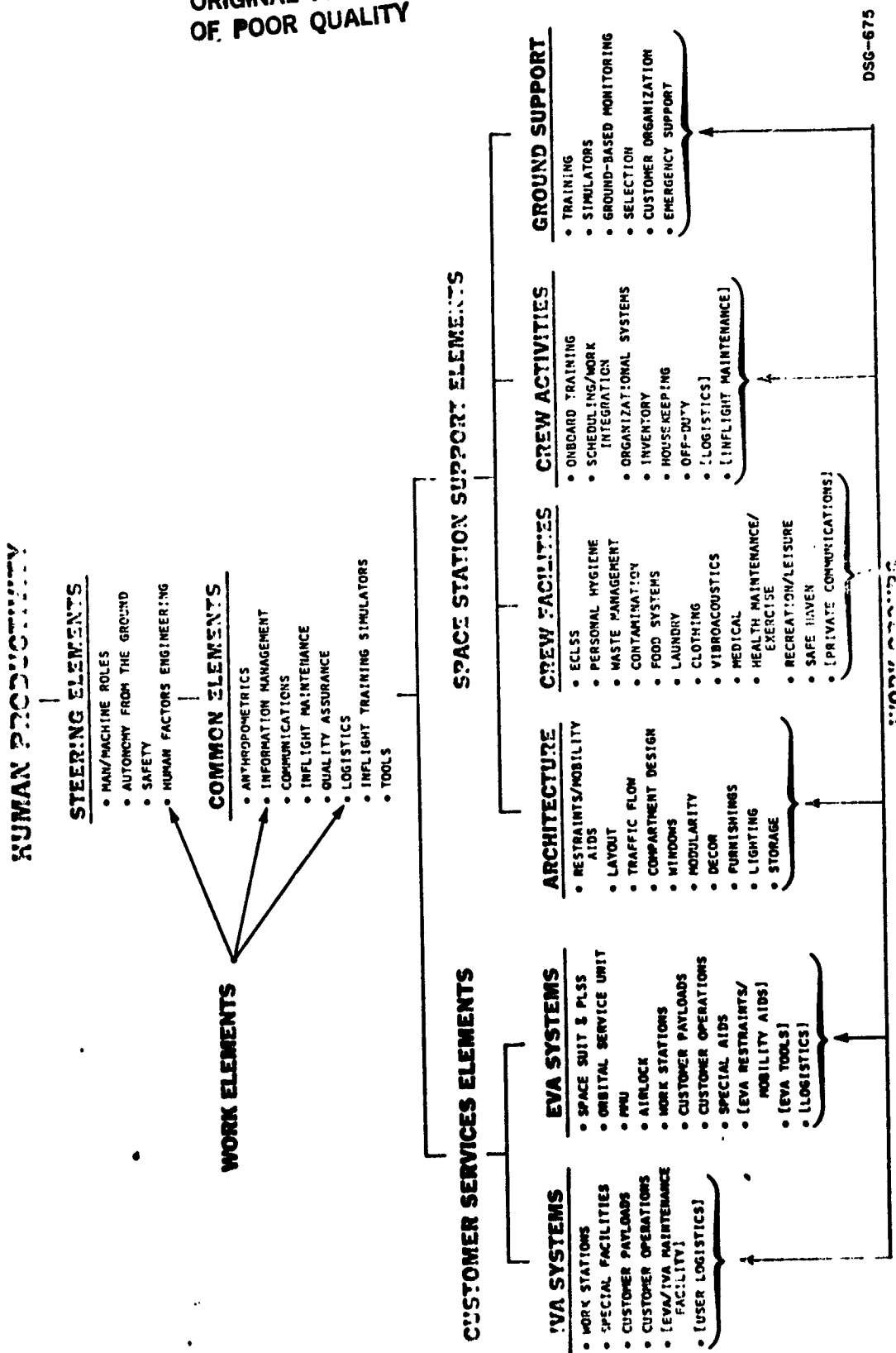
- PROVIDE FOR WELL ORGANIZED CUSTOMER INVOLVEMENT
- DEVELOP A MULTI-CENTER ACTIVITY
- PROVIDE A FORUM FOR CENTER, INDUSTRY, AND UNIVERSITY INTERACTION
- ACCOMMODATE GROWTH AND EVOLUTION
- CARRY OUT AN EARLY, DETAILED DEFINITION

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CONCEPTUAL DEFINITION - WHAT IS IT?

- o PHASE A STUDY OF HUMAN PRODUCTIVITY PROGRAM
- o COMPETITIVE PROCUREMENT INVOLVING AEROSPACE INDUSTRY
- o CONCEPTUAL DEFINITION OF ENTIRE PROGRAM, EXCLUDING EVA SYSTEMS
- o DEFINITION NOT SO DETAILED AS TO INVOLVE PROPRIETARY INFORMATION
- o IDENTIFIES IMPORTANT TRADE STUDIES, CRITICAL ASSUMPTIONS, AND DESIGN ISSUES
- o STARTS 10/84 AND ENDS 6/85
- o EXTENSION OF THE ACTIVITIES OF THE HUMAN PRODUCTIVITY WORKING GROUP
- o FEEDS INTO PHASE B CONTRACTS

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CONCEPTUAL DEFINITION - WHY DO IT?

THE HUMAN PRODUCTIVITY PROGRAM IS NEW -- A DEFINITION IS REQUIRED:

- o TO PROVIDE INFORMATION/REQUIREMENTS INTO PHASE B STUDIES
- o TO IDENTIFY LONG LEAD TECHNOLOGY
- o TO IDENTIFY RESPONSIBILITY FOR WORK ELEMENTS
- o TO COORDINATE THE DEVELOPMENT OF CREW FACILITIES AND ACTIVITIES
- o TO LAY THE FOUNDATION FOR A COST EFFECTIVE APPROACH TO IMPROVING HUMAN PRODUCTIVITY

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CONCEPTUAL DEFINITION - PROCESS

INCLUDES ALL OF THE HUMAN PRODUCTIVITY PROGRAM:

- o EXCLUDING EVA SYSTEMS WHICH ARE COVERED IN SEPARATE, PARALLEL CONTRACTS
- o EMPHASIS ON BREADTH NOT DEPTH
- o DEFINITION IS ITERATIVE STARTING WITH "STEERING" WORK ELEMENTS

PROCESS INVOLVES THE FOLLOWING DIVISIONS:

- o WORK ELEMENTS INTO WORK UNITS
- o WORK UNITS INTO TASKS
- o PRIMARY EMPHASIS ON TASK LEVEL:

- OBJECTIVE
- DELIVERABLE
- APPROACH
- INPUTS
- ELEMENT COORDINATION
- ELEMENT DELIVERABLE DISTRIBUTIONS
- ENGINEERING TRADE STUDIES
- REQUIRED MANPOWER
- SPECIAL REQUIREMENTS
- REQUIREMENTS REFERENCE
- START DATE
- COMPLETION DATE

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CONCEPTUAL DEFINITION - PROCESS
(Continued)

CONTRACT DELIVERABLES:

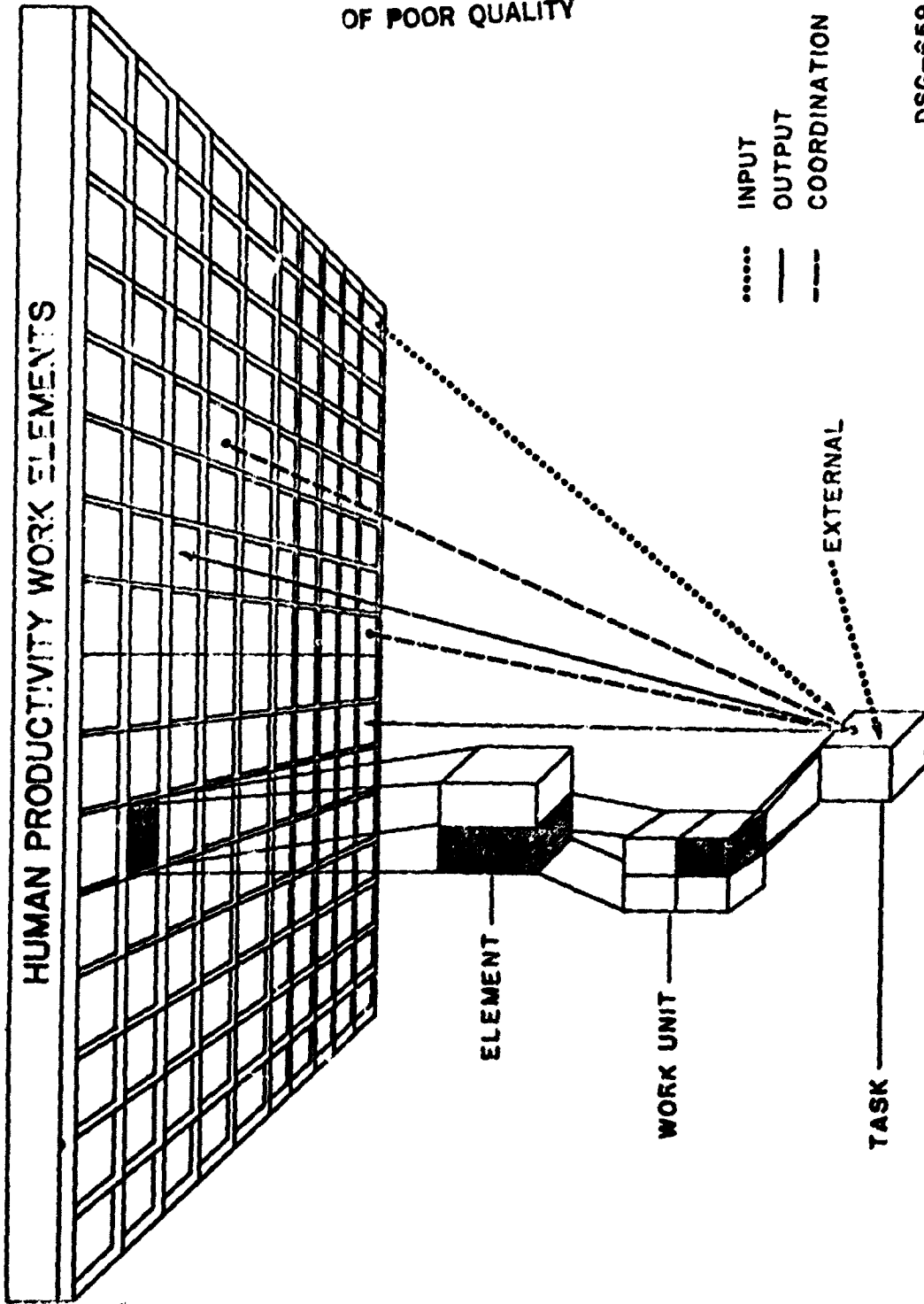
- 1) REVIEW OF LITERATURE AND "LESSONS LEARNED"
- 2) CRITIQUE OF CURRENT PROGRAM CONTENT
- 3) CRITICAL ASSUMPTION INVOLVED IN THE CONCEPTUAL DEFINITION
- 4) INTEGRATED AND PRIORITIZED TRADE STUDIES
- 5) FINAL CONCEPTUAL DEFINITION OF HUMAN PRODUCTIVITY PROGRAM
- 6) DESIGN DRIVERS

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HUMAN PRODUCTIVITY PROGRAM DEFINITION PROCESS

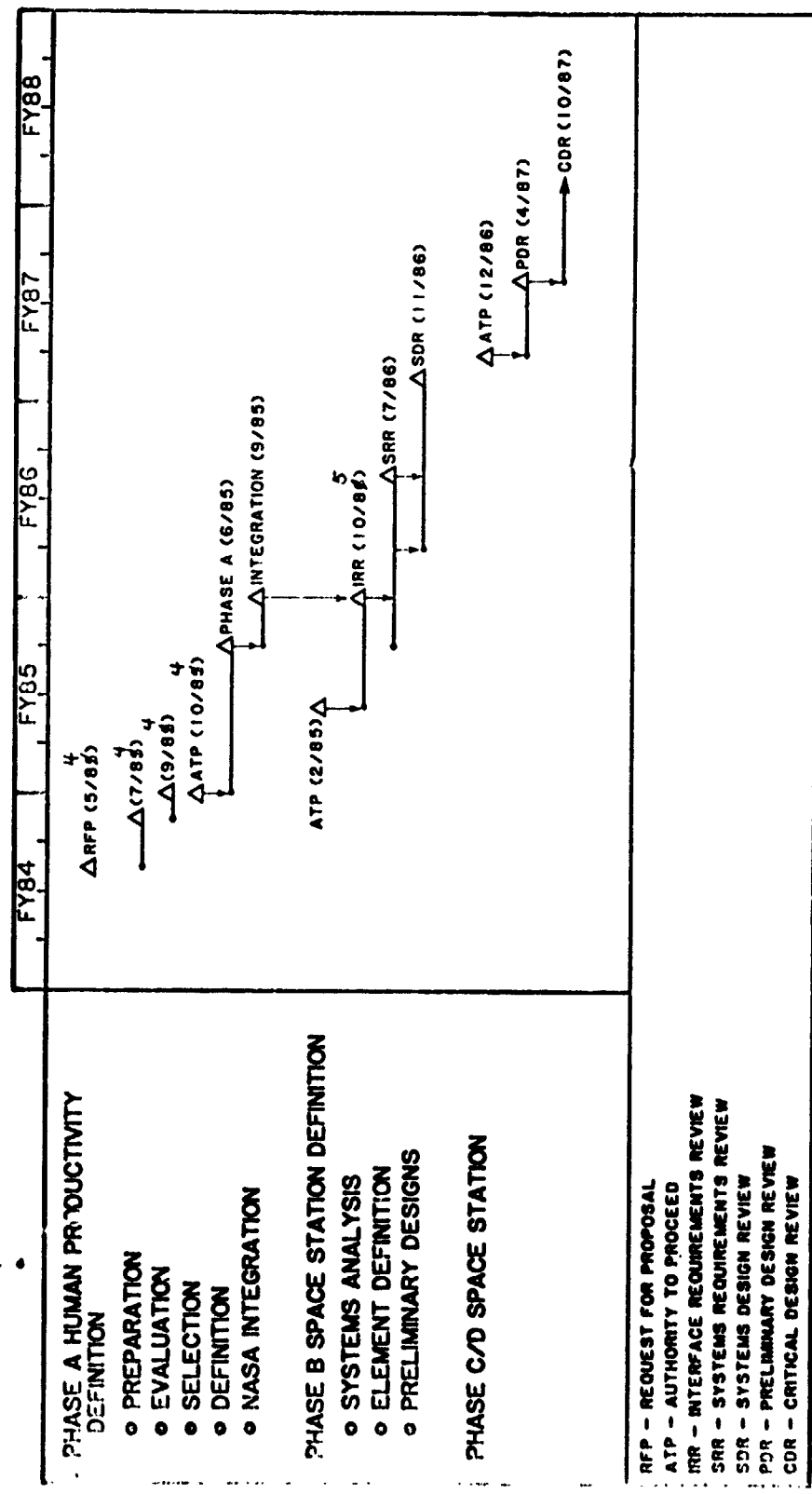


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..... INPUT
——— OUTPUT
- - - COORDINATION

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CONCEPTUAL DEFINITION - SCHEDULE



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PHASE A HUMAN PRODUCTIVITY DEFINITION

- o PREPARATION
- o EVALUATION
- o SELECTION
- o DEFINITION
- o NASA INTEGRATION

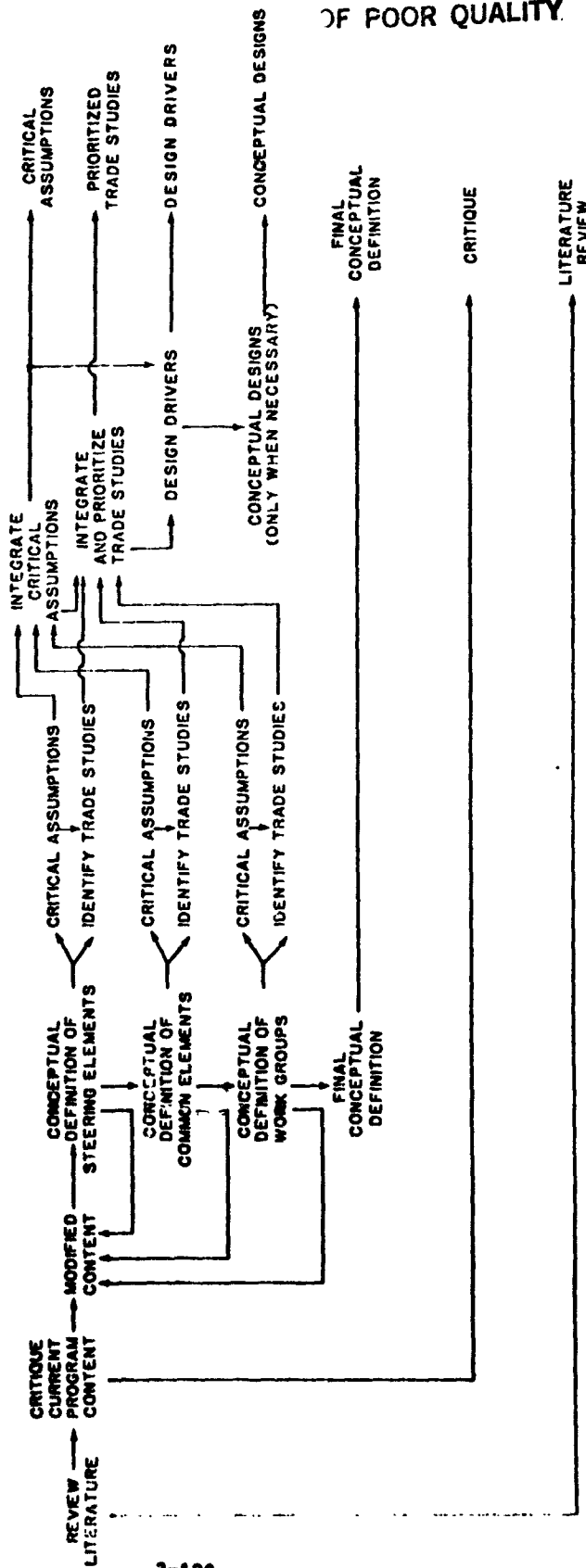
PHASE B SPACE STATION DEFINITION

- o SYSTEMS ANALYSIS
- o ELEMENT DEFINITION
- o PRELIMINARY DESIGNS

PHASE C/D SPACE STATION

- RFP - REQUEST FOR PROPOSAL
- ATP - AUTHORITY TO PROCEED
- IRR - INTERFACE REQUIREMENTS REVIEW
- SRR - SYSTEMS REQUIREMENTS REVIEW
- SDR - SYSTEMS DESIGN REVIEW
- PDR - PRELIMINARY DESIGN REVIEW
- CDR - CRITICAL DESIGN REVIEW

HUMAN PRODUCTIVITY PROGRAM - CONCEPTUAL DEFINITION

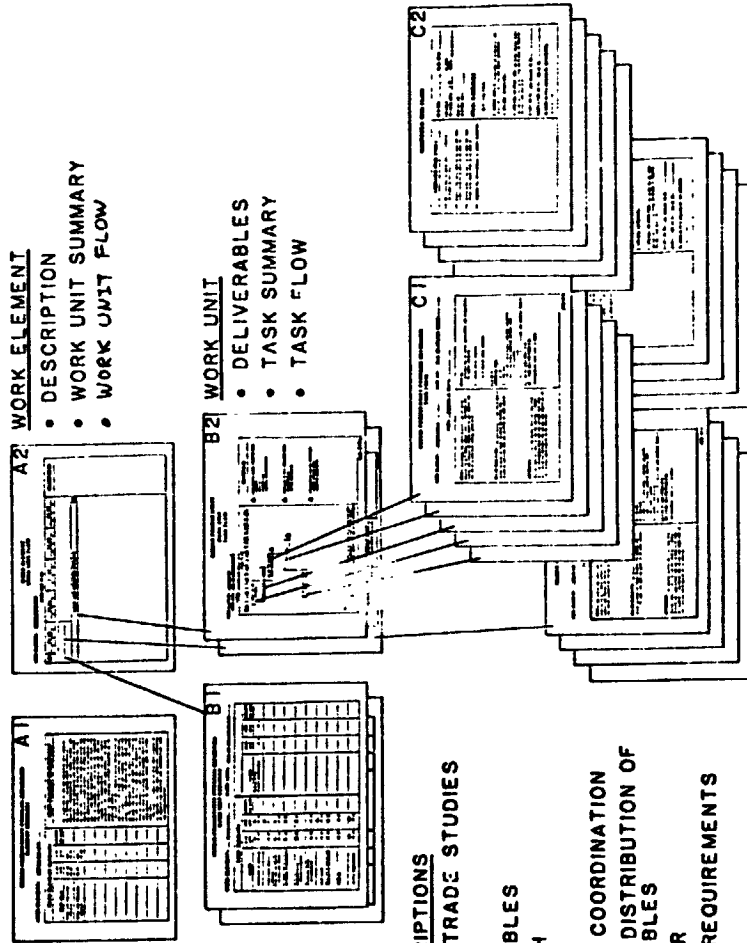
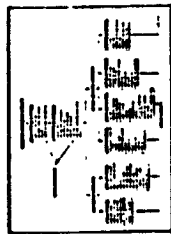


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HUMAN PRODUCTIVITY PROGRAM - DEFINITION PROCESS

HUMAN PRODUCTIVITY WORK ELEMENTS



- WORK ELEMENT**
- DESCRIPTION
 - WORK UNIT SUMMARY
 - WORK UNIT FLOW

- WORK UNIT**
- DELIVERABLES
 - TASK SUMMARY
 - TASK FLOW

- TASK DESCRIPTIONS**
- IDENTIFY TRADE STUDIES
 - GOAL
 - DELIVERABLES
 - APPROACH
 - INPUTS
 - ELEMENT COORDINATION
 - ELEMENT DISTRIBUTION OF DELIVERABLES
 - MANPOWER
 - SPECIAL REQUIREMENTS

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CONCEPTUAL DEFINITION - EXAMPLE

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WORK ELEMENT:

VIBROACOUSTICS

WORK UNITS:

NOISE AND VIBRATION
CONTROL

NOISE AND VIBRATION
EFFECTS

TASKS:

1. INVENTORY OF SOURCES
2. INDIVIDUAL SOURCE MODELS
3. DISTRIBUTED SOURCE PREDICTION MODEL
4. AIRBORNE TRANSMISSION
5. REVERBERATION CHARACTERISTICS
6. STRUCTURE-BORNE TRANSMISSION
7. PATH MODEL
8. ABSORPTIVE MATERIALS
9. DAMPING
10. ACTIVE SUPPRESSION
11. SYSTEM NOISE PREDICTION/CONTROL

1. NAS CONSULTATION
2. PRESSURE/GRAVITY EFFECTS
3. TTS MEASUREMENTS
4. INTELLIGIBILITY IN NOISE
5. EVA/IVA HEARING PROTECTION
6. PRESSURE/GRAVITY/BACKGROUND EFFECTS ON VOICE SIGNAL
7. VOICE COMMAND SYSTEM PERFORMANCE
8. COMMUNICATION DEVICES EVA/IVA
9. COGNITIVE EFFECTS
10. ANNOYANCE/SLEEP
11. EVA/IVA TASKS
12. CREW SURVEY
13. CONTINUED NAS CONSULTATION

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**HUMAN PRODUCTIVITY PROGRAM DEFINITION
ELEMENT SUMMARY**

WORK ELEMENT: VIBROACOUSTICS

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WORK ELEMENT SUMMARY			MANPOWER/ MAN-YEARS	WORK ELEMENT DESCRIPTION
WORK UNITS	START DATE	STOP DATE		
Noise and Vibration Effects	4th Qtr FY 84	End FY 89		<p>The objective of the vibroacoustic work element is to develop a strategy which facilitates effective communication of human speech and controls noise generation and exposure on board the Space Station. To meet this objective, we must better characterize the generation and transmission characteristics of noise aloft and the physiological effects of noise exposure in space. Two basic approaches will be used: (1) The development of cost-effective acoustic engineering control measures and (2) the development of communication aids and countermeasures. Of these two approaches, the development of engineering control measures is the preferred method.</p> <p>Terrestrial data bases provide information on the effects of noise on auditory thresholds, intelligibility, task performance, comfort and sleep. However, vibroacoustic data bases need to be developed for the space environment because the present approach which relies on terrestrial analogs may not be adequate. In lieu of adequate flight data, terrestrial data will be used in strategy development which will subsequently be updated based upon in-flight experience.</p> <p>The overall objective of this work element is to develop the most cost-effective combination of engineering controls and communication aids and countermeasures.</p>
Noise and Vibration Control	FY 85	End FY 89		

HUMAN PRODUCTIVITY PROGRAM DEFINITION WORK UNIT FLOW

WORK ELEMENT: VIBROACOUSTICS

WORK UNIT FLOW					DELIVERABLES			
FY84	FY85	FY86	FY87	FY88	FY89	FY90	FY91	
								<ul style="list-style-type: none"> • HEARING EXPOSURE LIMIT VALUES • REQUIRED COMMUNICATION SPECIFICATIONS • VIBROACOUSTIC PERFORMANCE CRITERIA • SLEEP COMPARTMENT NOISE LEVELS
								<ul style="list-style-type: none"> • VIBROACOUSTIC SOURCE PREDICTION MODEL • VIBROACOUSTIC PATH PREDICTION MODEL • VIBROACOUSTIC CONTROL STRATEGIES

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**HUMAN PRODUCTIVITY PROGRAM DEFINITION
WORK UNIT SUMMARY**

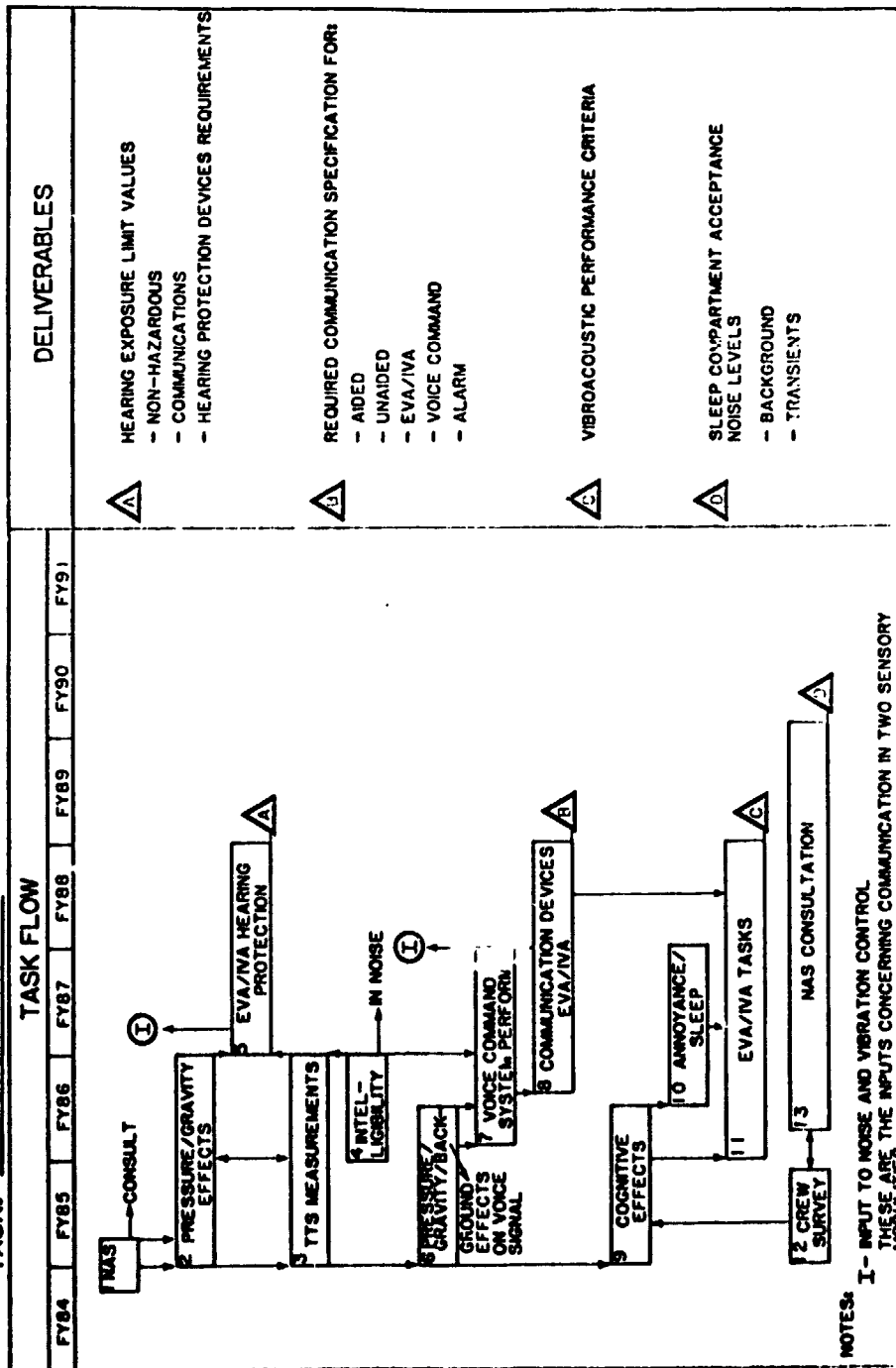
WORK ELEMENT: Vibroacoustics WORK UNIT: Noise and Vibration Effects

TASK SUMMARY							
TASKS	START DATE	STOP DATE	MANPOWER/ MAN-YEARS	TASKS	START DATE	STOP DATE	MANPOWER/ MAN-YEARS
NAS Consultation	4th Qtr FY 84	2nd Qtr FY 85		EVA/IVA Tasks	FY 86	FY 89	
Pressure/Gravity Effects	FY 85	FY 87		Crew Survey	FY 85	4th Qtr FY 85	
TTS Measurements	FY 85	FY 87		NAS Cont'd Consult.	FY 86	FY 90	
Intelligibility in Noise	FY 86	FY 87					
EVA/IVA Hearing Protection	FY 87	FY 89					
Pressure/Gravity/ Background Effects on Voice Signal	FY 85	3/4 FY86					
Voice Command System Performance	FY 86	FY 88					
Communication Devices EVA/IVA	3/4 FY86	FY 89					
Cognitive Effects	FY 85	3/4 FY86					
Annoyance	3/4 FY86	FY 88					

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HUMAN PRODUCTIVITY WORK UNIT TASK FLOW

WORK ELEMENT: VIBROACOUSTICS
 WORK UNIT: NOISE AND VIBRATION EFFECTS
 TASK:



DELIVERABLES

A HEARING EXPOSURE LIMIT VALUES
 - NON-HAZARDOUS
 - COMMUNICATIONS
 - HEARING PROTECTION DEVICES REQUIREMENTS

B REQUIRED COMMUNICATION SPECIFICATION FOR:
 - AIDED
 - UNAIDED
 - EVA/IVA
 - VOICE COMMAND
 - ALARM

C VIBROACOUSTIC PERFORMANCE CRITERIA

D SLEEP COMPARTMENT ACCEPTANCE NOISE LEVELS
 - BACKGROUND
 - TRANSIENTS

HUMAN PRODUCTIVITY PROGRAM DEFINITION WORK UNIT SUMMARY

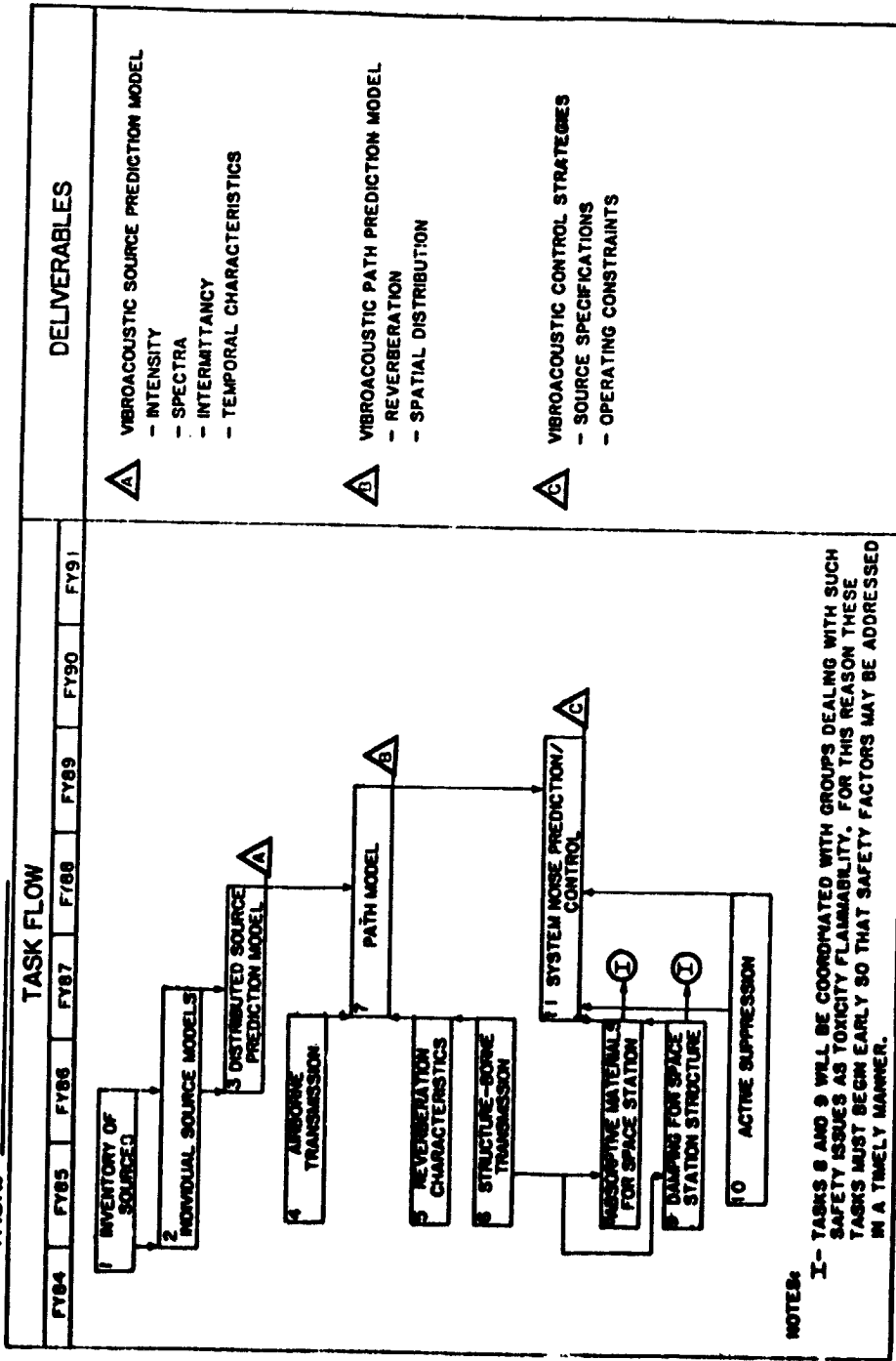
WORK ELEMENT: Vibroacoustics WORK UNIT: Noise and Vibration Control

TASK SUMMARY							
TASKS	START DATE	STOP DATE	MANPOWER/ MAN-YEARS	TASKS	START DATE	STOP DATE	MANPOWER/ MAN-YEARS
Inventory of Sources	3/4 FY 84	3/4 FY 86		System Noise Prediction/Control	FY 84	FY 90	
Individual Source Models	FY 85	3/4 FY 87					
Distributed Source Prediction Model	3/4 FY 86	3/4 FY 88					
Airborne Transmission	FY 85	FY 87					
Reverberation Characteristics	FY 85	FY 87					
Structure-Borne Transmission	FY 85	FY 87					
Path Model	FY 87	3/4 FY 89					
Absorptive Materials	FY 85	FY 87					
Damping	FY 85	FY 87					
Active Suppression	3/4 FY 85	3/4 FY 88					

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HUMAN PRODUCTIVITY WORK UNIT TASK FLOW

WORK ELEMENT: VIBROACOUSTICS
 WORK UNIT: NOISE AND VIBRATION CONTROL
 TASK: _____



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HUMAN PRODUCTIVITY PROGRAM DEFINITION TASK FORM

WORK ELEMENT: Vibroacoustics WORK UNIT: Noise and Vibration Control

TASK: Inventory of Sources

GOAL: Determine the anticipated type of noise sources (e.g.) fans, pumps, etc.), estimate the number and nature of noise sources per module and the total acoustical energy generated.

DELIVERABLE(S): An inventory of the anticipated noise sources on Space Station including the acoustic spectrum and use profile of each source.

APPROACH: Carefully study Skylab, Salyut, etc. Station configurations and operations will then be studied to estimate the nature and magnitude of the various anticipated noise sources.

INPUTS:

1. Information on noise generation and transmission in space vehicles.
2. Known noise sources.
3. Anticipated noise sources.

ELEMENT

COORDINATION:

1. ECLSS
2. Thermal
3. IVA - Work Stations; customer payloads
4. EVA - Airlock; orbital service unit
5. Personal hygiene
6. Health maintenance
7. Safe haven
8. Attitude and Orbital Control

**ELEMENT DISTRIBUTION
OF TASK DELIVERABLES:**

Intermediate work unit product.

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MANPOWER/MAN-YEARS

<p>ENGINEERING TRADE STUDIES</p> <ul style="list-style-type: none"> (1) Distribution of noise sources relative to human activities (2) Engineering alternatives to meet the functions associated with noise sources (3) Utilization alternatives to meet the functions associated with noise sources (4) Engineering alternatives to source isolation 	<p>GENERIC: _____ TEST BED: _____</p> <p>FOCUSED TECHNOLOGY: 2 MY _____ FLIGHT TEST: _____</p> <p>PROTOTYPE TECHNOLOGY: _____</p> <p><u>SPECIAL REQUIREMENTS</u></p> <p>1. NEW FACILITIES:</p> <p>2. UNIQUE SKILLS: Knowledge of acoustics, and Space Station Systems and their operations</p> <p>3. SPECIAL HARDWARE:</p> <p>4. SPECIAL INFORMATION: Detailed design information on noise generating machinery in Shuttle, Skylab, and SpaceLab</p> <p>START DATE: <u>4th Quarter FY 84</u></p> <p>COMPLETION DATE: <u>Mid FY 86</u></p> <p>REQUIREMENTS DOCUMENT REFERENCE: 6.11.2.2.1B</p>
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