FLUID MANAGEMENT SYSTEM (FMS) FLUID SYSTEMS OVERVIEW

TECHNOLOGY FOR SPACE STATION EVOLUTION - A WORKSHOP

JANUARY 16

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NASA JOHNSON SPACE CENTER

AGENDA	Propulsion & Power Division	
	R. S. Baird	1/16/90

FLUID MANAGEMENT SYSTEM DESCRIPTION

- SYSTEM REQUIREMENTS:
  - GENERAL REQUIREMENTS
  - INTEGRATED NITROGEN SYSTEM REQUIREMENTS
  - INTEGRATED WATER SYSTEM REQUIREMENTS
  - INTEGRATED WASTE GAS SYSTEM REQUIREMENTS
- PHYSICAL DESCRIPTION:
  - STATION OVERVIEW
  - INTERNAL TO PRESSURIZED VOLUME
  - EXTERNAL TO PRESSURIZED VOLUME
  - PRELIMINARY MASS AND POWER SUMMARY

FLUID MANAGEMENT SYSTEM EVOLUTION

- POTENTIAL EVOLUTION REQUIREMENTS
- EVOLUTION DESIGN ADAPTABILITY
- EVOLUTION TECHNOLOGY DEVELOPMENTAL NEEDS
- TECHNOLOGY WORK CURRENTLY IN PROGRAM
- EVOLUTION STUDY

FLUID MANAGEMENT SYSTEM GENERAL DESCRIPTION	Propulsion & Power Division	
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GENERAL REQUIREMENTS

- SUPPLY NITROGEN - INTEGRATED NITROGEN SYSTEM [INS]
- SUPPLY WATER - INTEGRATED WATER SYSTEM [IWS]
- WASTE GAS COLLECTION, STORAGE AND DISPOSAL
  - INTEGRATED WASTE GAS SYSTEM [IWGS]
- CONTPOLLED VENTING COORDINATION
  - CONTROLLED VENTING SYSTEM [CVS]

ELEMENT UNIQUE HARDWARE DESIGN, DEVELOPMENT, AND CERTIFICATION

- MSFC: USL, HABITATION MODULE, AND LOGISTICS (PLUMBING AND RESUPPLY TANKER)
- JSC: TRUSS, NODES, AND DOCKING ADAPTERS (PLUMBING, PALLET, AND RACKS)

INTEGRATED NITROGEN SYSTEM DESCRIPTION	Propulsion & Power Division	
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REQUIREMENTS:

- SUPPLY NITROGEN TO STATION USERS:
  - LAB EXPERIMENT GAS
  - SYSTEM PRESSURIZATION GAS
  - SYSTEM MAINTENANCE PURGE GAS
- PROVIDE ECLSS EMERGENCY ACCESS TO NITROGEN

IMPLEMENTATION:

- LOGISTIC TRANSPORT TO STATION IN SUPERCRITICAL FLUID STATE
- CENTRALIZED THERMAL CONDITIONING AND LOW PRESSURE (600 TO 800 PSIA) STORAGE ON THE FLUID MANAGEMENT AND DISTRIBUTION (FMAD) PALLET
- SUPPLY TO INTERNAL USERS IN "ON DEMAND", COMMON PRESSURE (200 PSIA) UTILITY BUS FORMAT
- SUPPLY TO EXTERNAL USERS IN "ON DEMAND" UTILITY FORMAT
- MANUAL INTERNAL CONNECTION TO ECLSS

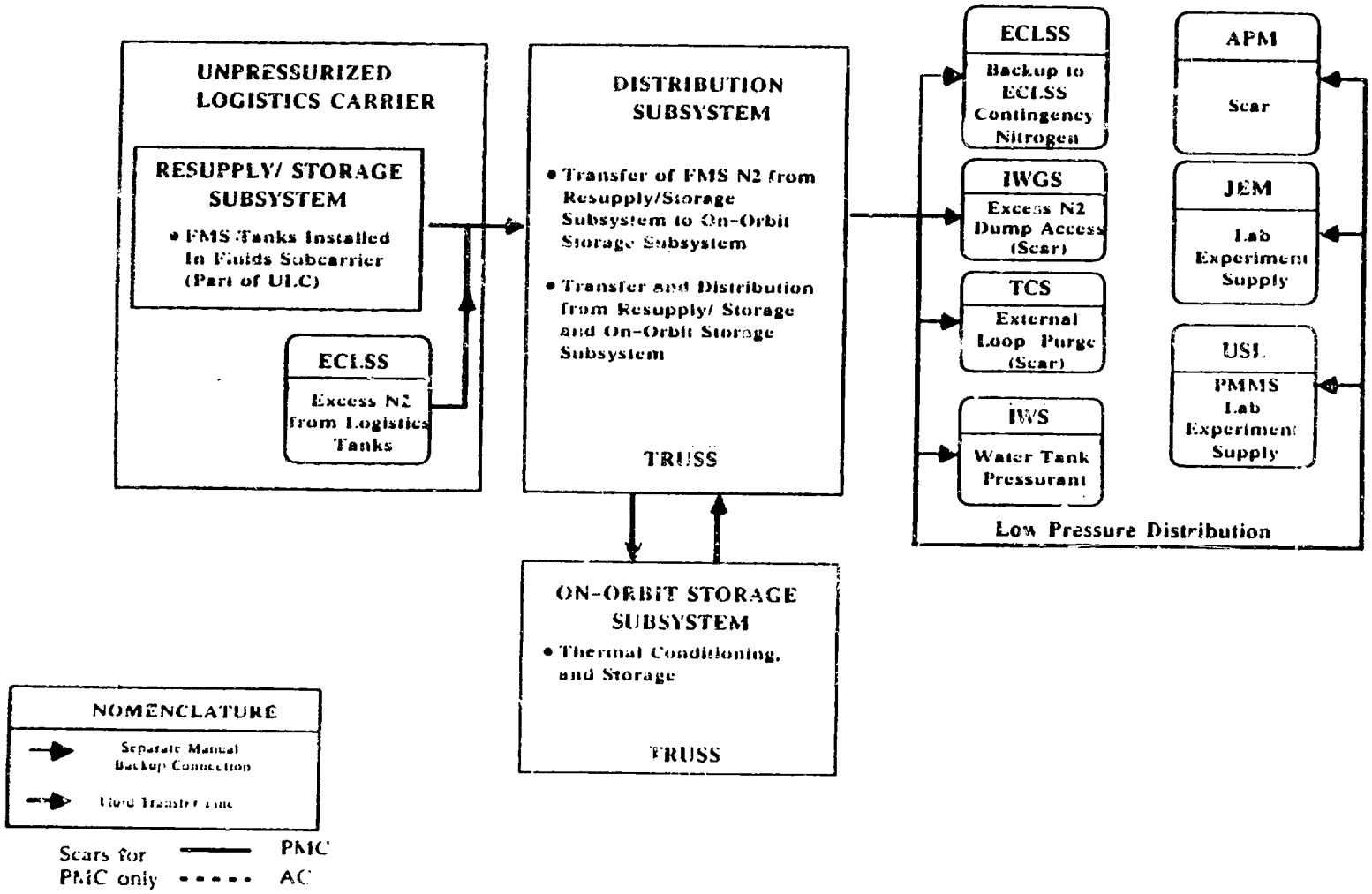

FIGURE 3-1: TOP-LEVEL PMC/AC INS FUNCTIONAL SCHEMATIC

INTEGRATED WATER SYSTEM DESCRIPTION	Propulsion & Power Division	
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REQUIREMENTS:

- SUPPLY WATER TO STATION LABORATORY EXPERIMENT USERS
- PROVIDE ECLSS DIRECT ACCESS TO SCAVENGED NSTS FUEL CELL WATER
- PROVIDE TEMPORARY STORAGE OF ECLSS EXCESS HYGIENE WATER TO SUPPORT SCHEDULED OVERBOARD DISPOSAL

IMPLEMENTATION:

- LABORATORY SUPPLY WATER SCAVENGED FROM NSTS FUEL CELLS
- SUPPLY TO LABORATORY USERS IN "ON-DEMAND", LOW PRESSURE (25 TO 30 PSIA) UTILITY BUS FORMAT
- SEPARATE STORAGE AND DISTRIBUTION OF FUEL CELL SOURCE AND HYGIENE SOURCE WATER
- INTERNAL STORAGE IN NODES 2 AND 3 (ONE RACK IN EACH)
- SCHEDULED OVERBOARD VENT OF HYGIENE SOURCE WATER FROM HABITATION MODULE AND USL AT PMC
- ECLSS PROVIDED PRIORITY ACCESS TO SCAVENGED NSTS FUEL CELL WATER

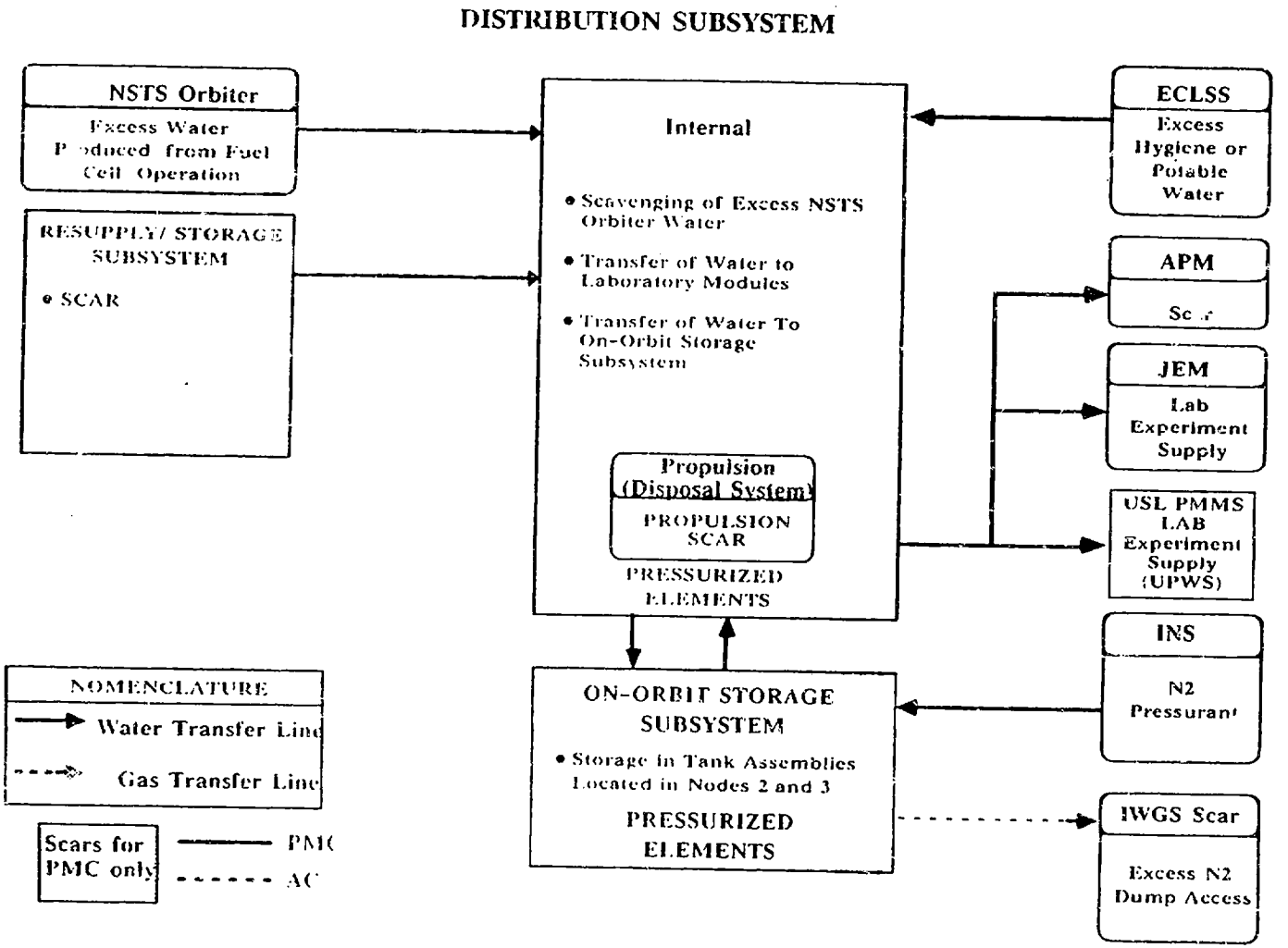

FIGURE 3-1 TOP-LEVEL PMC/AC IWS FUNCTIONAL SCHEMATIC

INTEGRATED WASTE GAS SYSTEM DESCRIPTION	Propulsion & Power Division	
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REQUIREMENTS:

- COLLECT, STORE, AND DISPOSE OF WASTE GASES BY AC
  - LAB EXPERIMENT BULK "SAFE" WASTE GASES
  - ECLSS WASTE GASES
  - SYSTEM PRESSURIZATION VENT GASES
  - SYSTEM MAINTENANCE PURGE GASES
- COORDINATE OVERBOARD VENTING TO SUPPORT EXTERNAL CONTAMINATION ENVIRONMENT CONTROL FOR PMC AND AC

IMPLEMENTATION:

- SEPARATE COLLECTION, STORAGE, AND DISPOSAL OF:
  - LAB MIXED WASTE GASES (N2, Ar, O2, Kr, Xe, He, AND TRACE CONTAMINANTS)
  - REDUCING WASTE GASES (H2, N2, AND AMMONIA)
- CENTRALIZED COMPRESSION AND STORAGE OF EACH WASTE GAS TYPE ON FMAD PALLET
- COORDINATE NONPROPULSIVE DISPOSAL OF WASTE FLUIDS BY PMC
- SCHEDULED PROPULSIVE DISPOSAL OF BULK WASTE GASES BY AC

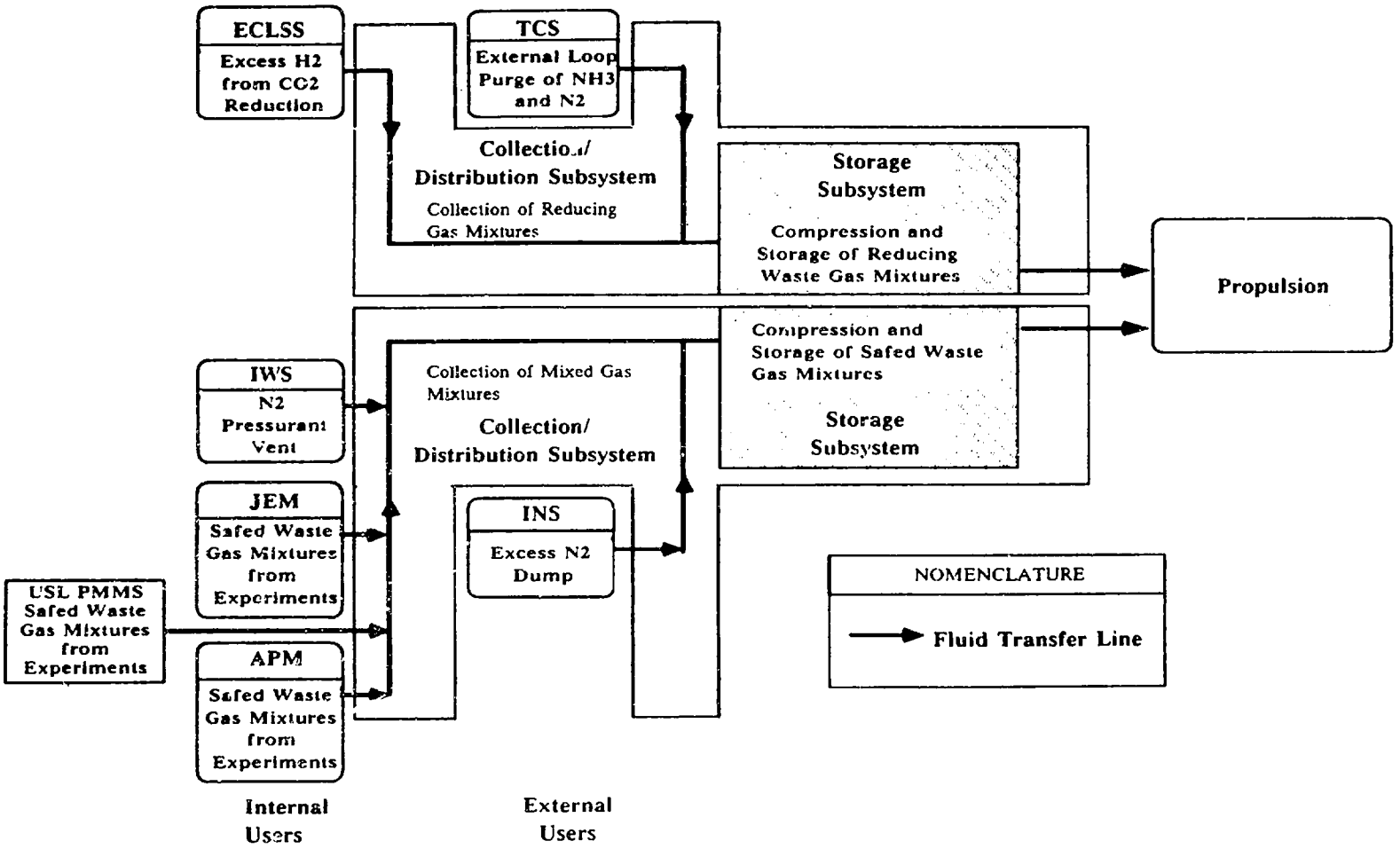
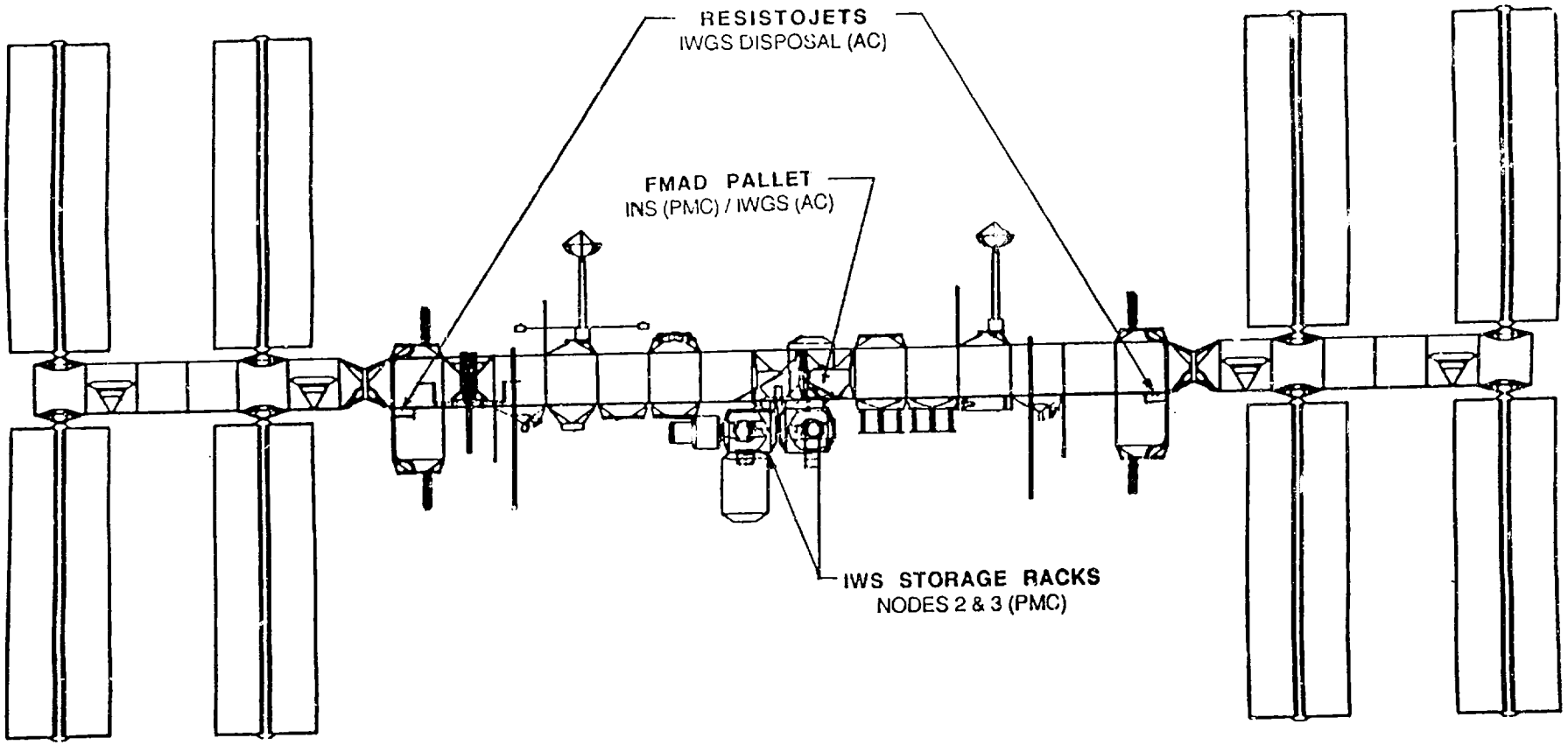
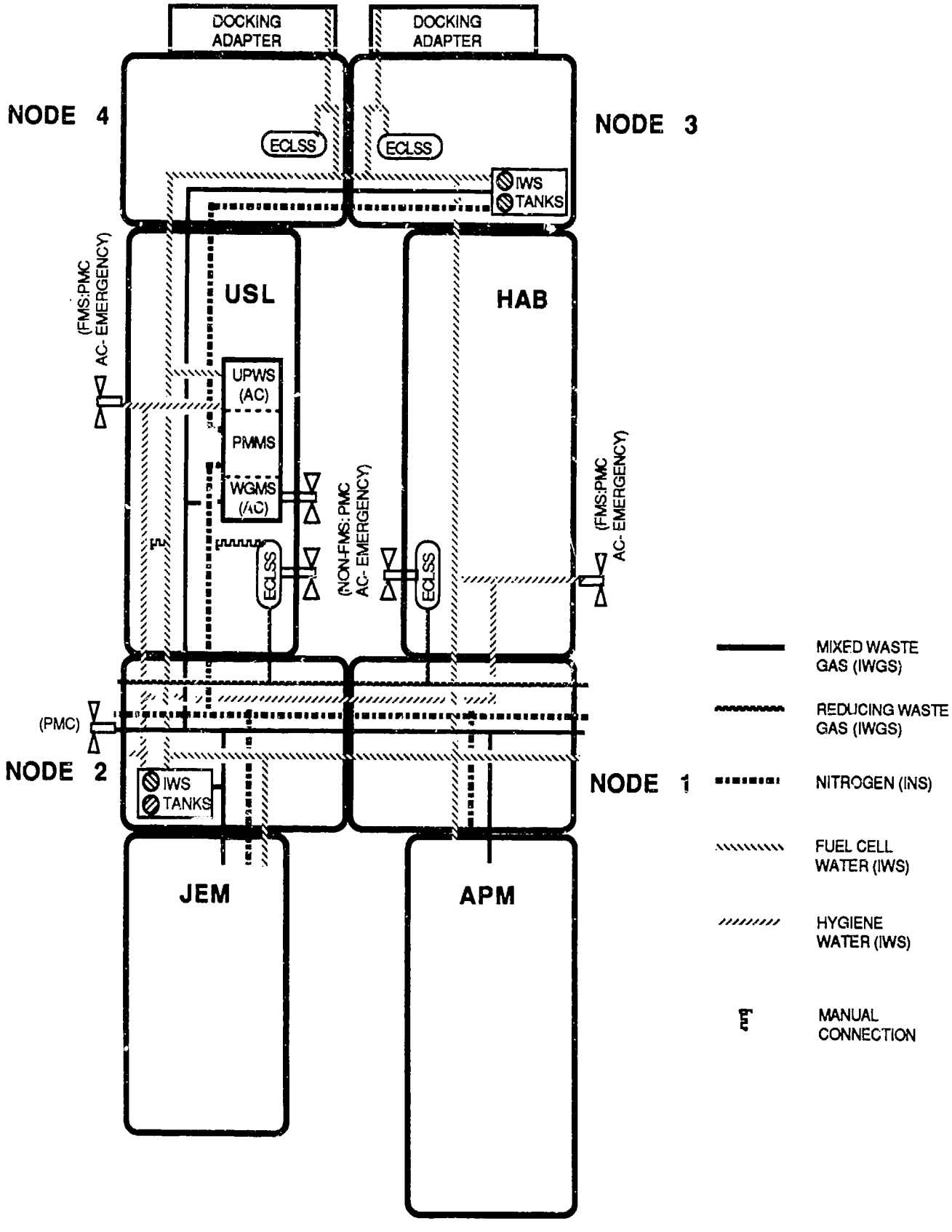


FIGURE 3-1 TOP-LEVEL PMC/AC IWGS FUNCTIONAL SCHEMATIC

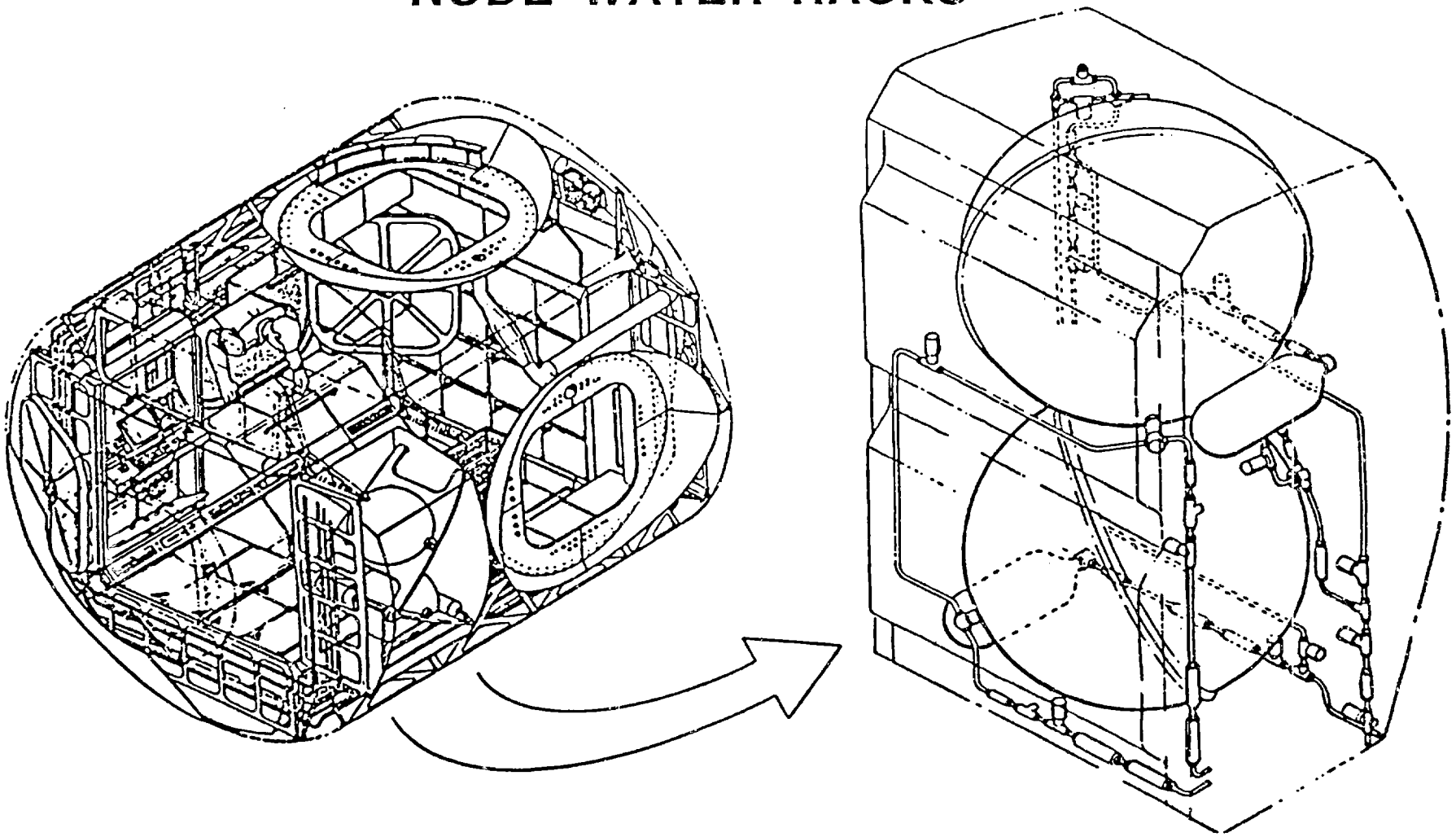


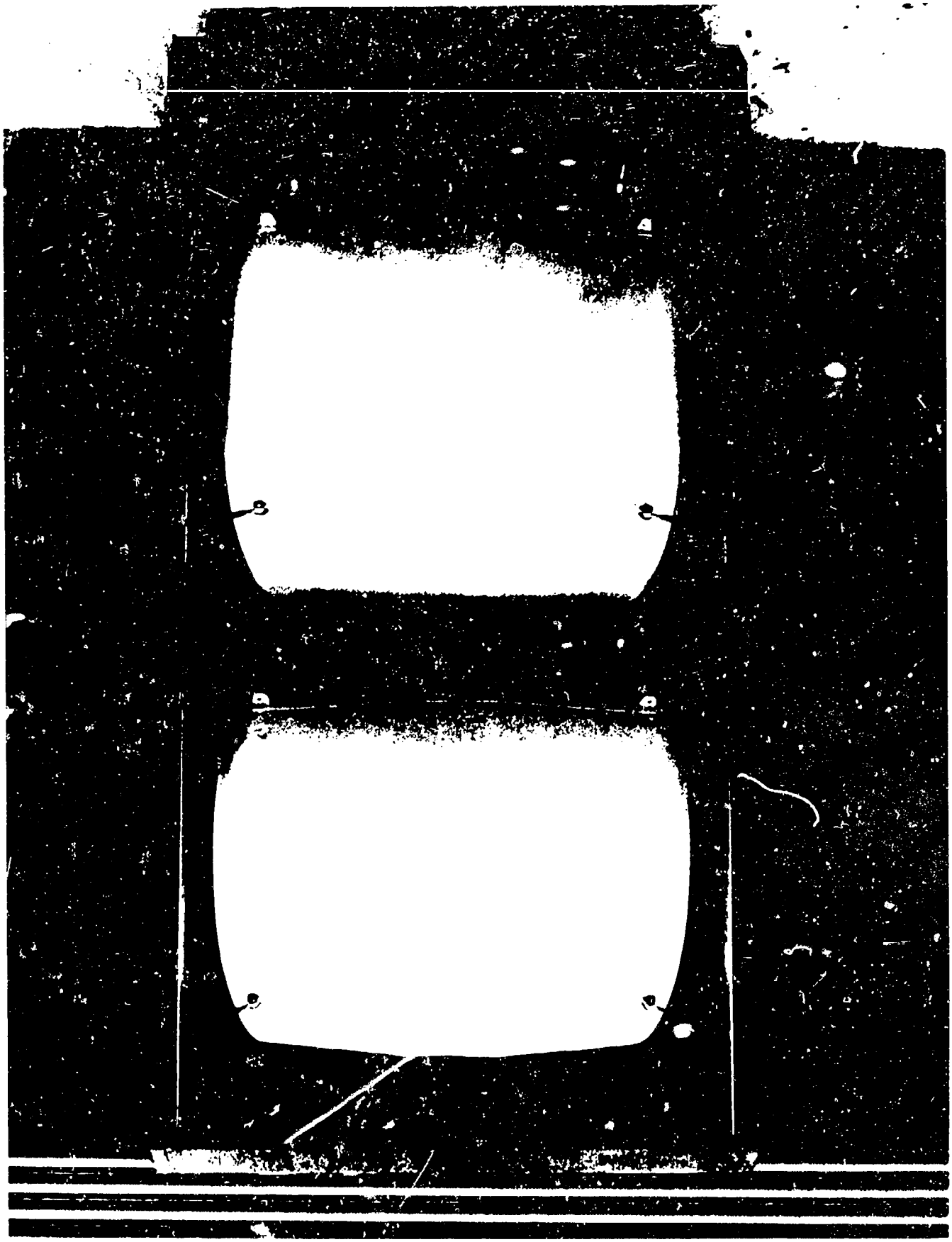
FLUID SYSTEM CONFIGURATION

FMS PRESSURIZED VOLUME PMC AND AC PHASE CONFIGURATION

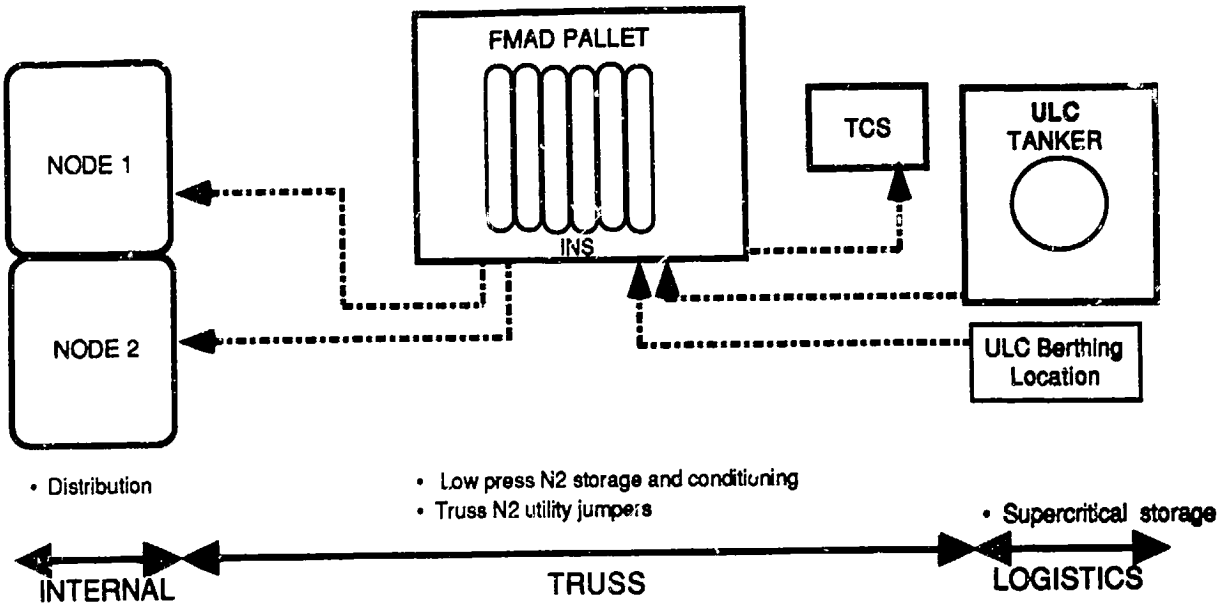


FLUID MANAGEMENT SYSTEM
NODE WATER RACKS

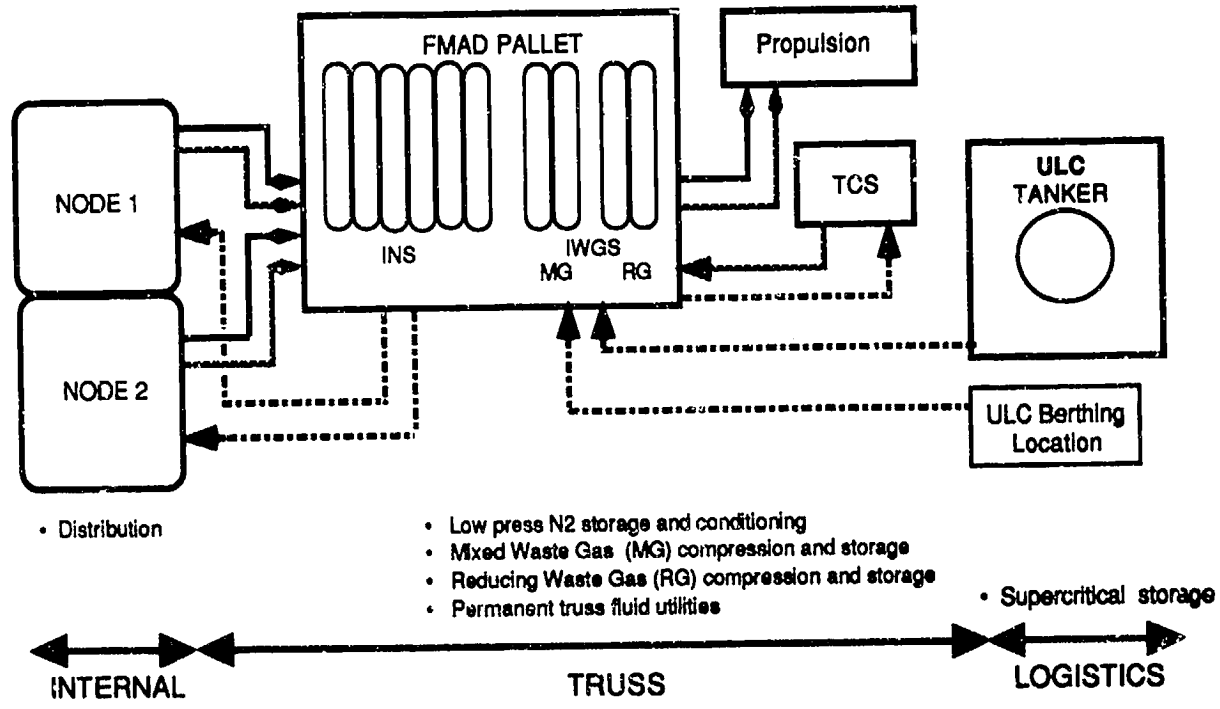


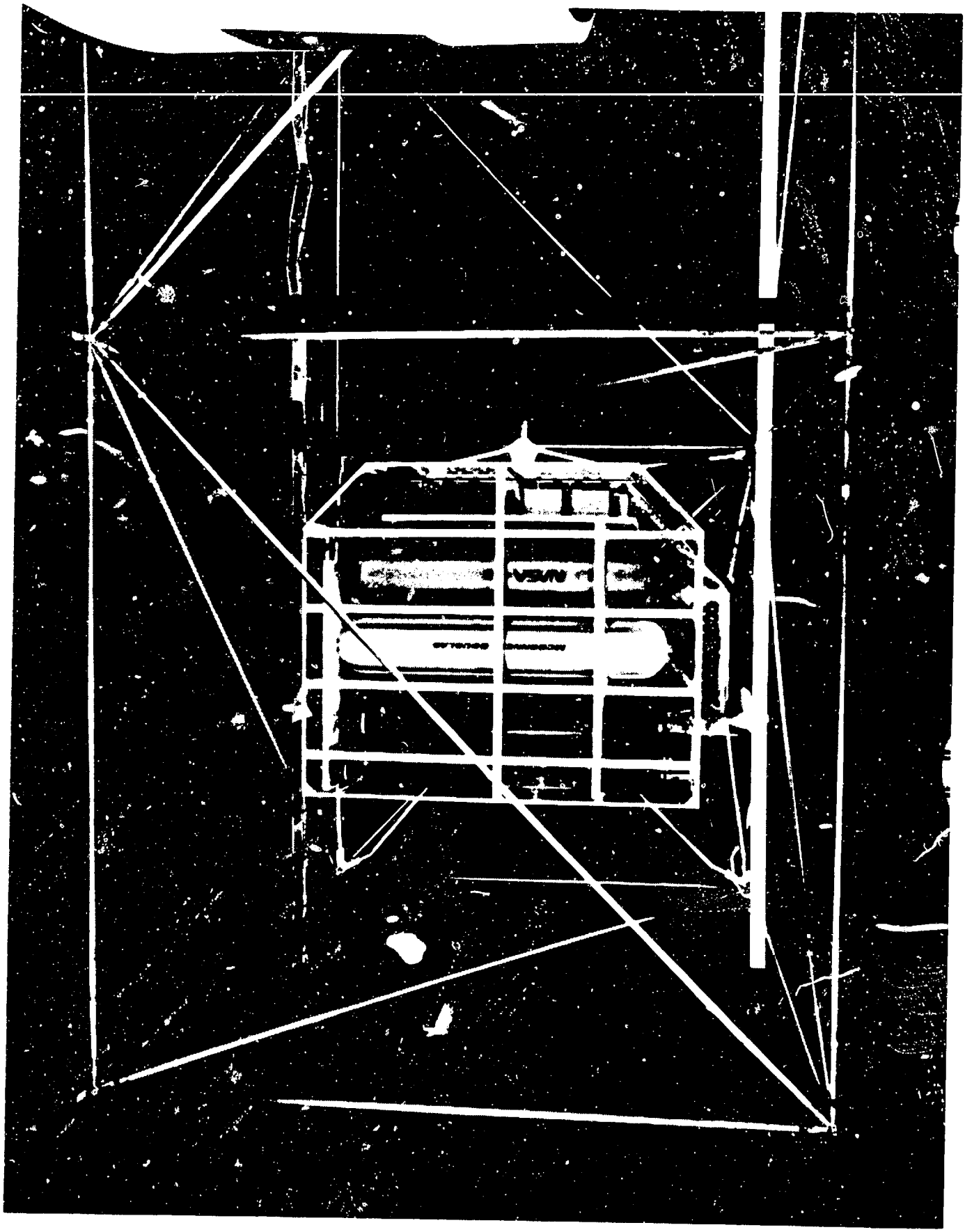


FMS EXTERNAL PMC PHASE CONFIGURATION



FMS EXTERNAL AC PHASE CONFIGURATION





FLUID MANAGEMENT SYSTEM
PRELIMINARY MASS AND POWER SUMMARY

MASS & POWER SUMMARY		MASS (Lbm)		POWER (WATTS)
FLUID SYSTEMS MASS:				
IWS		836.34		101.00
IWGS (G12)		633.90		77.60
IWGS (3X)		760.30		215.80
FLUID SYSTEM CONTROL		319.00		0.09
IWS RACK	[2 EAC	140.07		31.80
STRUCTURAL/OTHER MASS:				
PALLET (GENERAL)		914.10		0.00
RACK (GENERAL)	[2 EACH	168.00		0.00
TOTAL : FLUIDS				
PALLET (PMC)		2069.44		101.00
PALLET (AC)		3453.64		394.40
RACK (EACH)		308.07		31.80
RACK (TOTAL)		616.14		63.60
PMCPI TOTAL		2685.58		164.60
AC TOTAL		4069.78		458.00
UTILITY DISTRIBUTION				
HAB (WP01)		40.92		2.00
USL (WP01)		110.01		6.00
TRUSS (PMC)		298.96		5.20
TRUSS (AC)		638.56		5.20
NODE 1 (PMC)		81.43		11.00
NODE 1 (AC)		78.93		10.00
NODE 2 (PMC)		91.61		7.60
NODE 2 (AC)		89.11		6.60
NODE 3		57.92		2.40
NODE 4		47.76		2.40
JEM (NASDA)		0.00		0.00
APM (ESA)		0.00		0.00
PMC TOTAL		728.60		36.60
AC TOTAL		1063.30		34.60
TOTAL FMS				
PMC TOTAL		3414.18		201.20
AC TOTAL		5142.98		492.60

FLUID MANAGEMENT SYSTEM POTENTIAL EVOLUTION REQUIREMENTS	Propulsion & Power Division	
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EXPANSION OF STATION SCIENCE ACTIVITIES

- ADDITIONAL EXPERIMENT FLUID SUPPLY SERVICES
  - GASES: Kr, Ar, He, CO2
  - CRYOGENS: He
- INCREASED CAPACITY OF EXISTING NITROGEN AND WATER SUPPLY AND WASTE GAS COLLECTION SERVICES

TRANSPORTATION NODE

- ADDITION OF SIGNIFICANT CRYOGENIC FLUID (O2, H2, AND N2) HANDLING SERVICES
  - LONG TERM STORAGE AND BOILOFF CONTROL
  - ON-ORBIT FLUID DISTRIBUTION AND TRANSFER
- EXPANSION OF EXISTING NITROGEN AND WATER SERVICES TO SUPPORT ADVANCED STATION PROPULSION
- EXPANSION OF EXISTING NITROGEN SERVICES FOR HIGH PRESSURE USERS
- ADDITION OF EARTH STORABLE PROPELLANT (HYDRAZINE AND BI-PROPS) STORAGE, DISTRIBUTION, AND TRANSFER SERVICES

FURTHER REDUCTION OF AVAILABLE EVA MAINTENANCE SUPPORT

- ENHANCED ROBOTIC MAINTENANCE COMPATIBILITY
- ENHANCED LIFE AND REDUNDANCY

FLUID MANAGEMENT SYSTEM EVOLUTION DESIGN ADAPTABILITY	Propulsion & Power Division	
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DESIGN ADAPTABILITY IN PLACE

- ORU DESIGN TO BE COMPATIBLE WITH ROBOTIC INSTALLATION AND MAINTENANCE
- ORU DESIGN TO ACCOMMODATE INSTALLATION OF NEW TECHNOLOGY COMPONENTS WHEN AVAILABLE
- NODE PLUMBING ROUTING WILL NOT PRECLUDE THE POSSIBILITY OF LATER (BY CDR) SCARING FOR ADDITIONAL NODES

DESIGN ADAPTABILITY OPTIONS:

- ADAPTABLE TO ADDITION OF NEW FLUID SERVICES:
  - ADDITIONAL LINES AND INTERFACES IN THE UTILITY TRAYS
  - ADDITIONAL FMAD PALLETS
  - ADDITION OF LINES IN NODES:
    - FULL DISTRIBUTION TO USERS (IF INSTALLED ON GROUND)
    - NODE FLUID SERVICING STATION (SCARABLE FOR ON-ORBIT INSTALLATION)
- ADAPTABLE TO INCREASED CAPACITY OF CURRENT FLUID SERVICES WITH ADDITIONAL FMAD PALLETS AND/OR UPGRADED ORUS
- ADAPTABLE TO ADDITIONAL NODES AND MODULES WITH ADDITION OF PLUMBING IN EXISTING NODES (EARLY IN DESIGN PROCESS)

FLUID MANAGEMENT SYSTEM EVOLUTION TECHNOLOGY DEVELOPMENT NEEDS	Propulsion & Power Division	
	R. S. Baird	7/13/90

COMPRESSORS: INCREASED LIFE AND PERFORMANCE

LEAK DETECTION:

- APPLICABLE TO ALL FLUID LINES
- INSENSITIVE TO BACKGROUND ENVIRONMENT

FLUID SYSTEM GAUGING: DISTRIBUTION , MONITORING, AND INVENTORY CONTROL

INSTRUMENTATION:

- WASTE GAS CONTENT
- LONG TERM, ON-ORBIT OPERATIONS CALIBRATION

FLUID LINES:

- ADVANCED LIGHT WEIGHT LINES
- MAINTENANCE INSPECTION, REPAIR, AND REPLACEMENT TECHNIQUES

QUICK DISCONNECT / FITTING: ENHANCED LIFE AND AUTOMATION/ROBOTIC COMPATIBILITY

LARGE SCALE, ON-ORBIT SLOSH CONTROL

CRYOGENIC FLUID HANDLING:

- LONG TERM BULK STORAGE
- ON-ORBIT REFRIGERATION AND INSULATION
- DISTRIBUTION AND TRANSFER TECHNIQUES

LIGHT WEIGHT TANKAGE

FLUID SYSTEM TECHNOLOGY DEVELOPMENT CURRENTLY IN PROGRAM	Propulsion & Power Division	
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COMPRESSOR

- COMPLEMENTARY JSC/MDSSC IWGS WASTE GAS PROTOTYPE DEVELOPMENT:
  - SOUTHWEST RESEARCH INSTITUTE: MIXED WASTE GAS PISTON TECHNOLOGY
  - AIRESEARCH/ALLIED SIGNAL: REDUCING WASTE GAS DIAPHRAGM TECHNOLOGY
- IWGS COMPRESSOR PROTOTYPE LONG TERM OPERATIONS TESTING PLANNED

LEAK DETECTION

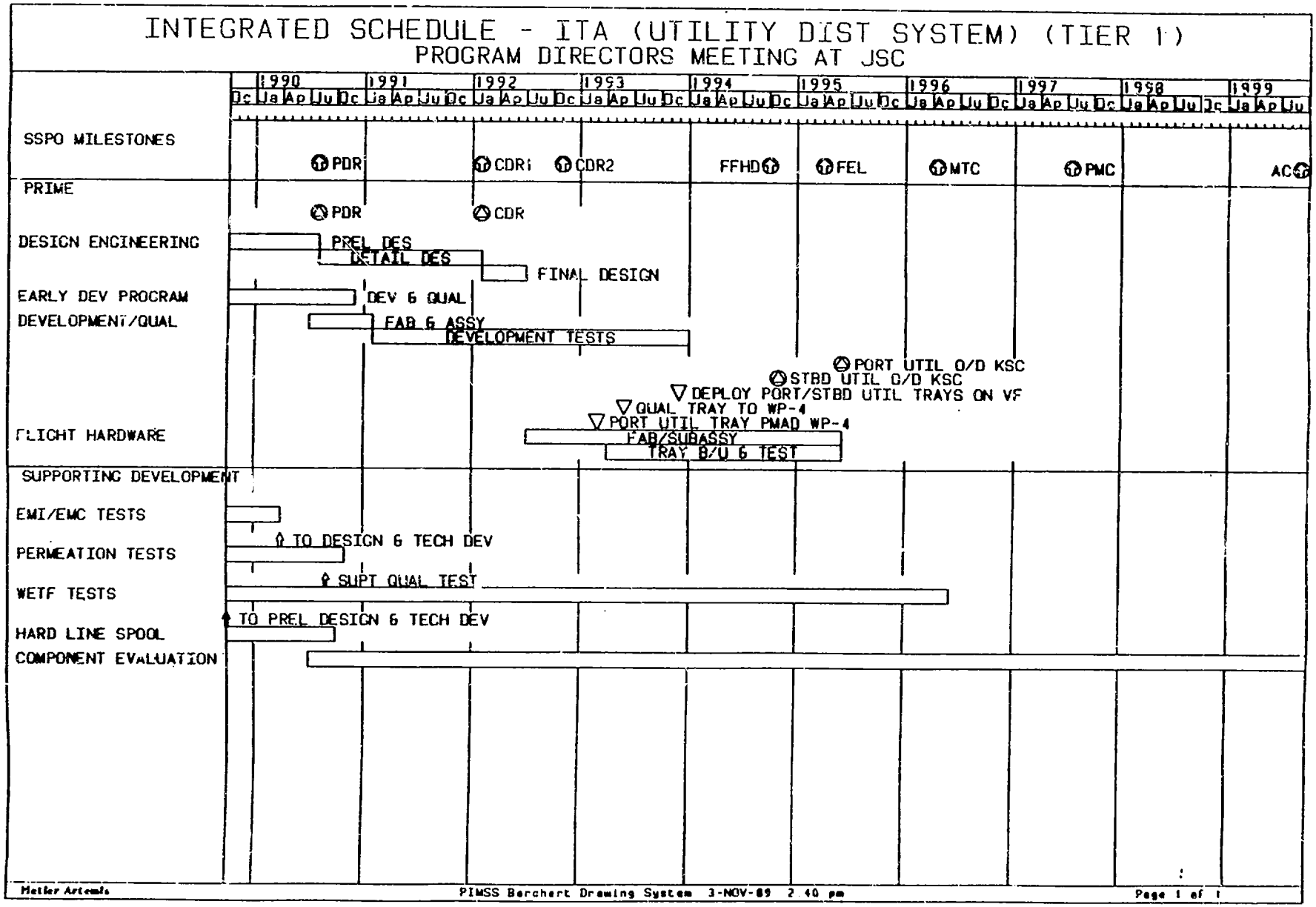
- JSC PROOF OF CONCEPT OF CAPACITANCE FOIL TECHNOLOGY
- MDSSC DEVELOPMENT AND TESTING OF IONIZATION GAGE TECHNOLOGY

DEPLOYABLE LINE

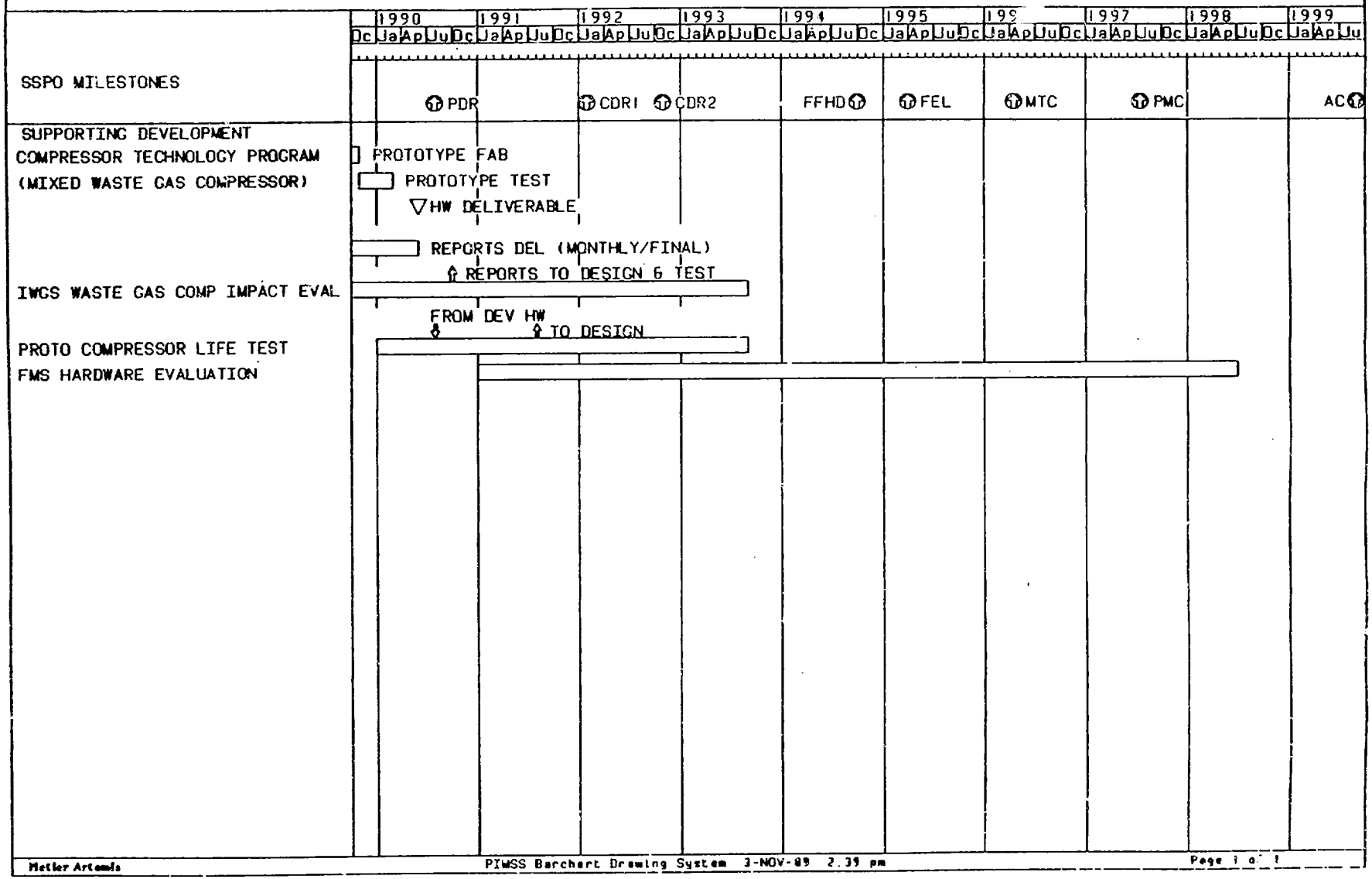
- COMPLEMENTARY JSC/MDSSC PERMEATION TESTING OF NON-METALLIC LINES
- COMPLEMENTARY JSC/MDSSC EVALUATION OF DEPLOYABLE METALLIC LINE CONCEPTS

QUICK DISCONNECT AND FITTING PROTOTYPE DEVELOPMENT

- FITTING PROTOTYPE TECHNOLOGY DEVELOPMENT - (MDSSC/STANLEY AVIATION)
- QUICK DISCONNECT PROTOTYPE TECHNOLOGY DEVELOPMENT - (MDSSC/SYMETRICS)


INTEGRATED SCHEDULE - ITA (UTILITY DIST SYSTEM) (TIER 1)
PROGRAM DIRECTORS MEETING AT JSC
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
SSPO MILESTONES
PDR
CDR1
CDR2
FFHD
FEL
MTC
PMC
AC
PRIME
PDR
CDR
DESIGN ENGINEERING
PREL DES
DETAIL DES
FINAL DESIGN
EARLY DEV PROGRAM
DEV & QUAL
DEVELOPMENT/QUAL
FAB & ASSY
DEVELOPMENT TESTS
PORT UTIL O/D KSC
STBD UTIL O/D KSC
DEPLOY PORT/STBD UTIL TRAYS ON VF
QUAL TRAY TO WP-4
PORT UTIL TRAY PMAD WP-4
FLIGHT HARDWARE
FAB/SUBASSY
TRAY B/U & TEST
SUPPORTING DEVELOPMENT
EMI/EMC TESTS
TO DESIGN & TECH DEV
PERMEATION TESTS
SUPT QUAL TEST
WETF TESTS
TO PREL DESIGN & TECH DEV
HARD LINE SPOOL
COMPONENT EVALUATION
Martin Marietta
PIMSS Barchart Drawing System 3-NOV-89 2:40 pm
Page 1 of 1

INTEGRATED SCHEDULE - FLUIDS MGMT SYSTEM (TIER 1)
PROGRAM DIRECTORS MEETING AT JSC



FLUID SYSTEM EVOLUTION STUDY	Propulsion & Power Division	
	R. S. Baird	1/16/90

- PROPULSION/FLUID MANAGEMENT/UTILITIES EVOLUTION STUDY TASK (4767209) FY90 START
- PURPOSE TO DETERMINE:
  - SYSTEM GROWTH CONCEPT CONSISTENT WITH SSF REFERENCE GROWTH CONFIGURATIONS
  - FUTURE CAPABILITY AND DERIVED ENABLING/ENHANCING TECHNOLOGY NEEDS
  - SCAR AND HOOK CANDIDATES WHICH ENABLE/FACILITATE ON-ORBIT GROWTH AND/OR TECHNOLOGY UPGRADES
  - SYSTEM IMPACTS:
    - SCAR COST AND WEIGHT ESTIMATES
    - "FAILURE TO SCAR" ASSESSMENT
    - IMPACTS OF GROWTH ON OTHER SYSTEMS
  - BASELINE PRELIMINARY DESIGN ASSESSMENT:
    - EVOLUTIONARY POTENTIAL/CAPABILITY
    - EXISTING EVOLUTIONARY DESIGN FEATURES (SCARS AND HOOKS)
    - RECOMMEND ADDITIONAL DESIGN FEATURES
  - EVOLUTION DESIGN REQUIREMENTS RECOMMENDED FOR THE PDRD