

Environmental Control and Life Support System

Charles Ray

Alan Adams

Marshall Space Flight Center

Technology for Space Station Evolution Workshop
January 16-19, 1990
Dallas, Texas

PRECEDING PAGE BLANK NOT FILMED

317

316
INTERNATIONAL

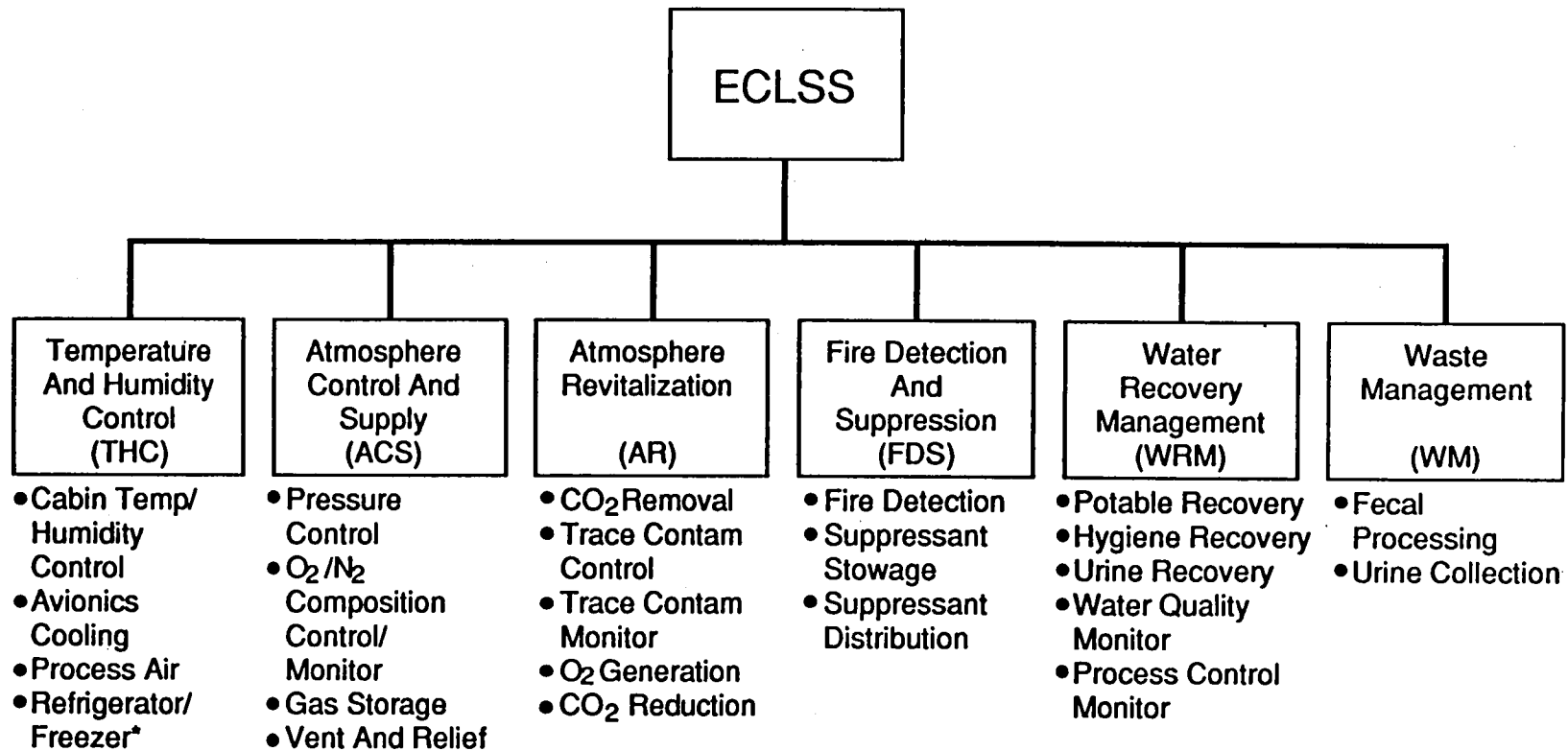
314-544
163606
P. 23
N93-27718

ECLSS SUBSYSTEM FUNCTIONS

**THE ECLSS IS DIVIDED INTO SIX SUBSYSTEMS: TEMPERATURE AND HUMIDITY CONTROL (THC),
ATMOSPHERE CONTROL AND AND SUPPLY (ACS), ATMOSPHERE REVITALIZATION (AR), FIRE DETECTION
AND SUPPRESSION (FDS), WATER RECOVERY MANAGEMENT (WRM) AND WASTE MANAGEMENT (WM).
THIS CHART PROVIDES A LISTING OF THE MAJOR FUNCTIONS OF EACH SUBSYSTEM.**

Technology For Space Station Evolution - A Workshop

ECLSS Subsystem Functions

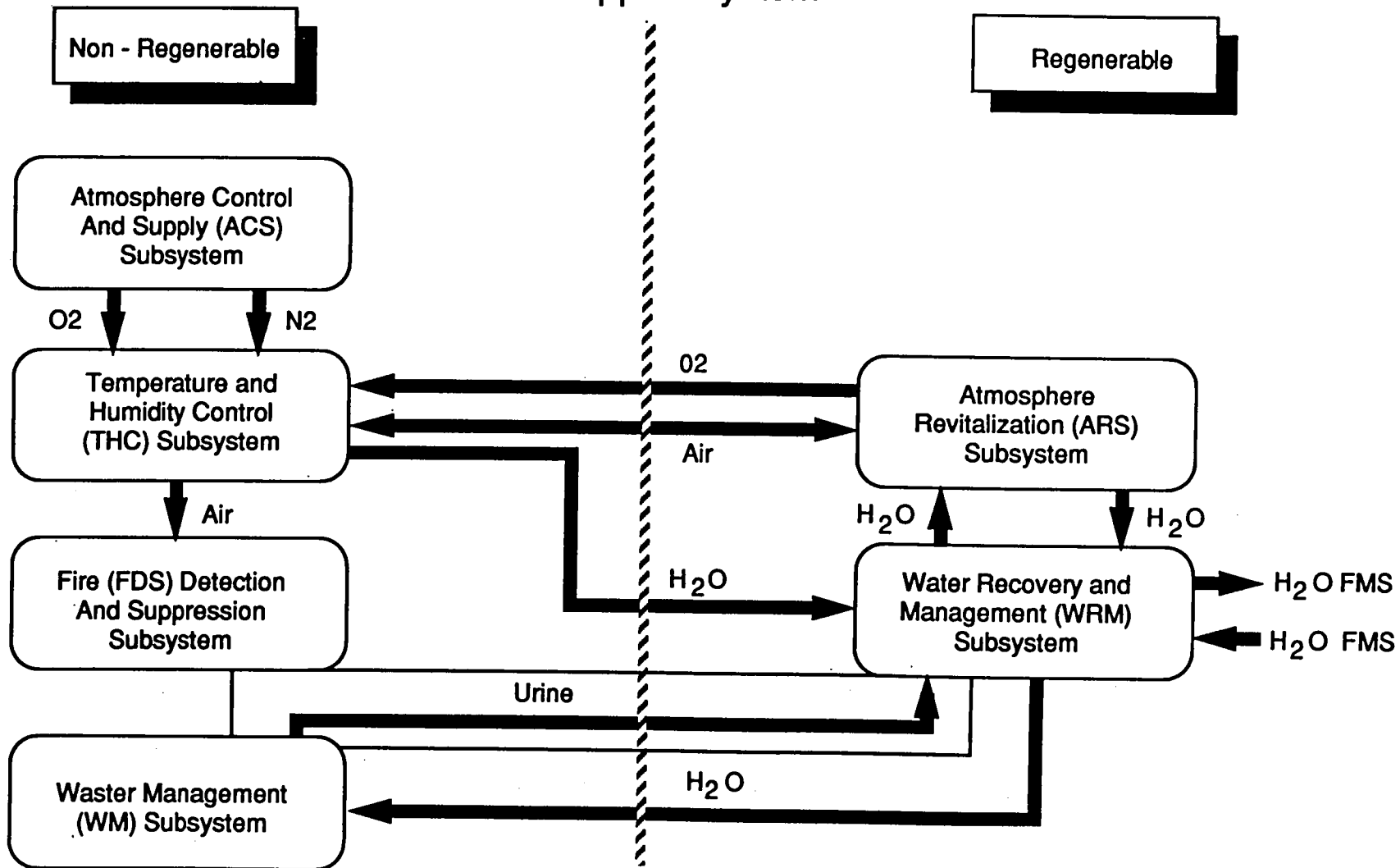


ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM

THE ECLSS CONSISTS OF NON-REGENERABLE AND REGENERABLE HARDWARE. THE NON-REGENERABLE HARDWARE IS FOUND MAINLY IN FOUR OF THE MAJOR SUBSYSTEMS: ATMOSPHERE CONTROL AND SUPPLY (ACS), TEMPERATURE AND HUMIDITY CONTROL (THC), FIRE DETECTION AND SUPPRESSION (FDS) AND WASTE MANAGEMENT (WM). THE REGENERABLE HARDWARE, WHICH POSES THE GREATEST TECHNOLOGICAL CHALLENGE, IS FOUND IN THE ATMOSPHERE REVITALIZATION (AR) AND THE WATER RECOVERY AND MANAGEMENT (WRM) SUBSYSTEMS. THE REGENERABLE SYSTEMS PROVIDE A MEANS OF GENERATING OXYGEN, REMOVING/REDUCING CARBON DIOXIDE AND RECLAIMING WATER FOR USE BY THE CREW WHICH MINIMIZES THE SPACE STATION LOGISTICS BURDEN.

Technology For Space Station Evolution - A Workshop

Environmental Control And Life Support System

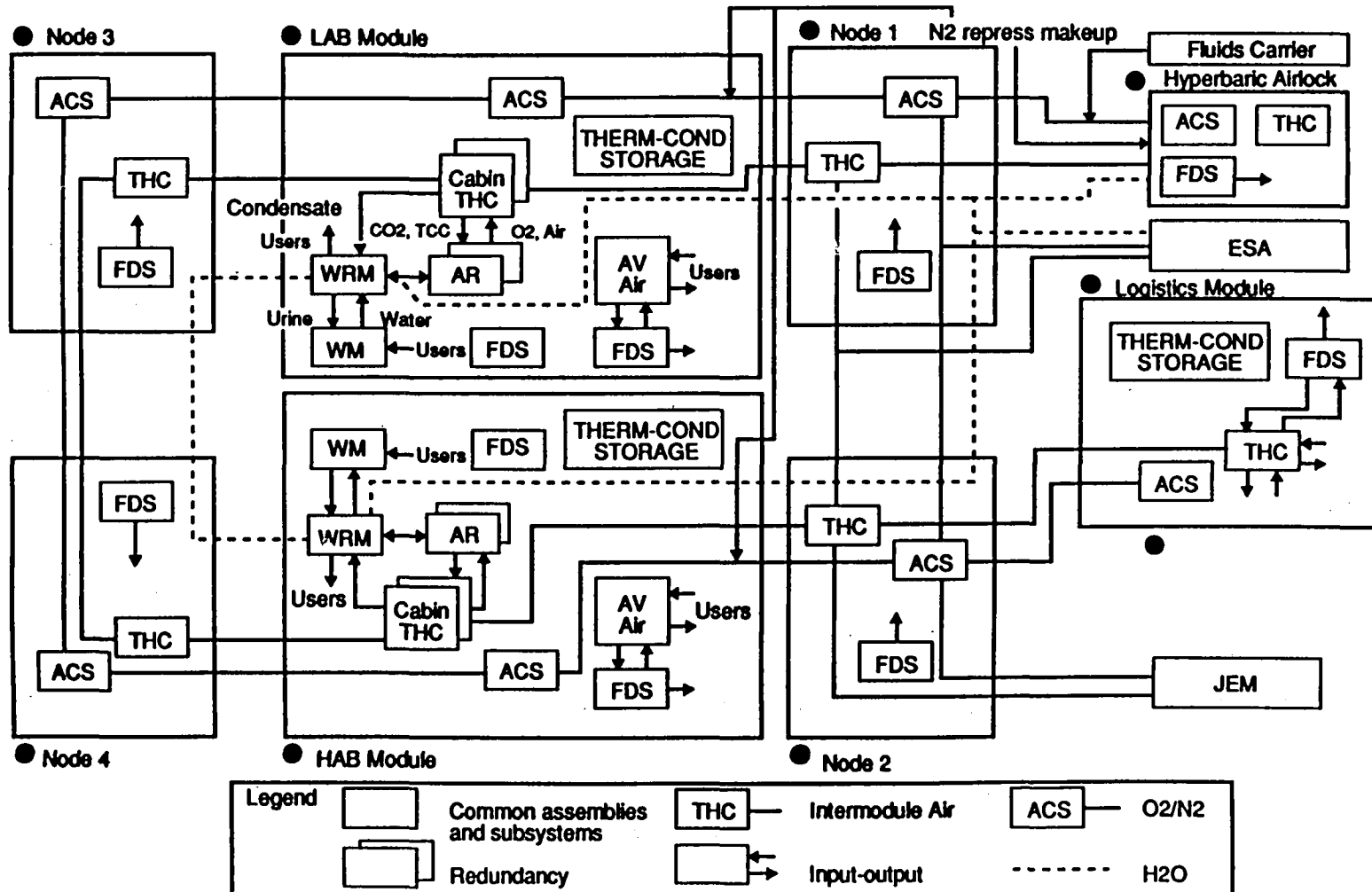


ECLSS DISTRIBUTED SYSTEM

THE ECLSS IS TRULY A DISTRIBUTED SYSTEM. ECLSS HARDWARE/FUNCTION IS FOUND IN EVERY SPACE STATION ELEMENT. ALTHOUGH THE MAJOR COMPONENTS OF THE ECLSS ARE CONCENTRATED IN THE U.S. HABITATION AND LABORATORY MODULES, OTHER ECLSS FUNCTIONS SUCH AS ACS, THC, FDS CAN BE FOUND IN THE NODES, AIRLOCK AND LOGISTICS MODULES.

Technology For Space Station Evolution - A Workshop

ECLSS Distributed System



ECLSS DESIGN FEATURES

THIS CHART PROVIDES A SUMMARY OF THE MAJOR DESIGN FEATURES OF EACH ECLSS SUBSYSTEM.

Technology For Space Station Evolution – A Workshop

Environmental Control And Life Support System

Design Features

● System

- 4 Crewmen At PMC, 8 Crewmen At AC
- Attached Module Services Provided By Distribution System

● Temperature And Humidity Control

- Intermodule Process Air Provides CO₂ Removal O₂ Partial And Total Pressure Control For Station Pressurized Volume
- Avionics Cooling Supplied To All Powered Racks In U.S. Modules
- Redundant Assemblies In Hab And Lab

● Atmospheric Control And Supply

- Oxygen And Nitrogen Distributed To All Pressurized Modules
- Positive And Negative Relief Capability Provided In All U.S. Pressurized Modules

● Atmosphere Revitalization

- Redundant Assemblies In Hab And Lab
- Regenerable O₂ Generators, CO₂ Removal, CO₂ Reduction Units Located In Hab And Lab
- Distribution System To Provide Monitoring Of Trace Contaminants In Any Pressurized Module

● Fire Detection And Suppression

- FDS Functions Provided To All Powered Racks In U.S. Modules
- Portable Extinguisher To Backup Central Suppressant Storage

● Water Recovery Management

- Separated Potable And Hygiene Water Subsystems
- Potable And Hygiene Processors In Hab And Lab Integrated By Distribution Systems
- Urine Processed To Hygiene Water

● Waste Management

- Crew Exposure To Fecal Material Precluded

ECLSS FUNCTIONAL DISTRIBUTION

ECLSS HARDWARE IS LOCATED IN VIRTUALLY EVERY SPACE STATION ELEMENT. HOWEVER, SOME OF THE ECLSS FUNCTIONS ARE PROVIDED TO SOME OF THE SPACE STATION ELEMENTS THROUGH NON-HARDWARE MEANS SUCH AS INTERMODULE VENTILATION AND SAMPLING LINES.

Technology For Space Station Evolution – A Workshop

ECLSS Functional Distribution

ECLSS Function	HAB	LAB	LOG	HAL	Node	JEM	ESA
Temperature/Humidity Control							
Air Temp Control	HW	HW	HW	HW	HW	HW	HW
Humidity Control	HW	HW	HW	HW	HW	HW	HW
Ventilation	HW	HW	HW	HW	HW	HW	HW
Avionics Cooling	HW	HW	HW	HW	HW	HW	HW
Refrigerator/Freezer	HW		HW				
Atmosphere Control/Supply							
O ₂ /N ₂ Pressure Control	HW	HW	HW	HW	HW	HW	
Vent And Relief	HW	HW	HW	HW	HW	HW	HW
Monitoring	HW	HW	SL	HW	SL	HW	SL
O ₂ /N ₂ Distribution	HW	HW	HW	HW	HW	HW	HW
Atmosphere Revitalization							
CO ₂ Removal	HW	HW	IMV	HW	IMV	HW/ IMV	IMV
CO ₂ Reduction	HW	HW					
O ₂ Generation	HW	HW					
Contaminant Control	HW	HW	IMV	IMV	IMV	IMV	IMV
Contaminant Monitoring	HW	HW	SL	SL	SL	SL	SL

HW – Hardware

IMV – Intermodule Ventilation

SL – Sampling Line

Technology For Space Station Evolution – A Workshop

ECLSS Functional Distribution (Continued)

ECLSS Function	HAB	LAB	LOG	HAL	Node	JEM	ESA
Fire Detection/Suppression	HW	HW	HW	HW	HW	HW	HW
Water Recovery/Management							
Potable H ₂ O Processing	HW	HW					
Hygiene H ₂ O Processing	HW	HW					
Urine Processing	HW	HW					
Distribution	HW	HW	HW	HW	HW	HW	HW
Waste Management							
Fecal Processing/Storage	HW	HW					
Return Waste Storage			HW				

HW – Hardware

IMV – Intermodule Ventilation

SL – Sampling Line

PRECEDING PAGE BLANK NOT FILMED

329

328
INTERNATIONAL SPACE STATION

CARBON DIOXIDE REMOVAL

THIS CHART PRESENTS THE FUNCTIONAL DESCRIPTION OF THE CARBON DIOXIDE REMOVAL SUBSYSTEM FOR THE SPACE STATION FREEDOM PROGRAM. PROVIDED ALSO IS A GENERAL SCHEMATIC DISPLAYING THE PRIMARY INPUTS AND OUTPUTS OF THE UNIT.

Technology For Space Station Evolution - A Workshop

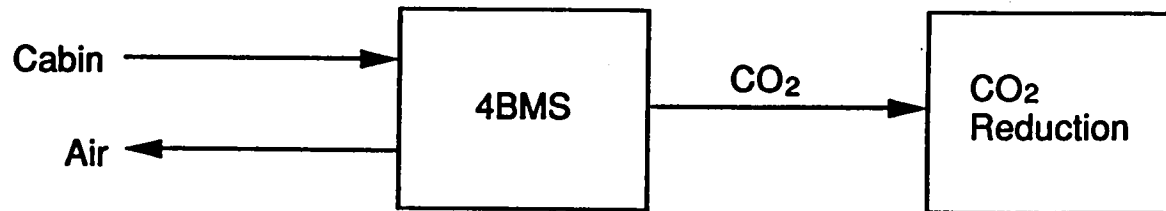
CO₂ Removal

Functional Description:

- Selectively Remove Carbon Dioxide Generated By The Crew's Metabolic Processes From The Cabin Atmosphere, Maintaining A Maximum pp CO₂ Limit As Shown Below:

<u>Mode Of Operation</u>	<u>ppCO₂</u>
Normal	3.0 mm Hg
90 Day Degraded	7.6 mm Hg
45 Day Emergency	12.0 mm Hg

- Concentrate The Removed CO₂ For Downstream Processing In The Carbon Dioxide Reduction System.



CARBON DIOXIDE REDUCTION

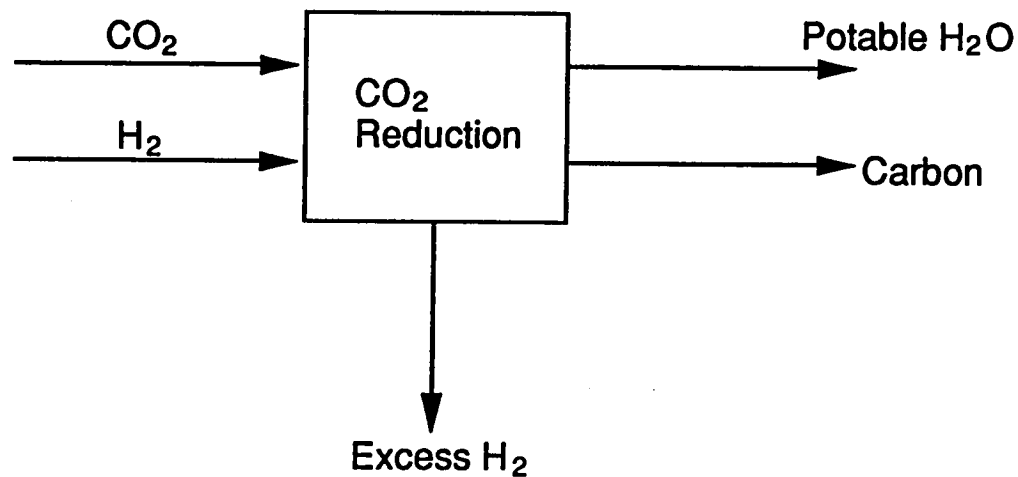
THIS CHART PRESENTS THE FUNCTIONAL DESCRIPTION OF THE CARBON DIOXIDE REDUCTION SUBSYSTEM FOR THE SPACE STATION FREEDOM PROGRAM. PROVIDED ALSO IS A GENERAL SCHEMATIC DISPLAYING THE PRIMARY INPUTS AND OUTPUTS OF THE UNIT.

Technology For Space Station Evolution - A Workshop

CO₂ Reduction

Functional Description:

- Reduce CO₂ To Form Solid Carbon By-Product And Potable Water
- CO₂ Is Fed From CO₂ Removal Device
- Processes At A 4-Man Load Under Normal Conditions And 8-Man Load Under Emergency Conditions.



OXYGEN GENERATION

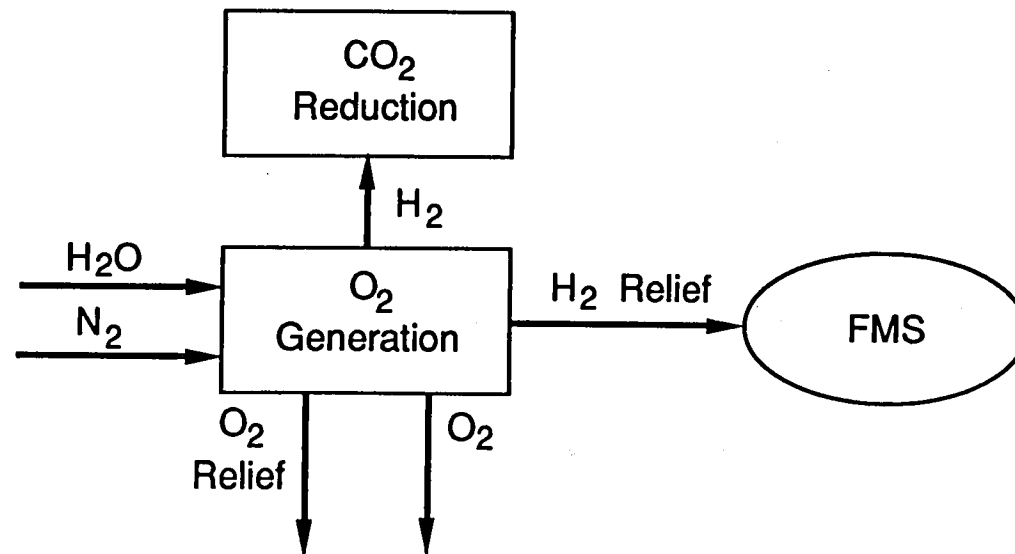
THIS CHART PRESENTS THE FUNCTIONAL DESCRIPTION OF THE OXYGEN GENERATION SUBSYSTEM FOR THE SPACE STATION FREEDOM PROGRAM. PROVIDED ALSO IS A GENERAL SCHEMATIC DISPLAYING THE PRIMARY INPUTS AND OUTPUTS OF THE UNIT.

Technology For Space Station Evolution - A Workshop

Oxygen Generation

FUNCTIONAL DESCRIPTION

- The OGA Produces Oxygen By Electrolyzing Processed Hygiene Water. Normal Production Is 9.08 lb-O₂/Day; Emergency Condition 45 Day Production Is 15.75 lb-O₂/Day.
- The Oxygen Is Delivered To The Cabin Ventilation System Or Stored For EVA.
- The Hydrogen By-Product Is Fed To The Carbon Dioxide Reduction System.



URINE PROCESSOR

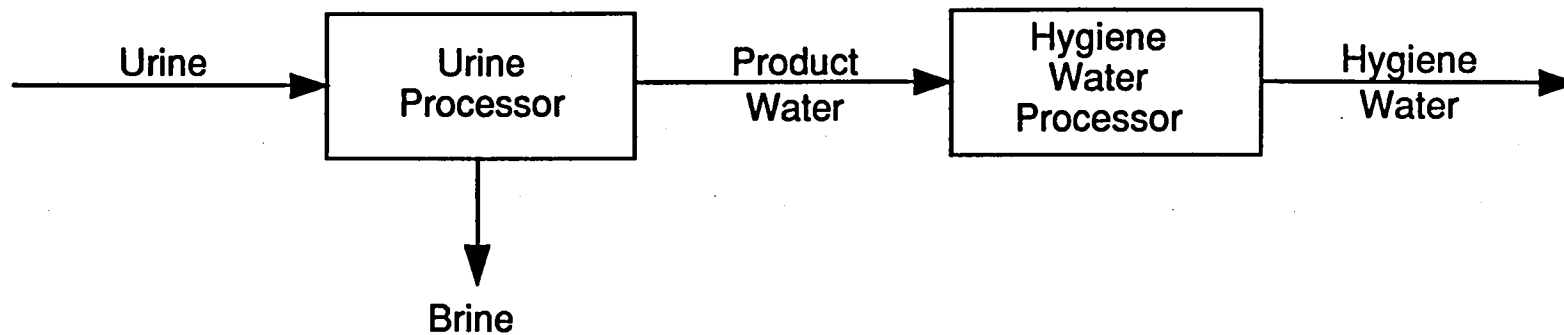
THIS CHART PRESENTS THE FUNCTIONAL DESCRIPTION OF THE URINE PROCESSOR SUBSYSTEM FOR THE SPACE STATION FREEDOM PROGRAM. PROVIDED ALSO IS A GENERAL SCHEMATIC DISPLAYING THE PRIMARY INPUTS AND OUTPUTS OF THE UNIT.

Technology For Space Station Evolution - A Workshop

Urine Processor

Functional Description:

- Recover Hygiene Water From Human Urine
- Processing Rate Is 50-70 Lbs/Man/Day



POTABLE WATER RECOVERY

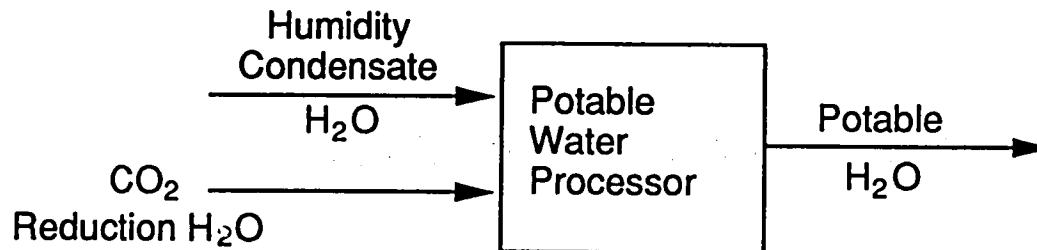
THIS CHART PRESENTS THE FUNCTIONAL DESCRIPTION OF THE POTABLE WATER PROCESSOR SUBSYSTEM FOR THE SPACE STATION FREEDOM PROGRAM. PROVIDED ALSO IS A GENERAL SCHEMATIC DISPLAYING THE PRIMARY INPUTS AND OUTPUTS OF THE UNIT.

Technology For Space Station Evolution - A Workshop

Potable Water Recovery

Functional Description:

- Recover Water From Humidity Condensate And CO₂ Reduction Product Water
- Supply Potable Water For Crew (6.26-11.35 LBM/PERSON-DAY)
- Water Quality Must Meet PDRD Specifications
- Supply Water To All Modules At Specific Use Points



Environmental Control and Life Support System

Invited Presentations

341

PRECEDING PAGE BLANK NOT FILMED

INTENTIONALLY BLANK