Environmental Control and Life Support System

Charles Ray
Alan Adams
Marshall Space Flight Center

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ECLSS SUBSYSTEM FUNCTIONS

THE ECLSS IS DIVIDED INTO SIX SUBSYSTEMS: TEMPERATURE AND HUMIDITY CONTROL (THC), ATMOSPHERE CONTROL 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.
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ECLSS Subsystem Functions

ECLSS

- Temperature And Humidity Control (THC)
  - Cabin Temp/Humidity Control
  - Avionics Cooling
  - Process Air
  - Refrigerator/Freezer

- Atmosphere Control And Supply (ACS)
  - Pressure Control
  - O₂/N₂ Composition Control/Monitor
  - Gas Storage
  - Vent And Relief

- Atmosphere Revitalization (AR)
  - CO₂ Removal
  - Trace Contam Control
  - Trace Contam Monitor
  - O₂ Generation
  - CO₂ Reduction

- Fire Detection And Suppression (FDS)
  - Fire Detection
  - Suppressant Stowage
  - Suppressant Distribution

- Water Recovery Management (WRM)
  - Potable Recovery
  - Hygiene Recovery
  - Urine Recovery
  - Water Quality Monitor
  - Process Control Monitor

- Waste Management (WM)
  - Fecal Processing
  - Urine Collection
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.
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Environmental Control And Life Support System

Non - Regenerable

Atmosphere Control And Supply (ACS) Subsystem

Temperature and Humidity Control (THC) Subsystem

Fire (FDS) Detection And Suppression Subsystem

Waster Management (WM) Subsystem

O2 N2

Air

H2O

Urine

Regenerable

Atmosphere Revitalization (ARS) Subsystem

Water Recovery and Management (WRM) Subsystem

H2O FMS

H2O

H2O
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.
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ECLSS Distributed System

Legend:
- Common assemblies and subsystems
- Redundancy

Input-output

H2O

Fluids Carrier

Hyperbaric Airlock

ESA

JEM

Node 3

LAB Module

Node 1

N2 repress makeup

Node 2

HAB Module

Node 4

HAB Module
ECLSS DESIGN FEATURES

THIS CHART PROVIDES A SUMMARY OF THE MAJOR DESIGN FEATURES OF EACH ECLSS SUBSYSTEM.
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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.
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<tr>
<th>ECLSS Function</th>
<th>HAB</th>
<th>LAB</th>
<th>LOG</th>
<th>HAL</th>
<th>Node</th>
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HW – Hardware
IMV – Intermodule Ventilation
SL – Sampling Line
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ECLSS Functional Distribution (Continued)

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HW – Hardware  IMV – Intermodule Ventilation  SL – Sampling Line
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.
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:

<table>
<thead>
<tr>
<th>Mode Of Operation</th>
<th>ppCO₂</th>
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<td>Normal</td>
<td>3.0 mm Hg</td>
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<td>90 Day Degraded</td>
<td>7.6 mm Hg</td>
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<tr>
<td>45 Day Emergency</td>
<td>12.0 mm Hg</td>
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</table>

- 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.
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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.

![Diagram of CO₂ Reduction Process]

- CO₂
- H₂
- CO₂ Reduction
  - Potable H₂O
  - Carbon
  - Excess H₂
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.
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Oxygen Generation

FUNCTIONAL DESCRIPTION

- 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.
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.
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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