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Space Station Fluid Resupply

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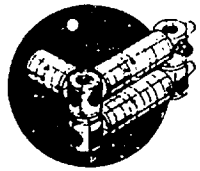
N93-27797



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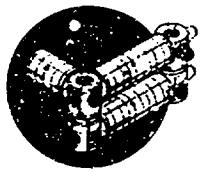
Contents:

- Requirements
- Design Considerations
- Configurations
- Operations
- Summary



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- **Requirements**

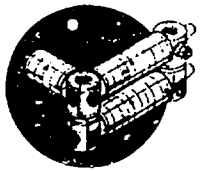
Resupply (PMC)

ECLSS Fluids — ~ 3200 lbs N_2 per year; ~3500 lbs O_2 per year

LAB Fluids — ~ 1300 lbs N2 per year

Contingency

ECLSS Fluids — ~ 700 lbs N_2 on station; ~ 900 lbs O_2 on station



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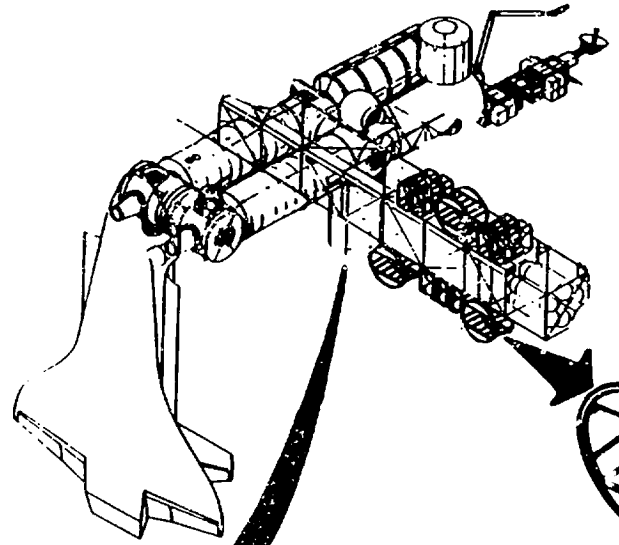
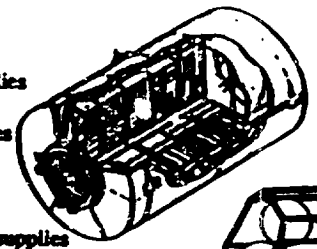
- **Design Considerations:**

Resupply	
Resupply Frequency	**~ 180 days**
Transportation State	**High pressure gas** **Supercritical fluid**
Contingency	
Supply Frequency	**On station @ PMC; as required thereafter**
Transportation State	**High pressure gas (3000 psi)** **Supercritical fluid**

Space Station Fluid Resupply

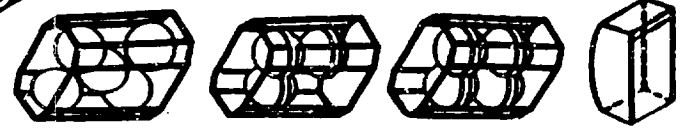


- Pressurized Logistics Module (PLM) (3 required)
  - Cargo:
  - Crew Support:
    - Food
    - Personnel supplies
    - Housekeeping supplies
  - Station Support
    - Maintenance supplies
    - Spares
    - EVA support
  - Customer Support
    - USL Equipment & supplies
    - JEM Equipment & supplies
    - Columbus equipment & supplies
  - GSE Roller Floor



- Unpressurized Logistics Carrier (ULC) (4 required)
  - Carriers
    - Station spares
    - Platform and satellite supplies (resupply and ORU's)
    - Attached payloads
  - Modular interchangeable fluid/ propellant subcarriers
  - Direct mounting for a variety of non-commercial cargo configurations

- Subcarriers
  - Provides multiple combinations of subcarriers with the ULC
  - Efficient manifesting
  - Subcarriers are attached by automated attachments and umbilical mechanisms



High Pressure Gas subcarrier (HPSC) (6 required)

Oxygen subcarrier (OSC) (3 required)

Fluids subcarrier (FSC) (3 required)

Dry Cargo subcarrier (DCSC) (8 required)

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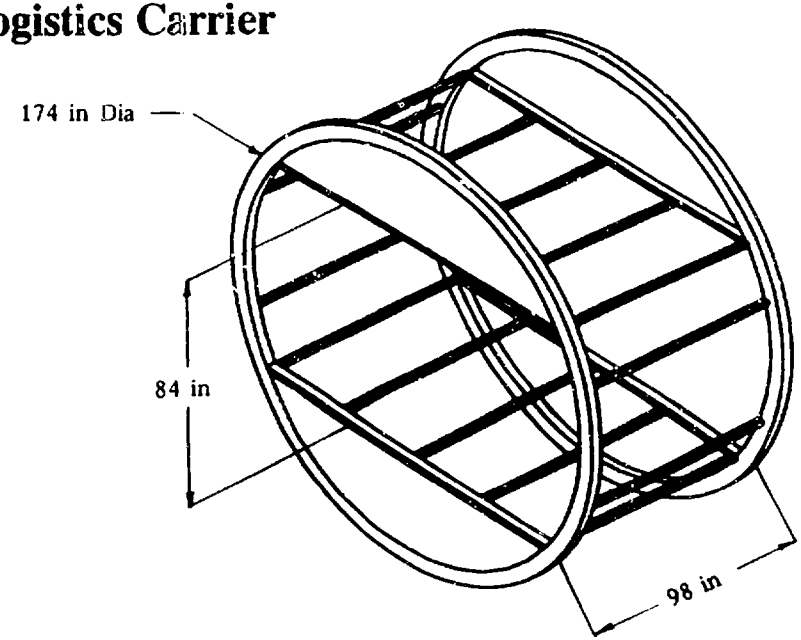
- **Unpressurized Logistics Carrier**



Outfitting

- Cargo Accommodations
  - Subcarrier Attach Mechanisms
  - Non Containerized Cargo Attachments
- Subsystems
  - EPS
  - DMS
  - TSS
  - MS
  - Passive Thermal Control System (PTCS)
  - Mechanisms
    - Automated Umbilical Mechanism
    - Subcarrier Attachment Mechanisms

Characteristics

- Empty Weight: 2,251 lbs
- Cargo Accommodation capability
  - Combinations of Subcarriers (FSC, OSC, HPSC, DCSC)
  - Seat Track on Member Faces for Oversized Cargo

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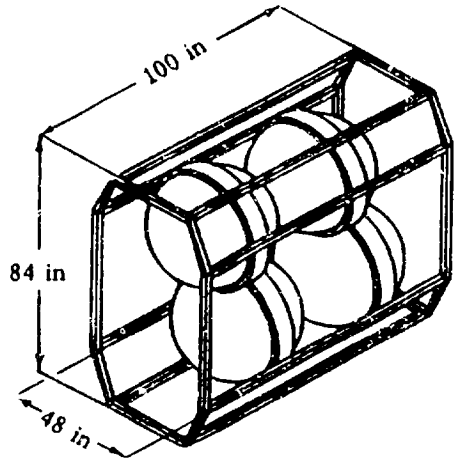
• Fluids Subcarrier (FSC)



<u>Outfitting</u>

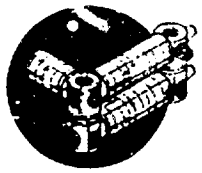
- Cargo accommodations
  - 3 ECLSS Supercritical N_2 (SCN_2) tanks
  - 1 Lab SCN_2 tank

- Subsystems
  - MS
  - EPS
  - DMS
  - TSS
  - Passive Thermal Control System (PTCS)
  - Tanks and Plumbing
  - Mechanisms
    - Automated Umbilical Mechanism
    - ULC Attachment Mechanism
    - ITA Attachment Mechanism

<u>Characteristics</u>

- Total Dry Weight – 1940 lbs

- Cargo Accommodations Capability
  - ECLSS SCN_2 – 1434 lbs
  - Lab SCN_2 – 478 lbs



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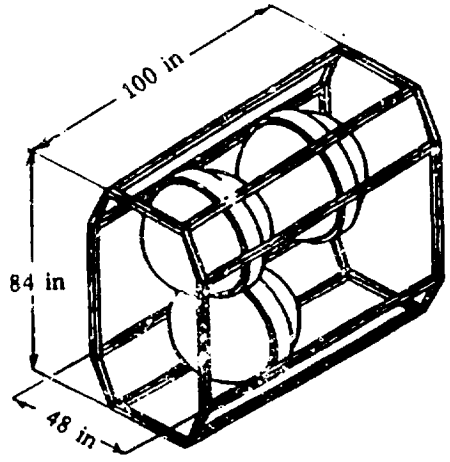
- **Oxygen Subcarrier (OSC)**



Outfitting

- Cargo accommodations
  - 3 ECLSS Supercritical O_2 (SCO_2) tanks
- Subsystems
  - MS
  - EPS
  - DMS
  - TSS
  - Passive Thermal Control System (PTCS)
  - Tanks and Plumbing
  - Mechanisms
    - Automated Umbilical Mechanism
    - ULC Attachment Mechanism
    - ITA Attachment Mechanism

Characteristics

- Total Dry Weight - 1459 lbs
- Cargo Accommodations Capability
  - ECLSS SCO_2 - 2175 lbs

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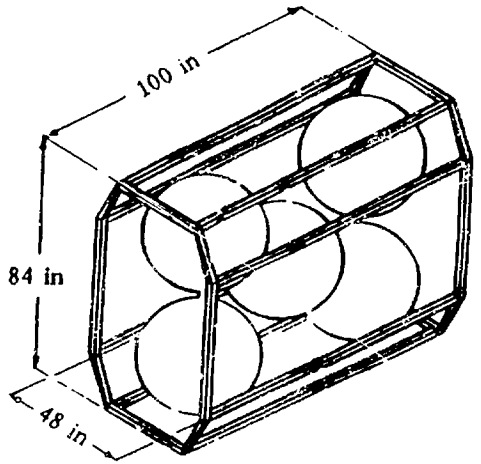
- **High Pressure Subcarrier (HPSC)**

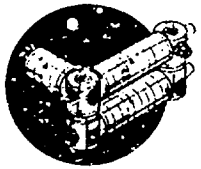


Outfitting

- Cargo accommodations
  - 3 High Pressure N_2 (HPN_2) tanks
  - 2 HP O_2 tanks
- Subsystems
  - MS
  - EPS
  - DMS
  - TSS
  - Passive Thermal Control System (PTCS)
  - Mechanisms
    - Automated Umbilical Mechanism
    - ULC Attachment Mechanism
    - ITA Attachment Mechanism

Characteristics

- Total Dry Weight - 3226 lbs
- Cargo Accommodations Capability
  - HPN_2 - 588 lbs
  - HPO_2 - 506 lbs



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Space Station Fluid Resupply

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- Transportation and Transfer Plan – Resupply
  - Prelaunch and post launch operations phases
    - Load fluids into supercritical tanks on the subcarriers
    - Transport fluids to the SS in a liquid state
  - On station operations phase
    - Change state of fluid from liquid to supercritical by turning on tank heaters
    - Transfer fluids from subcarriers to users
    - Complete unloading of subcarriers
  - Prelanding operations phase
    - Return subcarriers with residual gas

Space Station Fluid Resupply

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- Operations Phase Definitions
  - All LE's go through complete operations cycles consisting of 6 primary phases
  - Hab and US Lab go through operations cycles 1, 2 and 3 TOTAL CYCLE

PHASE DEFINITIONS

① Pre Launch Phase
Begins at start of preparations and processing for launch and ends at launch.

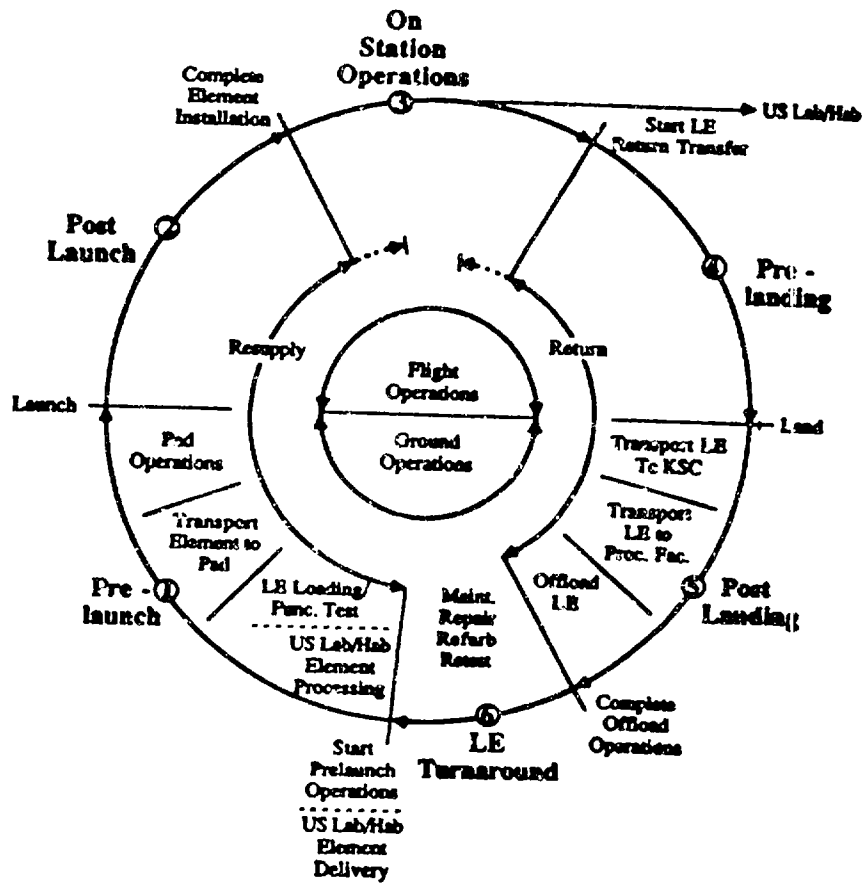
② Post Launch Phase
Begins at launch and ends at completion of element installation on SS.

③ On Station Operations Phase
Begins at completion of elements installation on SS and ends at start of transfer of returning LE from SS to the orbiter.

④ Prelanding Phase
Begins at start of transfer of returning LE from SS to the orbiter and ends at landing.

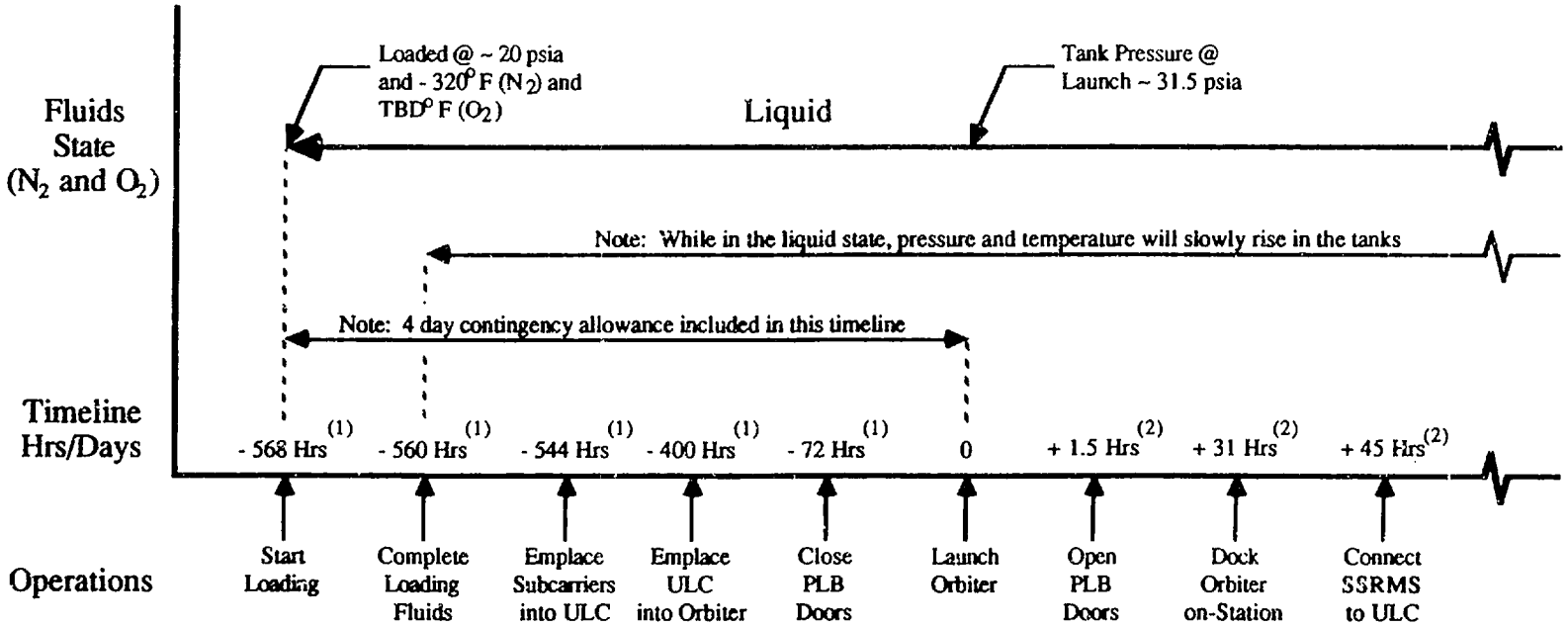
⑤ Post Landing Phase
Begins at landing and ends at completion of LE offload operations.

⑥ LE Turnaround
Begins at completion of LE unloading operations and ends at start of LE prelaunch operations.



Space Station Fluid Resupply

- Operations Flow - FSC and OSC

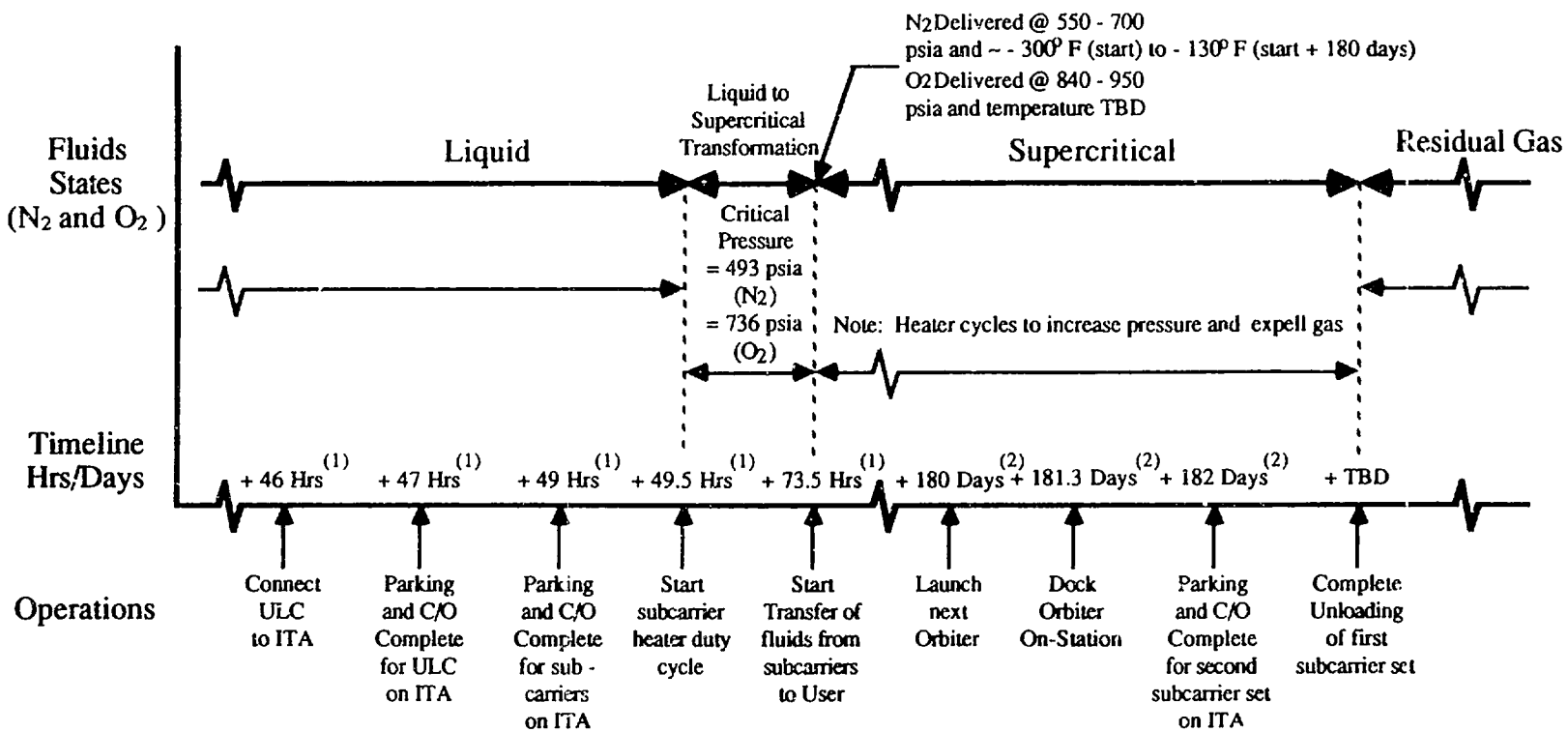


(1) Preliminary timeline estimate

(2) Preliminary timeline estimate from NSTS Integration and Operations Office

Space Station Fluid Resupply

- Operations Flow - FSC and OSC (continued)

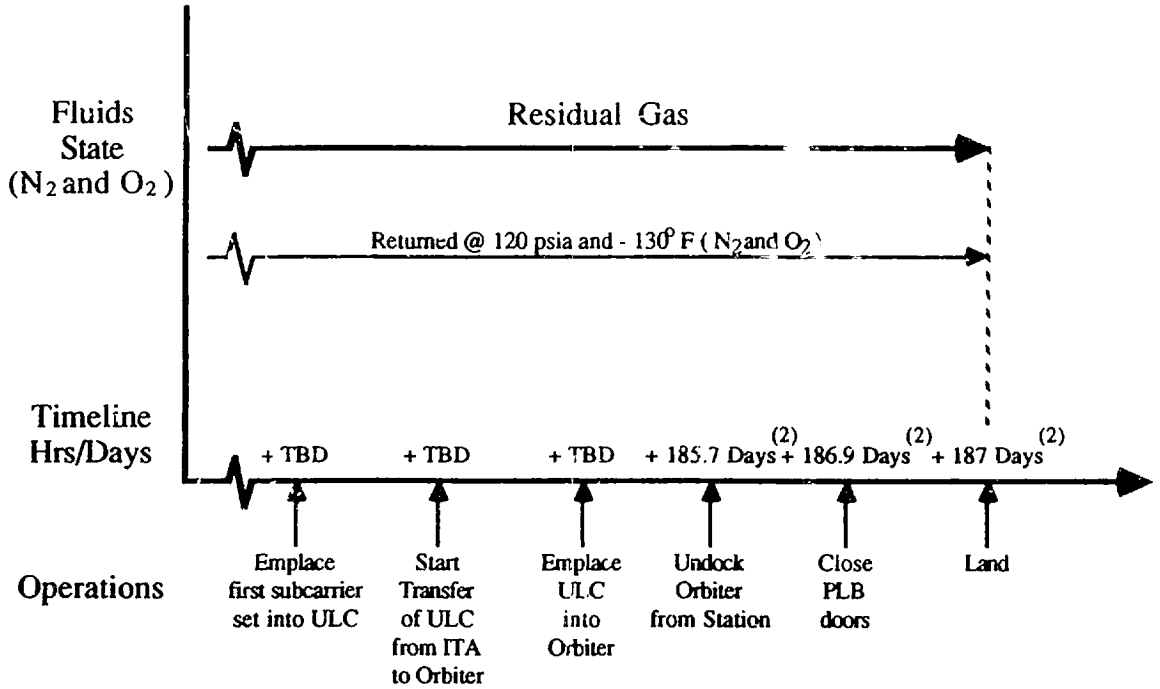


(1) Preliminary timeline estimate

(2) Preliminary timeline estimate NSTS Integration and Operations Office

Space Station Fluid Resupply

- Operations Flow - FSC and OSC (continued)



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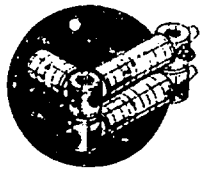

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Space Station Fluid Resupply

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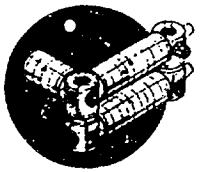
- Transportation and Transfer Plan – Contingency
  - Prelaunch and post launch operations phases
    - Load fluids into high pressure tanks on the HPSC
    - Transport fluids to the SS in a gaseous state
  - On station operations phase
    - Transfer fluids as required
    - Replace HPSC as required



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Space Station Fluid Resupply

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- Summary
  - SSF is resupplied with supercritical O_2 and N_2 for the ECLSS and USL on a 180 day resupply cycle
  - Resupply fluids are stored in the subcarriers on station between resupply cycles and transferred to the users as required
  - ECLSS contingency fluids (O_2 and N_2) are supplied and stored on station in a gaseous state
  - Efficiency and flexibility are major design considerations
  - Subcarrier approach allows multiple manifest combinations
  - Growth is achieved by adding modular subcarriers