N91-15942

11/22/88

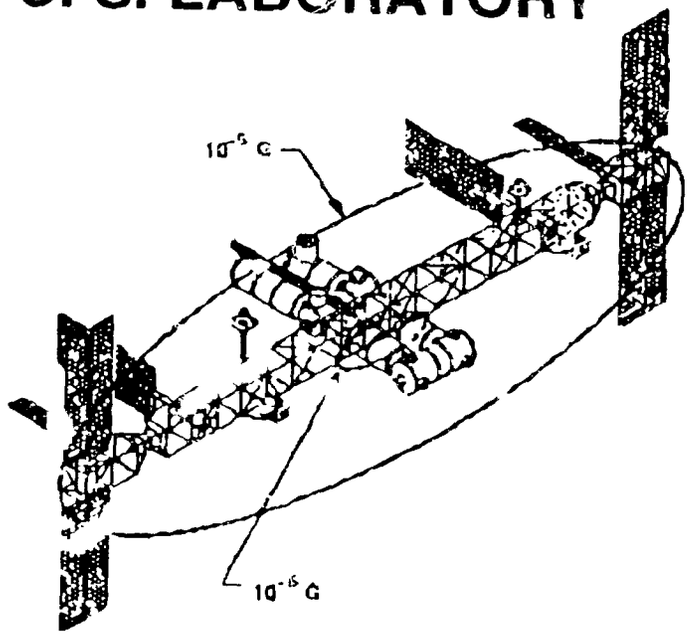
Space Station Toxic and Reactive Materials Handling Workshop

Summary of Presentation Entitled :
The Materials Processing Sciences Glovebox
Date of Presentation: 10:55 am , 12/1/88
Presenter: Larry Traweek

Summary:
The Materials Processing Science Glovebox is a rack mounted workstation which allows on orbit sample preparation and characterization of specimens from various experiment facilities. It provides an isolated safe, clean and sterile environment for the crew member to work with potentially hazardous materials. It has to handle a range of chemicals broader than even PMMS. The theme of the presentation is that **The Space Station Laboratory Experiment Preparation and Characterization Operations Provide The Fundamental Glovebox Design Characteristics** . The presentation discusses Glovebox subsystem concepts and how internal material handling operations affect the design.

Current Estimated Cost: $5M

SPACE STATION U. S. LABORATORY



MATERIALS PROCESSING SCIENCES GLOVEBOX

Larry S. Traweek
December 1, 1988

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MATERIALS PROCESSING SCIENCES GLOVEBOX

OVERVIEW

- DEFINITION AND REQUIREMENTS
- SUBSYSTEMS AND FUNCTIONAL SCHEMATIC
- SUBSYSTEM DESIGN AND PERFORMANCE FEATURES
- MATERIAL HANDLING ISSUES AFFECTING DESIGN
- CONCLUSIONS

THEME: SPACE STATION EXPERIMENT PREPARATION AND CHARACTERIZATION OPERATIONAL DEFINITION PROVIDES FUNDAMENTAL DESIGN GOALS FOR ALL GLOVEBOX SUBSYSTEMS

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MATERIALS PROCESSING SCIENCES GLOVEBOX

DEFINITION

- Rack Mounted, Crew Accessible but Isolated Work Area for Sample Preparation and Characterization Operations
- Provides User Protection to Handle Potentially Hazardous Materials

Therefore

- Provides an Internal Waste Handling Capability
- Airlock Isolation Entry of Specimens and Equipment
- Fluid Handling and Cleaning Tool Interfaces and Other Needed LSE Characterization Equipment Interfaces

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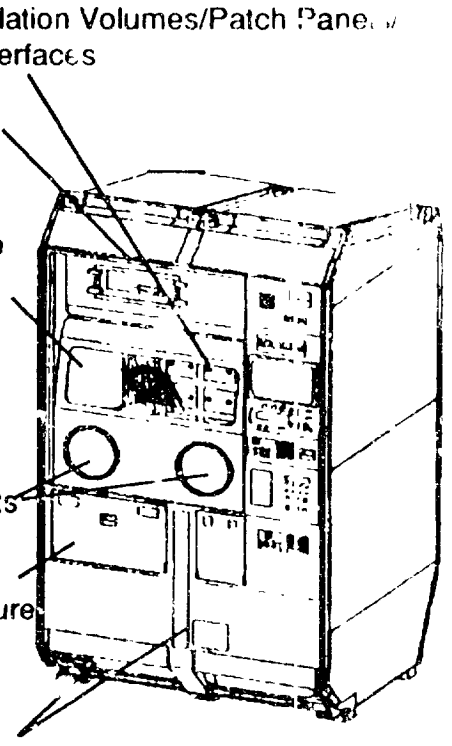
GLOVEBOX REQUIREMENTS



ACCOMODATIONS

Cleaning Fluids and Tools, etching and encapsulation equipment, access to subsystem and required LSE utilites, sample characterization and observation, biological preparation of media, pH meter, small mass measurement device, microscopic supplies, macroscopic inspection,device for analysis and results of data, separate and dispose of waste materials

PROVISIONS

Class 100 to Class 100k (continuous) cleanliness, determination of cleanliness levels, 0.5"ΔP steady state pressure operation below cabin, 10 air exchanges per hour, 1E-03 atm cc/sec helium inleakage at steady state ambient conditions, sterilization, prevention of crew contamination, glove removal and replacement, surface restraints in work area, video observation of internal operations, DMS interface, access to operational, maintenance and diagnostic data, lighting and illumination, imaging

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MATERIALS PROCESSING SCIENCES GLOVEBOX

Usage

- Integrated Glovebox Systems Are Used For Realizing Users Characterization Needs By:
  - Interfacing with Experiment Facilities (via Material Transporter)
  - Accomodating Supporting LSE, Services(video, power etc..)
  - Being Operator Friendly
- Design of Glovebox is Determined by How It is Used

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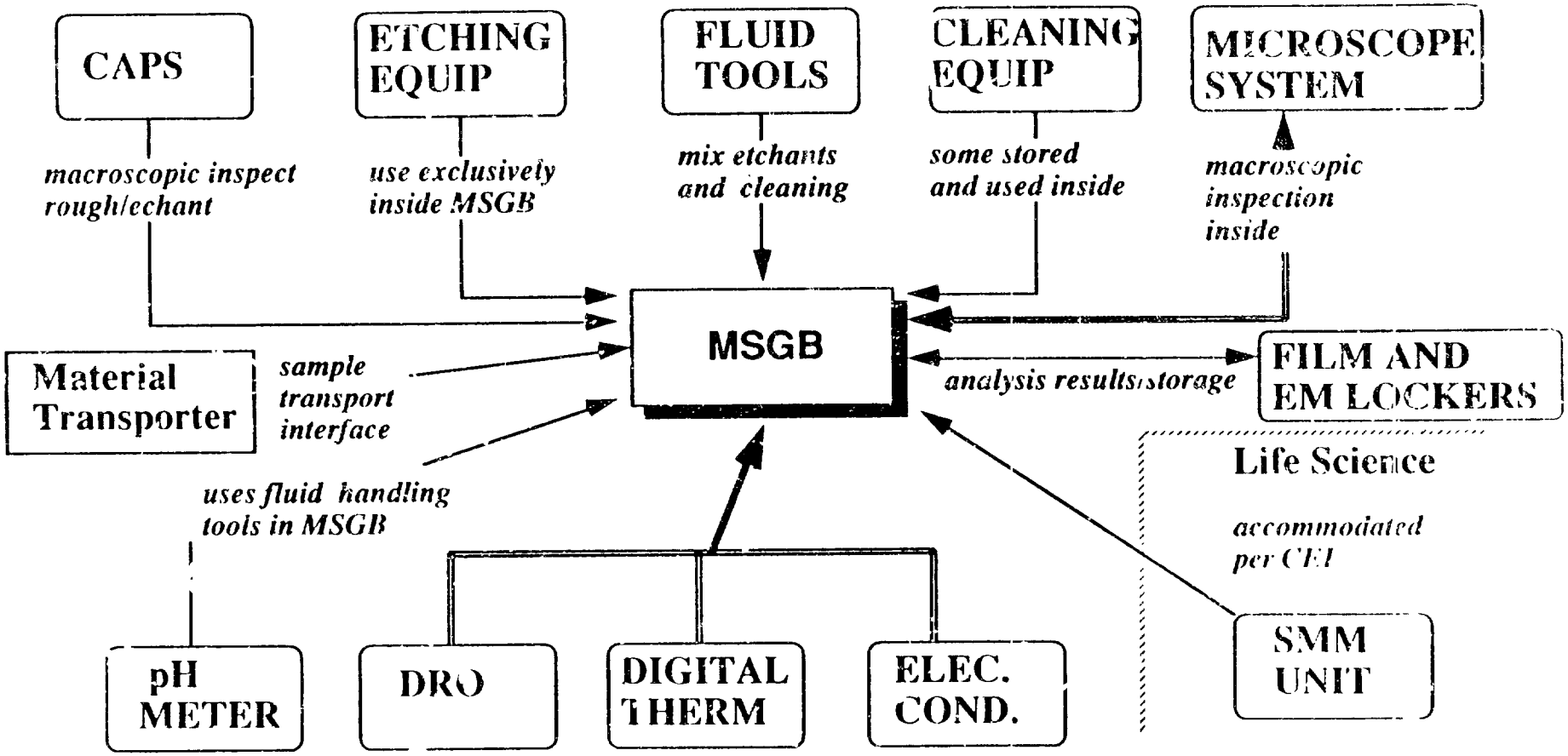
Glovebox- LSE Relationships

MATERIALS PROCESSING SCIENCES GLOVEBOX



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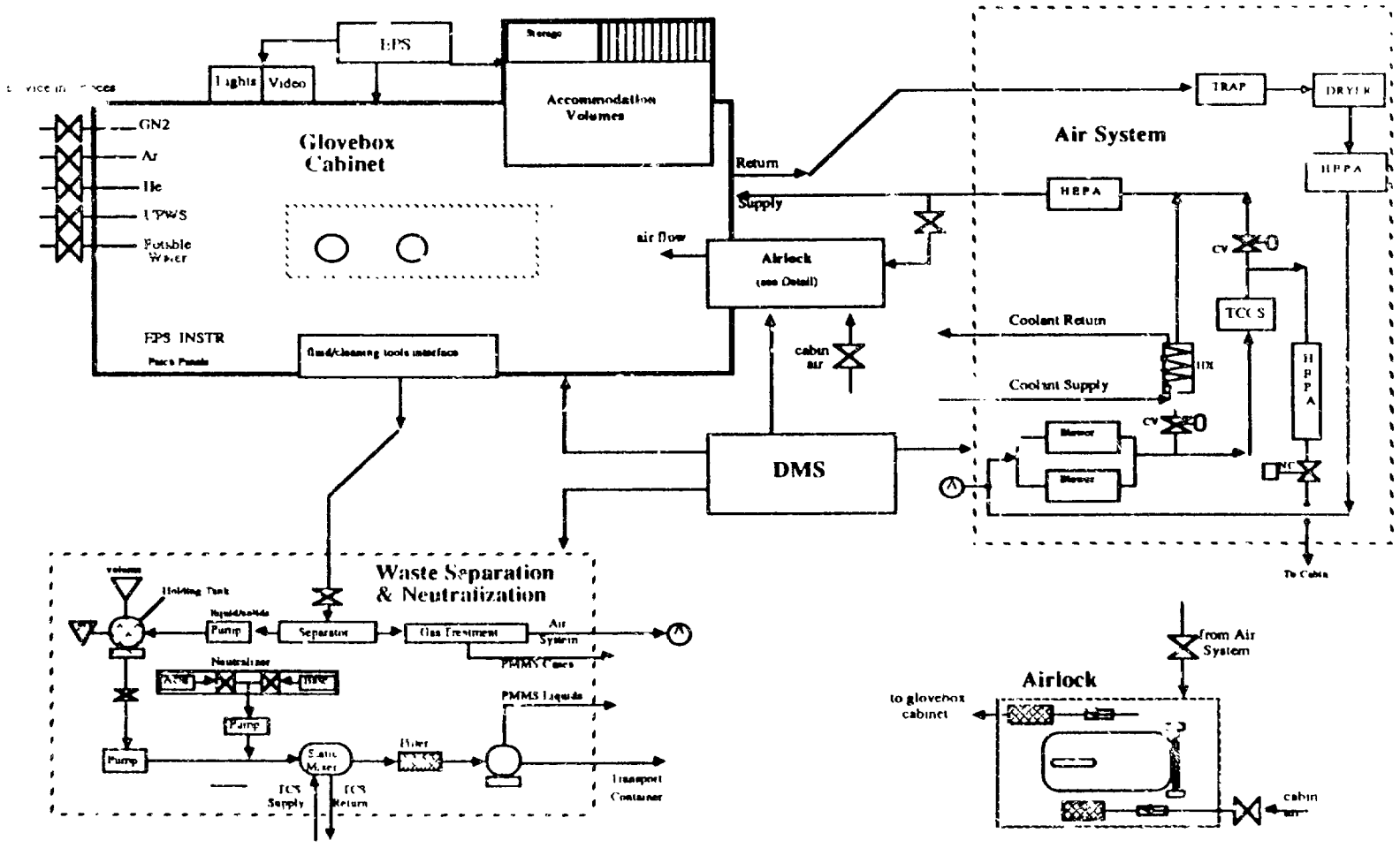
Subsystems

- 6 Subsystems Defined:
  - Cabinet (Work Area)
  - Accomodation Volumes (Storage, Access to Utilities)
  - Data Management System (Crew Access to Procedures, Maintenance, Video, Diagnostic Information)
  - Air System (Filtration/Cleansing of Internal Environment)
  - Waste Management (Storage, Treatment, Prep for PMMS)
  - Airlock (sterile/clean entry of specimens/equipment)

SPACE STATION TOXIC AND REACTIVE MATERIALS HANDLING WORKSHOP

SPACE STATION FUNCTIONAL SCHEMATIC

MATERIALS PROCESSING SCIENCES GLOVEBOX



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MATERIALS PROCESSING SCIENCES GLOVEBOX

CABINET

Design Features

- Work Volume Accessed Via Gloveports
- Interfaces Other Subsystems (Air, Waste Airlock, Storage/Service etc.)
- Human Factors of Operation a Major Design Consideration
- Dependent Upon Equipment Complement Needs For Characterization (other LSE)
- Materials of Construction Dependent on Chemical Compounds, Quantities, Mixtures and Possible Reactions

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MATERIALS PROCESSING SCIENCES GLOVEBOX

Accomodation Volumes

Design Features

- **Ease of Access to Stored Supplies**
- **Service/Storage Access Panels (for protection)**
- **Adequate Storage Volume to Support Operations**
- **Instrumentation Access to Rack Mounted LSE for Measurement**

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12/1/89

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MATERIALS PROCESSING SCIENCES GLOVEBOX

DMS

Design Features

- Computer Access to User Operational Procedures
- Computer Access to Internal Diagnostic and Repair/Maintenance Procedures
- Instrumentation Access for Leak Detection and Cleanliness (particulate/chemical) State Measurement and Validation
- Safety Interlocks (Normal, Transient Conditions)
- Video Observation of Internal Operations

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MATERIALS PROCESSING SCIENCES GLOVEBOX

Air System

Design Features

- Filtration and Trapping of Floating Fluid and Particulate Matter
- Removal of Organic and Inorganics Via TCCS
- Filtration from Class 100K to Class 100
- Closed Loop System Design Similar to GPWS and Biorack

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Waste Management System

Design Features

- Interfaced to Work Volume Via Fluid Tools and Cleaning Tools
- Chemcial Level Monitoring Instrumentation
- Separates Fluid and Solid Waste Materials
- Treats, Stores or Diverts to PMMS
- Multiple Use States: Startup/Shutdown/Cleaning/Validation

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MATERIALS PROCESSING SCIENCES GLOVEBOX

Airlock

Design Features

- Interfaces with Material Transporter/Portable Glovebox
- Preserves Environmental Integrity of Samples
- Large Enough to Import LSE and Specimen Containers
- Leak Integrity/Detection/Validation
- Human Factors Consideration for Operation

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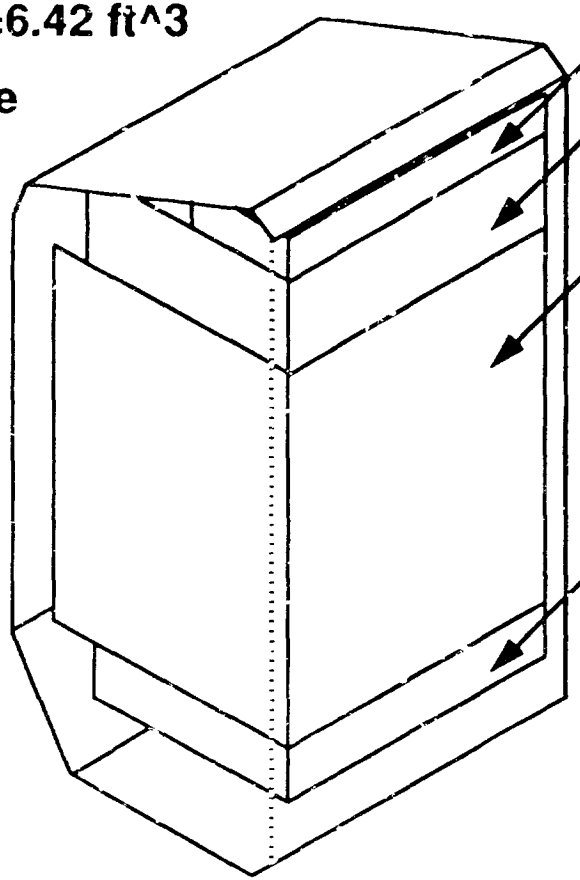
MATERIALS PROCESSING SCIENCES GLOVEBOX

Materials Handling Issues Affecting Design

Rack Packaging

- Avg Vol/Subsys=6.42 ft^3
- Adequate Volume For Meeting Design Goals



Total Interior Volume: 52.51 cu. ft.

Total Payload Volume: 38.50 cu.ft.

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MATERIALS PROCESSING SCIENCES GLOVEBOX

Materials Handling Issues Affecting Design

- SPECIMEN PREPARATION OPERATIONS
  - Fluid and Wet Chemistry Operations
    spill sets, chemical mixtures, quantities and state
  - Solids Particulate Generation
    quantitiy, size, chemical composition
  - Handling Operations
    tools needed, stored supplies, services
  - Visual or Video Observations

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MATERIALS PROCESSING SCIENCES GLOVEBOX

Materials Handling Issues Affecting Design

- CHARACTERIZATION OR REPAIR OPERATIONS
  - Measurements Required for Given Operations establish LSE complement baseline and thus volume, service accommodations etc..

DESIGN OF GLOVEBOX IS DETERMINED BY HOW IT IS TO BE USED

SPACE STATION *MATERIALS PROCESSING SCIENCES GLOVEBOX*

CONCLUSIONS

- Packaging Subsystems Within Volume Constraints May Not Be Possible Unless:
  - Re-interpretation of Use and Functional Limitations examples:
    - Waste Processing vs Total Storage
    - Internal Transport of LSE vs Feedthrough Accommodation
    - Self Contained Chemical and Cleanliness Monitoring System
    - Self Contained Leak Detection Validation System

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MATERIALS PROCESSING SCIENCES GLOVEBOX

CONCLUSIONS (continued)

- A Baselined Set of Mission Operation Scenarios Should be Developed to Establish Design

ie.. sets of materials to be handled, tools, LSE etc..

-Chemical Levels/Cleanliness Monitoring May Be Accomplished By a Shared Effort With PMMS

- Trade Study Recommedations Using Basline Set May Simplfy Unit

  - based upon User interviews followed by development of concepts and procedures to accommodate

example: compartmentalization of work area to achieve class 100 cleanliness from class 100k

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NASA

U. S. Laboratory Chemical Hazard Remediation

Presented by
J. L. Perry

George C. Marshall Space Flight Center
Structures and Dynamics Laboratory/ED62

Space Station Toxic and Reactive Materials Handling Workshop

November 29, 30 & December 1, 1988

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Space Station Project PMMS Objectives

Process Fluid Supply

Process Material Transport

Waste Dispensation

Chemical Storage and Leak Detection

PMMS Subsystems

Basic Subsystems

- Process Fluid Supply
- Waste Processing
- Water Recovery and Processing
- Chemical Storage and Transport

Peripheral Subsystems

- Portable Glovebox
- Emergency Shower and Eye Wash
- Vacuum Maintenance System

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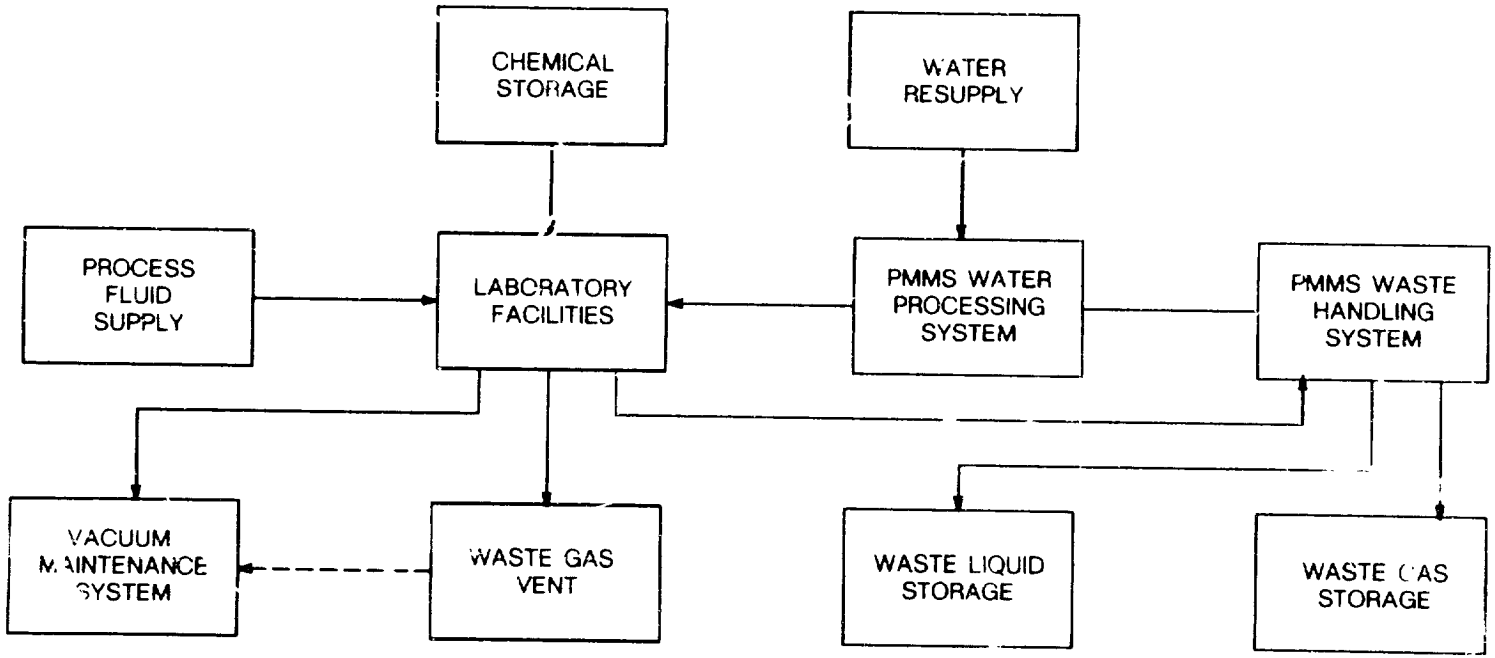
Process Material Management System



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USL Chemical Storage, Handling, and Isolation

Transport while maintaining isolation from the USL atmosphere

- Containment levels
- Portable glovebox

Ambient, safe storage for 90 day mission set

- PMMS-supplied
- User-supplied

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USL Waste Handling Requirements

Process and reclaim waste water as appropriate

Accommodate contaminated effluent

Handle leaks and spills within USL facilities

Separate and condition phases for storage or periodic venting as appropriate

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Potentially Hazardous Operations on the USL

Chemical and waste storage

Chemical and waste transportation

Chemical and waste processing

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USL Hazard Remediation Approach

Survey past experience on Skylab, Spacelab, and Shuttle

Gather data on each material candidate

Screen materials based on criteria and limits established by the Space Station Project

USL Material Database Development

Database includes the following information:

1. Chemical name and formula
2. Physical properties
3. Phases used
4. Hazard classification
5. Amount used or generated per cycle and the location in the USL
6. Total amount used or generated
7. Recommended treatment methods and location
8. Spacecraft maximum allowable concentration
9. Funtional classification
10. Major incompatibilities
11. Comments

Aid for matching USL and user requirements to reach the optimum design

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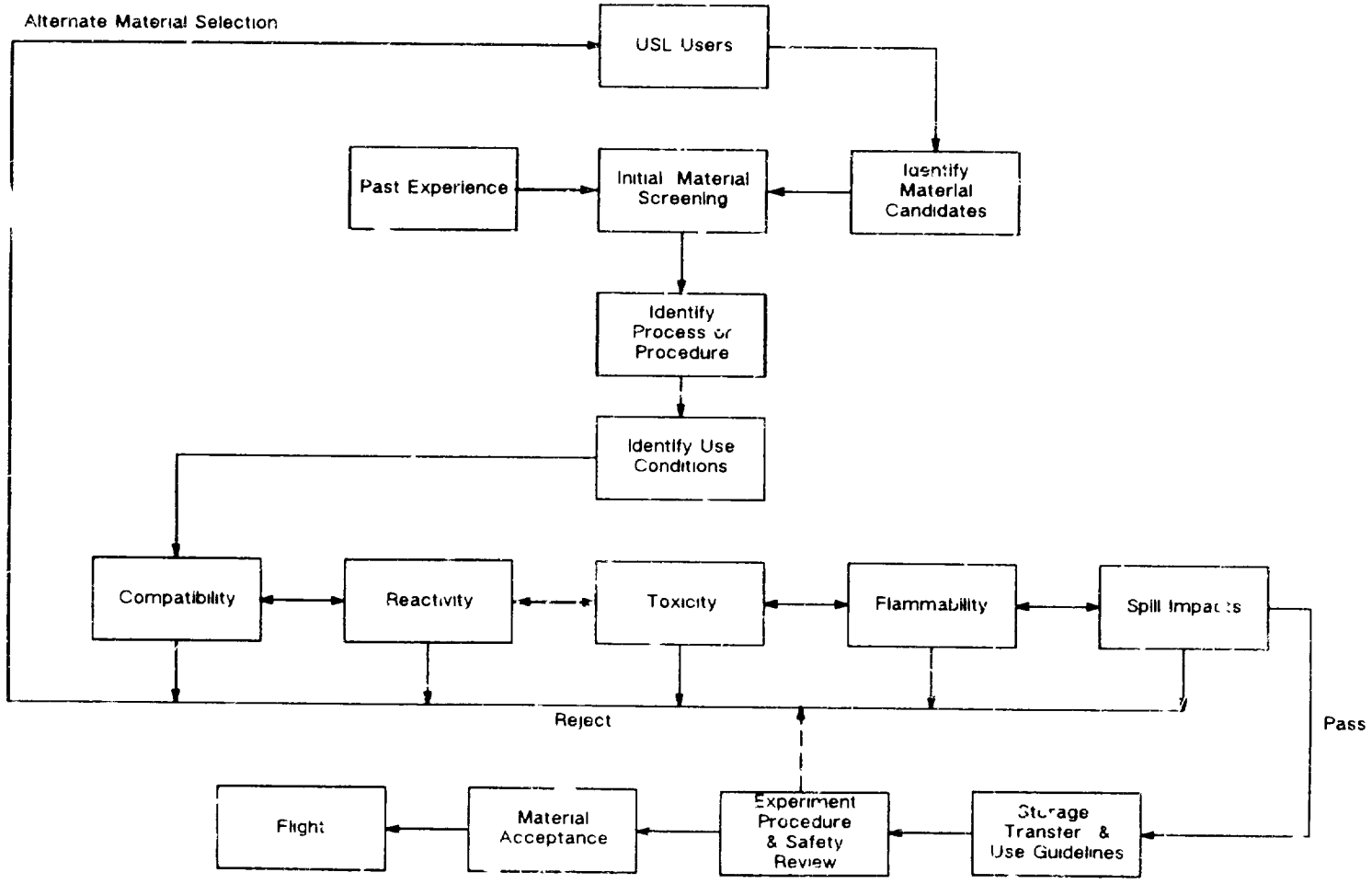
Criteria for USL Experiment Material Screening

Accommodation levels for storage, containment, and processing for sample, reagent and waste materials will be determined according to the following:

1. Concentration
2. Reactivity
3. Toxicity
4. Flammability limits
5. Chemical compatibility
6. Corrosiveness
7. Quantity
8. Use rate
9. pH
10. Solubility
11. Phase
12. Flash point
13. Latent heat of neutralization
14. Reaction and degradation products
15. Spacecraft maximum allowable concentration (SMAC)
16. Cleanup techniques
17. Detectable limits and detection techniques
18. Temperature and pressure conditions of use
19. Additional substances used in the same volume
20. Process or procedure performed
21. Storage, transfer, and use guidelines
22. Spill impacts on the ECLSS

Space Station USL Hazardous Material Control Procedure



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Develop USL Material Classifications and Waste Remediation Techniques

Segregate separately and store for further use or return to earth

Treat locally before central disposal

Treat locally before local disposal

Recover water from selected experiment operations

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PMMS Approach to Handling Chemical Classes

Local Treatment and Storage

Filter
Separate phases
Liquid storage
Segregate hazardous chemicals and return to proper storage *after* verifying containment

Transportation

Appropriate containment
Appropriate subsystem interfaces

Central Treatment and Storage

Filter
Separate phases
Reclaim water from candidate wastes
Inert gas purge potential for recycle

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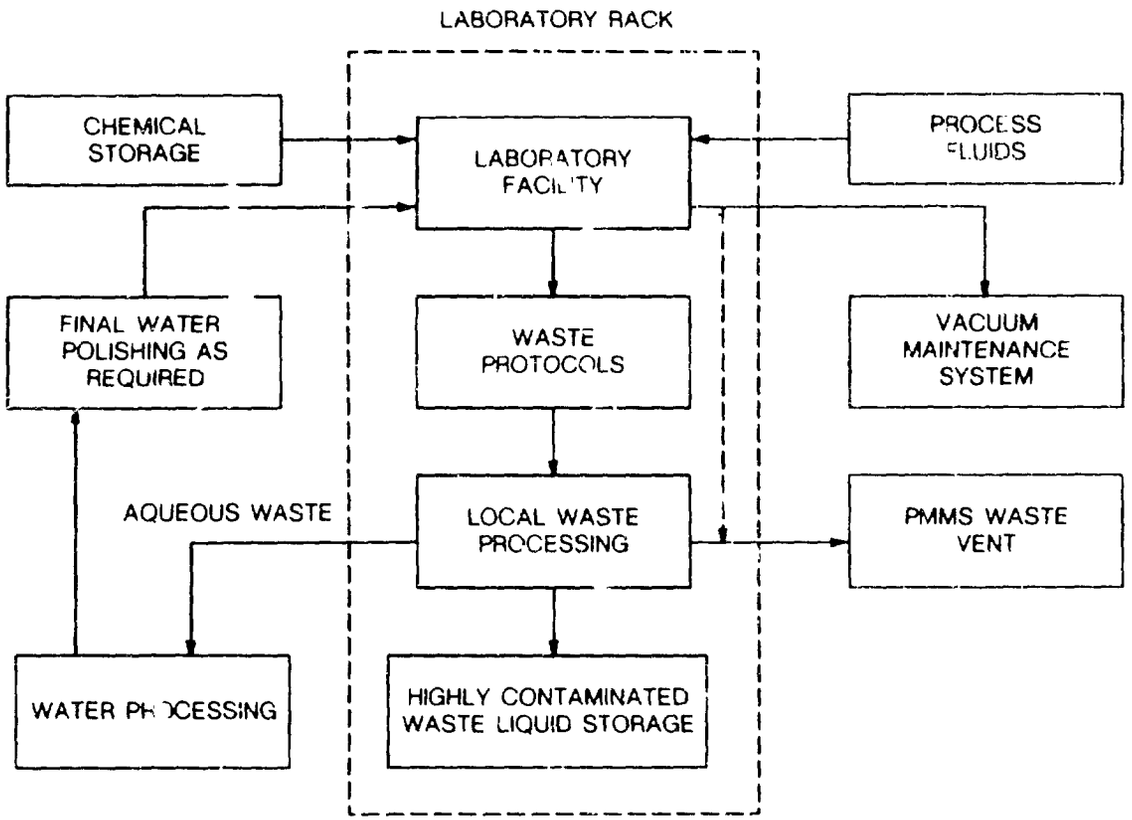
Rack-Level Waste Handling Methodology



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Personal Protective Equipment

Goggles, face protection, or both

Gloves or proper material

Protective coat or suit as appropriate

General laboratory safety equipment

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Summary

Requirements review

Hazard handling strategy

Hazard remediation strategy

Meet objectives and requirements of USL

DONALD E. STAFFORD

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Don is the founder and principal engineer of this service dedicated to assisting businesses, large or small, in meeting the demands of numerous local, state, and federal regulations pertaining to safety, health, and environmental issues.

Don received his BS in engineering at Arizona State University and has over twenty years of experience with the design and construction of semiconductor facilities and process equipment. A major effort at Motorola in the project management of a new GaAs crystal growth business followed by a major contribution in establishing a GaAs epitaxy business for Epitronics lead to a heavy involvement in hazardous materials issues.

Speaker and participant at numerous SEMI seminars on hazardous materials as well as participation with the Institute of Environmental Science and American Electronics Association.

GROUND BASED ELECTRONIC CRYSTAL GROWTH
SAFETY PRACTICES

- KEY CONSIDERATIONS
  - * FACILITY SELECTION
  - * EQUIPMENT SELECTION
  - * PERSONNEL SELECTION AND TRAINING
- DESIGN FOR SAFETY
  - * FACILITY
  - * EQUIPMENT
  - * PERSONNEL PROTECTION
- TRAINING
  - * FACILITIES OPERATION
  - * EQUIPMENT OPERATION
  - * EMPLOYEE SAFETY
- SUMMARY - Q&A

GROUND BASED ELECTRONIC CRYSTAL GROWTH
SAFETY PRACTICES

A. FACILITY SELECTION

1. ASSESS HAZARDS PARAMETERS

   - o TOXICITY
   - o QUANTITY
   - o SITE LOCATION

2. DEDICATE SPACE AND SERVICES

3. COMPARTMENTALIZE

   - o SMALLEST CUBIC FOOT OF SPACE REQUIRED FOR PROCESS
   - o MINIMIZE POSSIBLE CLEANUP AREA

GROUND BASED ELECTRONIC CRYSTAL GROWTH
SAFETY PRACTICES

B. EQUIPMENT SELECTION

1. IDENTIFY POSSIBILITIES FOR A CATASTROPHE

- o PRESENCE OF TOXIC SOLIDS OR GASES
- o FIRE POTENTIAL
- o CHEMICAL CONTAINMENT

2. DESIGN "IN" SAFETY FEATURES VS. ADD-AS-YOU-GO

3. EVALUATE VENDORS KNOWLEDGE OF HAZARDS

C. PERSONNEL SELECTION AND TRAINING

1. ESTABLISH BASELINE MEDICAL RECORDS

- HEAVY METALS BASELINE
- PULMONARY FUNCTIONS BASELINE

2. HAZARDS TRAINING

- CLASSROOM BEFORE PRODUCTION AREA
- EMERGENCY PROCEDURES
- OSHA RIGHT-TO-KNOW
- SPECIAL NOTES ON HANDLING HAZMAT

GROUND BASED ELECTRONIC CRYSTAL GROWTH
SAFETY PRACTICES

D. FACILITY SAFETY

1. FIRE PROTECTION

2. DETECTORS

- o SMOKE
- o TOXIC GAS
- o COMBUSTIBLE GAS

3. CENTRAL ALARM CENTER

- o MONITOR FIRE SYSTEM
- o MONITOR DETECTORS
- o EVACUATION ALARM
- o 24-HOUR MONITORING, ON OR OFF-SITE

4. CONTAMINATION SURVEILLANCE

- o WIPE SAMPLES
- o GAS/VAPOR DETECTOR PUMPS

GROUND BASED ELECTRONIC CRYSTAL GROWTH
SAFETY PRACTICES

E. EQUIPMENT SAFETY

1. DESIGN FOR SAFE OPERATION AND SHUTDOWN

- o REMOTE MONITORS OF CRITICAL PARAMETERS
- o REMOTE SHUTDOWN AT CENTRAL ALARM CENTER

2. DESIGN FOR CONTAINMENT OF TOXIC MATERIAL

- o HIGH VELOCITY EXHAUST HOODS
- o EXTENSIVE USE OF GLOVE BOX APPARATUS
- o NEGATE NEED FOR FULL-TIME RESPIRATORS

3. DESIGN FOR EXPEDIENT CLEANUP

- o ISOLATE AREA/EQUIPMENT
- o EASY BREAKDOWN OF EQUIPMENT

GROUND BASED ELECTRONIC CRYSTAL GROWTH
SAFETY PRACTICES

F. PERSONNEL PROTECTION

1. PROTECTIVE CLOTHING

- o DUAL USEAGE-CLEANROOM AND HAZMAT PROTECTION
- o CONSIDER DISPOSABLE GARMENTS, GLOVES

2. RESPIPATORY PROTECTION (OSHA 1910.134)

- o ROUTINE DUTIES VS. NON-ROUTINE DUTIES
- o AIR SUPPLIED VS. CHEMICAL CARTRIDGE
- o MASK MUST BE FITTED TO THE INDIVIDUAL
- o MEDICAL SURVEILLANCE REQUIRED
- o REQUIRES WRITTEN PROCEDURES

3. EYE/FACE PROTECTION

- o CHEMICAL SPLASH
- o FRAGMENTS

4. SPECIAL PROTECTION

- o HAZARDOUS MATERIAL CLEANUP
- o MAJOR FACILITY MODIFICATIONS

G. TRAINING

1. FACILITIES OPERATIONS

- REVIEW WRITTEN PROCEDURES
- HAZARDOUS MATERIALS MANAGEMENT
- EMERGENCY RESPONSE

2. EQUIPMENT OPERATIONS

- COMMUNICATE CHANGES
- REVIEW WRITTEN PROCEDURES

3. EMPLOYEE SAFETY

- SCHEDULED SAFETY MEETINGS
- SEEK EMPLOYEE INPUTS
- CONTINUAL REVIEW OF HAZARDOUS MATERIALS