N91 15941

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Workstations and Gloveboxes for Space Station

Lockheed Missiles and Space Company is responsible for designing, developing, and building the Life Sciences Glovebox, the Laboratory Sciences Workbench, and the Maintenance Workstation plus 16 other pieces of equipment for the U.S. Laboratory Module of the Space Station Freedom. The Laboratory Sciences Workbench and the Maintenance Workstation have been functionally combined into a double structure to save weight and volume which are important commodities on the Space Station Freedom. The total volume of these items is approximately 180 cubic feet. These workstations and the glovebox will be delivered to NASA in 1994 and will be launched in 1995. The requirement for all equipment on board the Space Station Freedom to have a very long lifetime of 30 years presents numerous technical challenges in the areas of design and reliability. The equipment must be easy to use by international crew members and also easy to maintain on-orbit. For example, seals must be capable of on-orbit changeout and reverification. The stringent contamination requirements established for Space Station Freedom equipment also complicate the zero gravity glovebox design. The current contamination control system for the Life Sciences Glovebox and the Maintenance Workstation will be presented. The requirement for the Life Sciences Glovebox to safely contain toxic, reactive, and radioactive materials presents unique challenges. Trade studies, CAD simulation techniques and design challenges will be discussed to illustrate the current baseline conceptual designs. Areas which need input from the user community will be identified.

SPACE STATION FREEDOM

BOEING Lockheed

SPACE STATION

TOXIC AND REACTIVE MATERIALS HANDLING

GLOVEBOXES AND WORKSTATIONS

LIFE SCIENCES GLOVEBOX

MARIA JUNGE

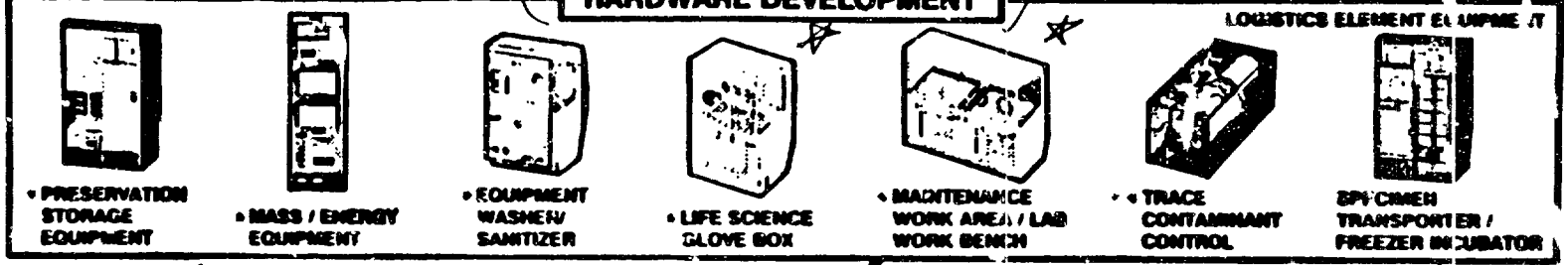
DECEMBER 1, 1988

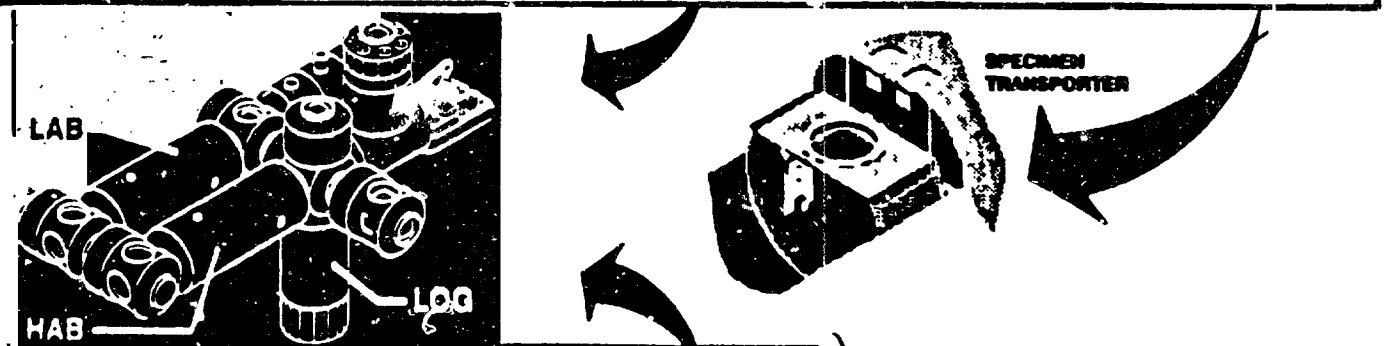
SPACE STATION

LOCKHEED'S ROLE IN WP-01

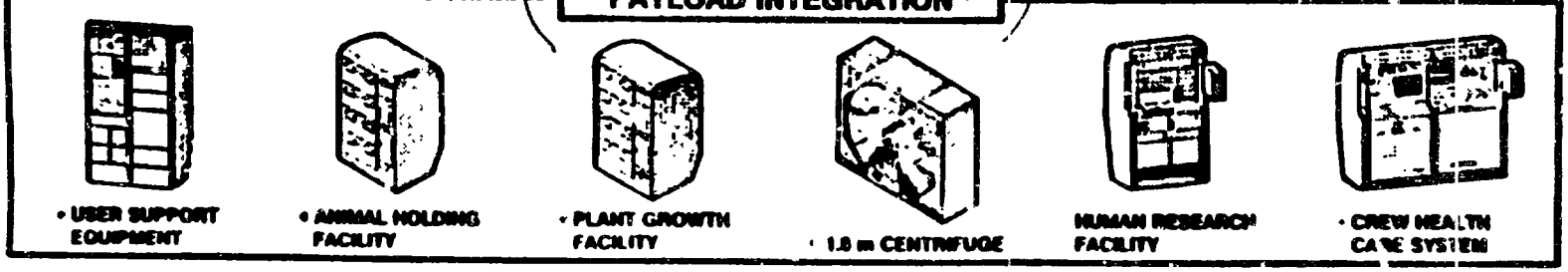
Lockheed

HARDWARE DEVELOPMENT





PAYLOAD INTEGRATION



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SPACE STATION

WP-01 HARDWARE ELEMENTS
LIFE SCIENCES GLOVE BOX

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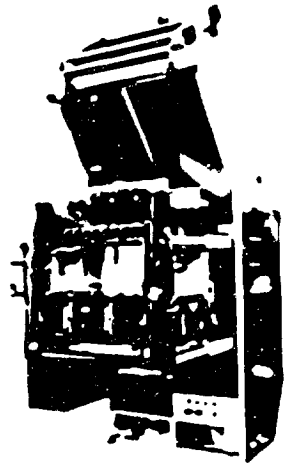

SPACELAB GENERAL PURPOSE WORKSTATION

GENERAL PURPOSE WORKSTATION GLOVE PORTS

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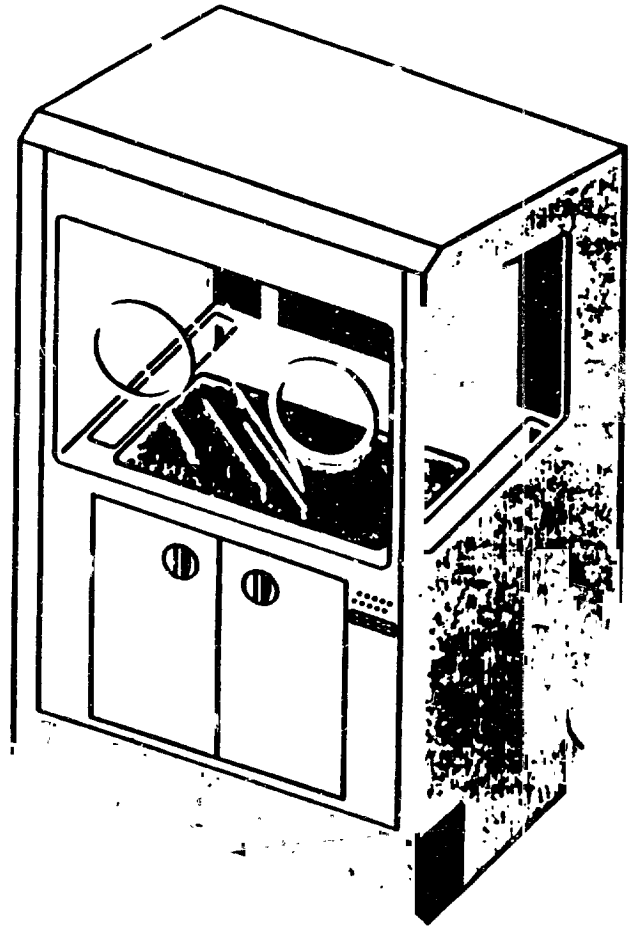
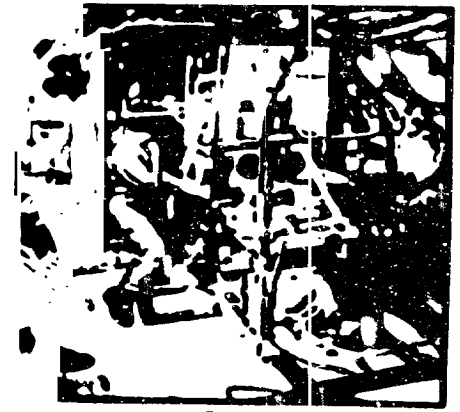
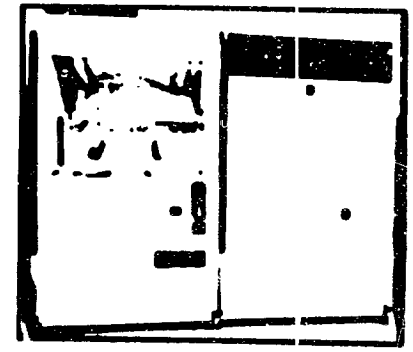


LIFE SCIENCES GLOVE BOX



KC-135 DEVELOPMENT TEST



GLOVE BOX AND EQUIPMENT WASHER SANITIZER METAL MOCK-UP

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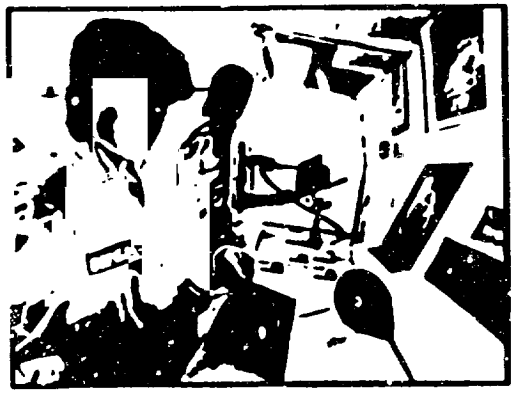
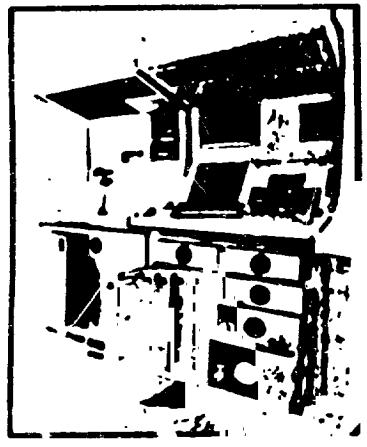
WP-01 HARDWARE ELEMENTS
MAINTENANCE WORKSTATION / LABORATORY SCIENCE WORKBENCH

SPACE STATION

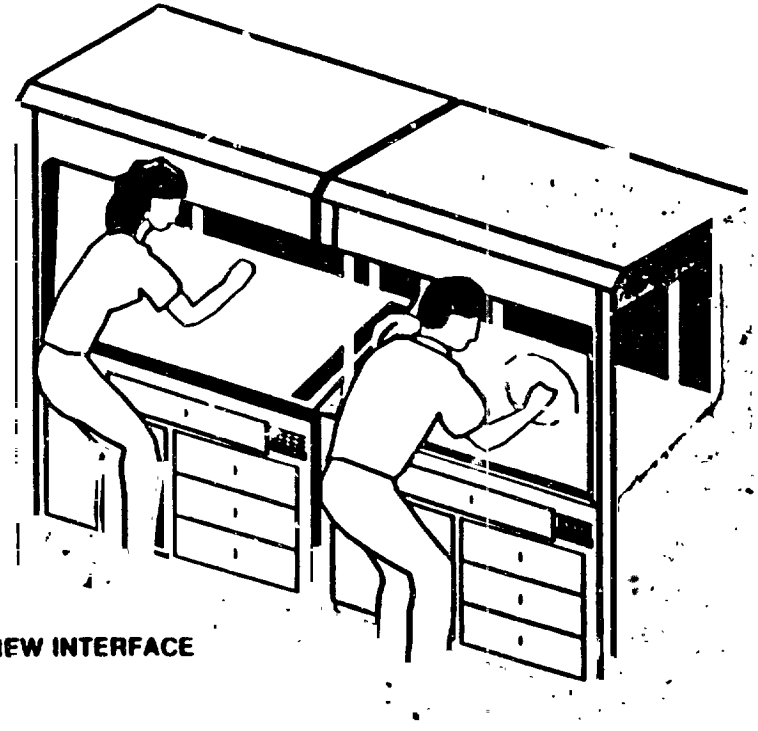
Lockheed



EQUIPMENT CALIBRATION AND REPAIR



MAINTENANCE WORKSTATION MOCK-UP



CREW INTERFACE

SPACELAB WORKBENCH

MAINTENANCE WORKSTATION LABORATORY SCIENCE WORKBENCH

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SPACE STATION FREEDOM

GENERAL PURPOSE WORK STATION

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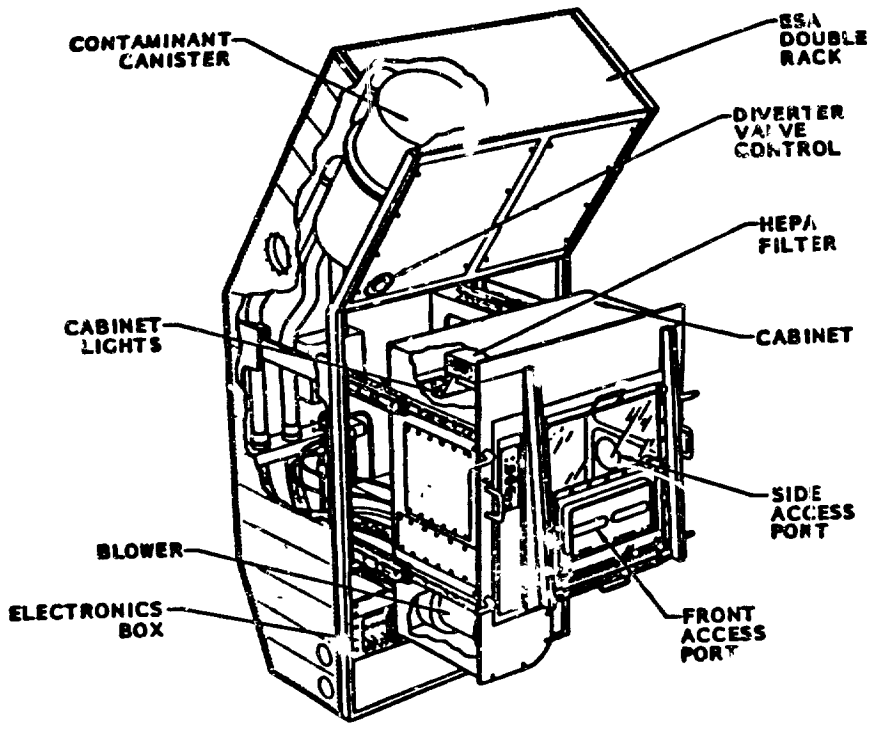


SPACELAB GPWS PROVIDES HERITAGE FOR SPACE STATION WORK STATIONS

LIFE SCIENCES GLOVEBOX

KEY REQUIREMENTS

LIFE SCIENCES GLOVEBOX SHALL:

- PROVIDE BIOISOLATION
- PREVENT ANIMAL ESCAPE
- CONTAIN AND COLLECT LIQUID, SOLID AND GAS WASTES
- CONTINUOUSLY CLEAN AND RECYCLE INTERNAL ATMOSPHERE
- PROVIDE A STERILE ENVIRONMENT (CLASS III BIOLOGICAL CABINET)
- PROVIDE 99.99% (FOR 0.3μ PARTICLES) EFFICIENT HEPA FILTRATION
- PROVIDE FOR DETERMINATION OF INTERNAL CLEANLINESS LEVELS
- PROVIDE ACCESS TO PROCEDURES FOR GLOVEBOX OPERATION
- PROVIDE VIDEO OBSERVATION CAPABILITY

LIFE SCIENCES GLOVEBOX

KEY REQUIREMENTS

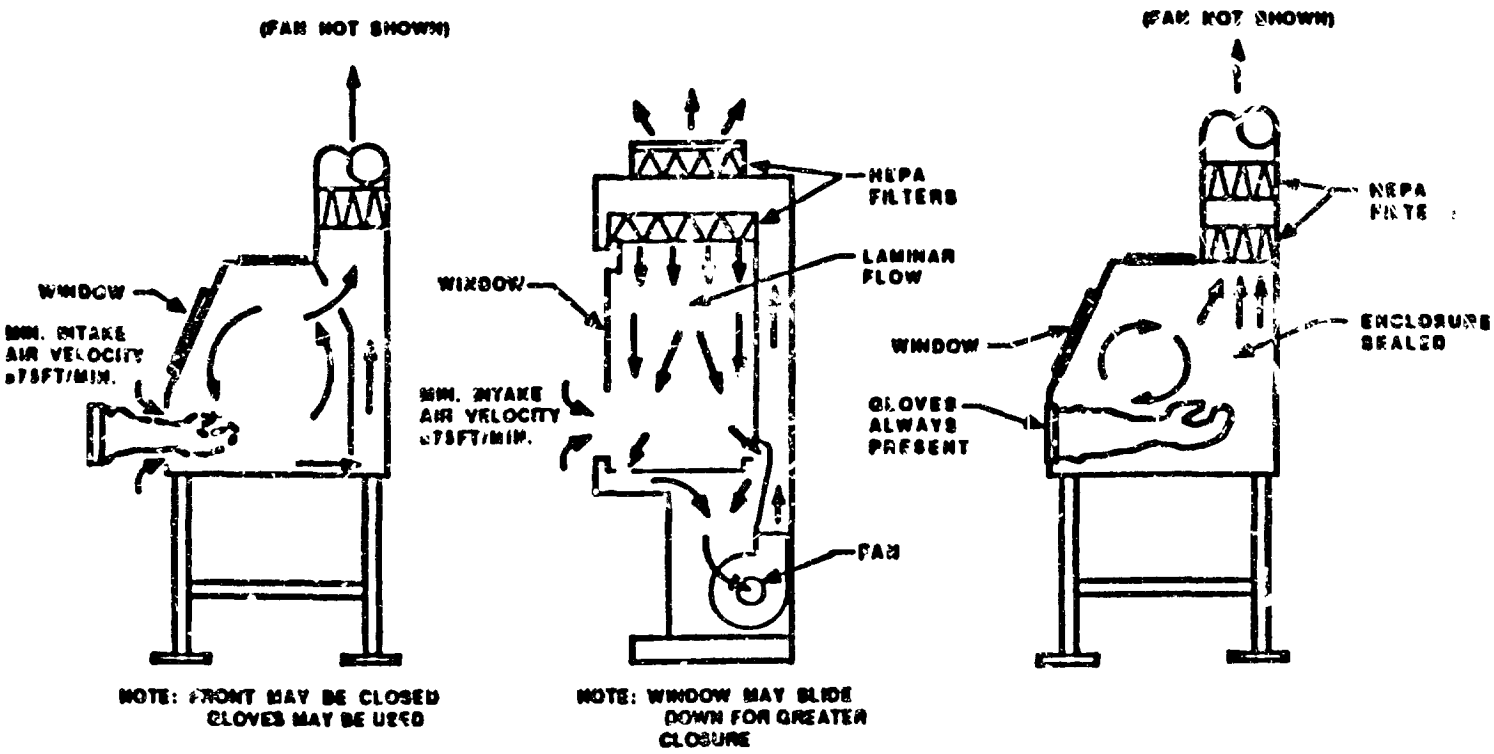
LIFE SCIENCES GLOVEBOX SHALL ACCOMMODATE:

- MASS MEASUREMENT DEVICES
- FLUID HANDLING TOOLS
- SPECIMEN LABELING DEVICE
- MODULAR HABITATS
- COMMONLY USED FLUIDS (AIR, WATER, ETC.)
- CRYOGENIC FREEZING OF SPECIMENS
- UTILITY INTERFACES TO SPECIFIED EQUIPMENT
- DATA ANALYSIS AND STORAGE DEVICES
- ROUTINE CLEANING AND PERIODIC DISINFECTION AND STERILIZATION

LIFE SCIENCES GLOVEBOX SHALL SUPPORT THE FOLLOWING OPERATIONS:

- GENERAL SPECIMEN HANDLING
- SURGERY, MICROSCOPY, DISSECTION, SAMPLE ACQUISITION, FIXATION
- CAGE AND CUVETTE MAINTENANCE
- CONSUMABLES RESUPPLY
- MAINTENANCE AND REPAIR
- IMAGING
- RECORDING AND HANDLING OF RADIOISOTPES, TOXIC, REACTIVE, AND INFECTIOUS MATERIALS

GLOVEBOX CLASSIFICATION



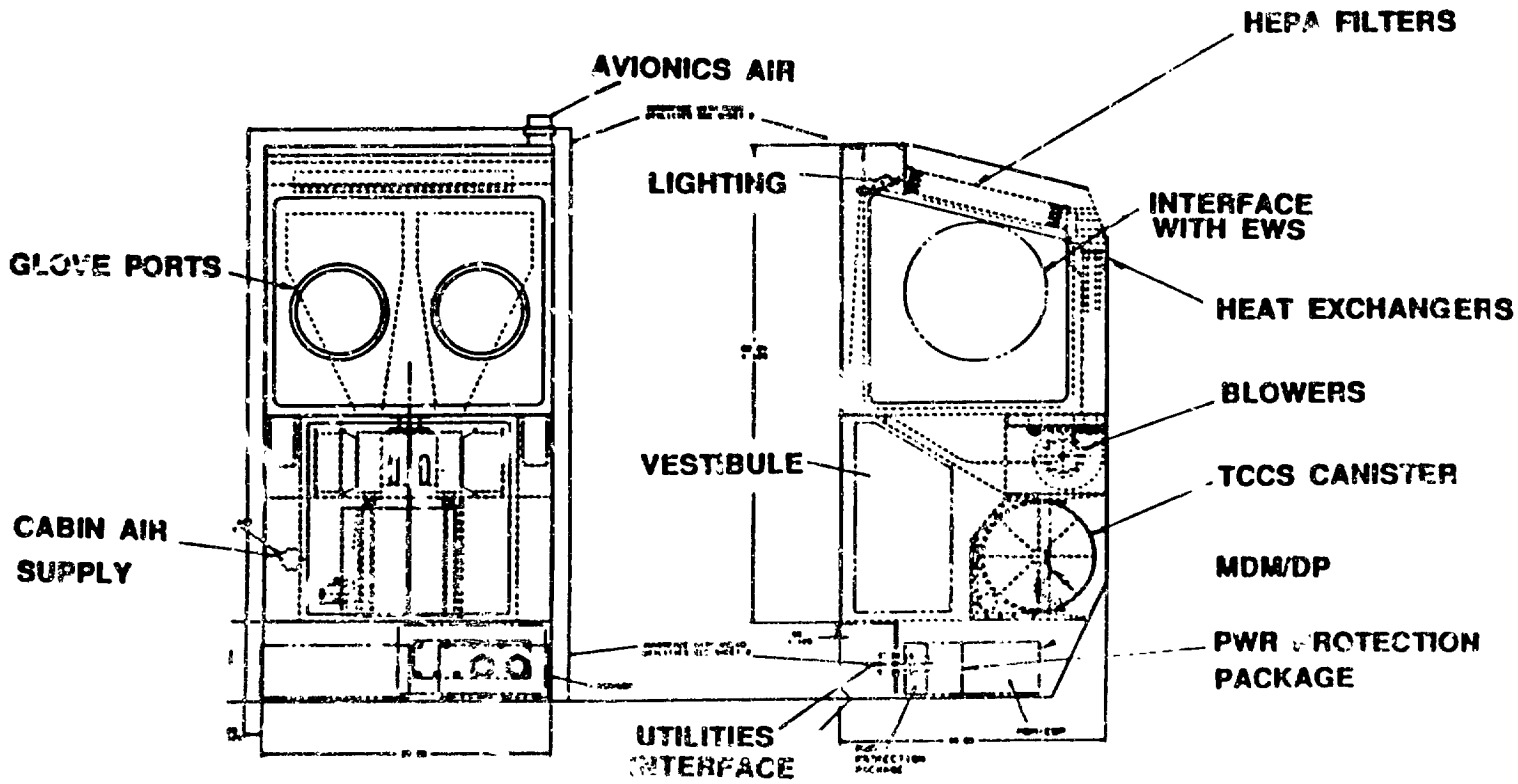
CLASS I CABINET

CLASS II CABINET

CLASS III CABINET

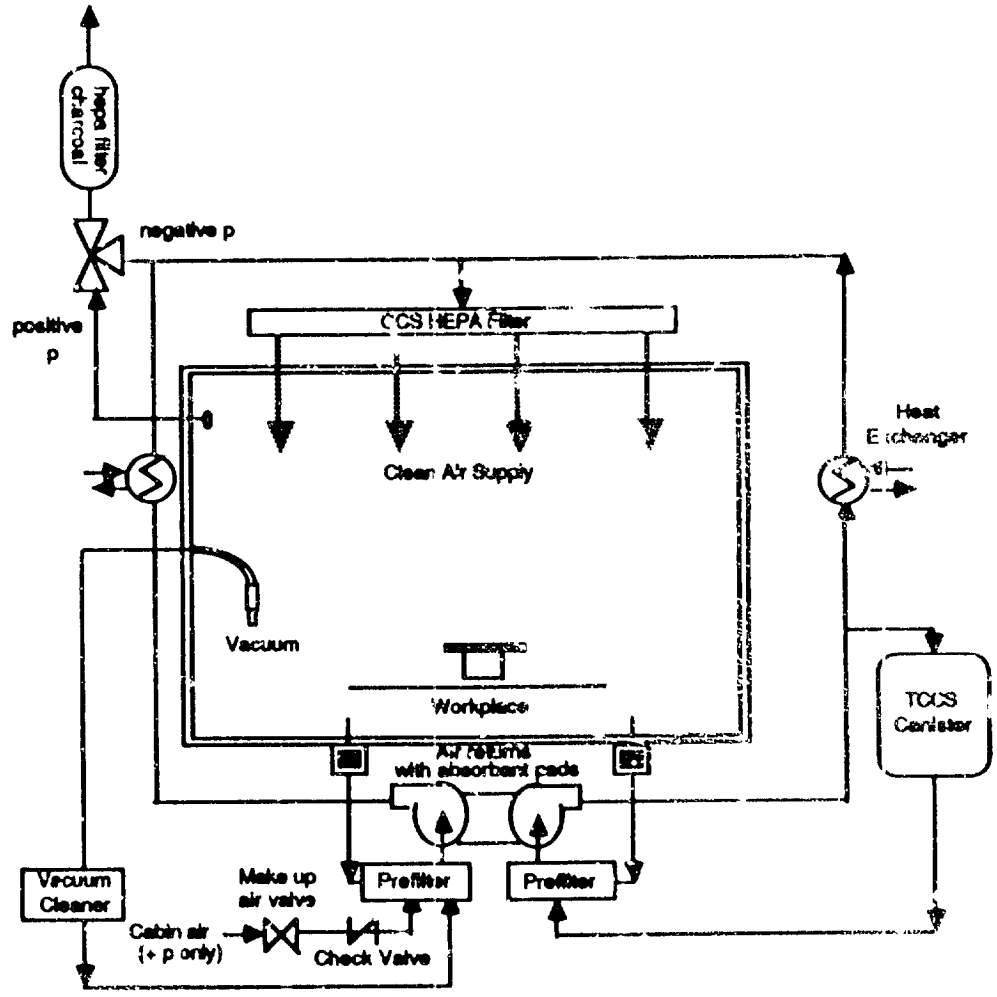
LIFE SCIENCES GLOVEBOX KEY FEATURES AND FUNCTIONS

- SUPPORT LIFE SCIENCES EXPERIMENTS IN BIOISOLATED CLEAN AREA
- ACCOMMODATES FULL CREW ANTHROPOMETRIC RANGE
- CLASS III BIOHAZARD CABINET WITH CONTAMINANT REMOVAL CAPABILITY
- TEMPERATURE CONTROLLED WORK VOLUME = 17.4 CU. FT.
- WORK SURFACE = 6 SQ. FT.
- GENERAL AND TASK LIGHTING
- ACCESS TO DMS, POWER, A/V, PMMS



LIFE SCIENCES GLOVEBOX CONTAMINATION CONTROL SYSTEM

- PROVIDES BOTH PARTICULATE AND GASEOUS CONTAMINATION CONTROL
- PROVIDES POSITIVE PRESSURE IN THE WORK VOLUME FOR ULTRACLEAN OPERATIONS
- PROVIDES NEGATIVE PRESSURE IN THE WORK VOLUME FOR CONTAMINANT PRODUCING TASKS
- PROVIDES VACUUM CLEANER FOR LOCALIZED WET/DRY PARTICULATE CONTAINMENT



CAPABILITIES

- STANDARD BED CONFIGURATION WILL ACCOMMODATE MOST CONTAMINANTS
- CUSTOMIZATION OF BED CONTENTS OPTIMIZES PERFORMANCE FOR A PARTICULAR MISSION
- COMPUTER MODEL AVAILABLE TO DETERMINE OPTIMUM BED CONFIGURATION
- POTENTIAL BED COMPONENTS:
  - ACTIVATED CARBON - MEDIUM TO HIGH MOLECULAR WEIGHT HYDROCARBONS (INCLUDING GLUTARALDEHYDE AND ETHANOL)
  - PHOSPHORIC ACID TREATED SECTION - AMMONIA
  - BASIC TREATED SECTION - ACID GASES (SUCH AS HYDROCHOLORIC AND PHOSPHO
  - CATALYST COATED SECTION - CO OXIDATION
  - SPECIAL SORBENT LAYERS - SELECTED MATERIALS SUCH AS FORMALDEHYDE
- COMPONENTS NOT EFFECTIVE FOR LOW MOLECULAR WEIGHT HYDROCARBONS AND HALOCARBONS + RADIOACTIVE COMPOUNDS WHICH FORM GASES NOT EASILY ABSORBED

SOURCE: ANIMAL AND PLANT RADIOISOTOPE EXPERIMENTS (GREEN BOOK)

- CALCIUM HOMEOSTASIS EXPERIMENT (^{47}Ca).

  - **ALTERNATIVE:** USE STABLE (NON-RADIOACTIVE) ISOTOPES, E.G., ^{40}Ca, ^{46}Ca, ^{48}Ca. COLLECT SAMPLES, FREEZE, ANALYZE BY MASS SPECTROMETER AFTER RETURN. STABLE ISOTOPES FREQUENTLY USED IN Ca STUDIES.

- CARDIOVASCULAR SYSTEM EXPERIMENT (RADIOACTIVE MICROSPHERES).

  - **ALTERNATIVE:** DETERMINE CARDIAC OUTPUT BY DYE DILUTION. WELL-ESTABLISHED, ACCURATE PROCEDURES. IF ISOTOPES REQUIRED, USE STABLE ^{58}Fe OR ^{50}Cr.

- HEMATOLOGY EXPERIMENTS (ISOTOPE NOT SPECIFIED, COUNTED WITH GAMMA COUNTER.)

  - **ALTERNATIVE:** USE STABLE ^{58}Fe, AS SPECIFIED IN EXPERIMENT. SAMPLES ANALYZED AFTER RETURN BY NEUTRON ACTIVATION.

POTENTIAL USER HAZARDOUS MATERIALS WITH PROPOSED ALTERNATIVES

SOURCE: ANIMAL AND PLANT RADIOISOTOPE EXPERIMENTS (GREEN BOOK)

- PLANT PHYSIOLOGY EXPERIMENT (UNSPECIFIED ISOTOPE, POSTFLIGHT: RADIOACTIVE COUNTING).

  - **ALTERNATIVE:** USE STABLE ISOTOPES (^{13}C, DEUTERIUM, ETC.) POSTFLIGHT: DETERMINE ISOTOPE CONCENTRATION.

- REPRODUCTION AND DEVELOPMENT EXPERIMENTS, (LABEL INFLIGHT WITH, E.G., ^{14}C-LEUCINE, ^{35}S-METHIONINE, METABOLIC PRODUCT: RADIOACTIVE $^{14}CO_2$).

  - **ALTERNATIVE:** USE STABLE ISOTOPES (^{13}C, DEUTERIUM, ETC.). POSTFLIGHT: DETERMINE ISOTOPE CONCENTRATION.

SPACE STATION

LSG - DISSECTION MICROSCOPE INSTALLATION

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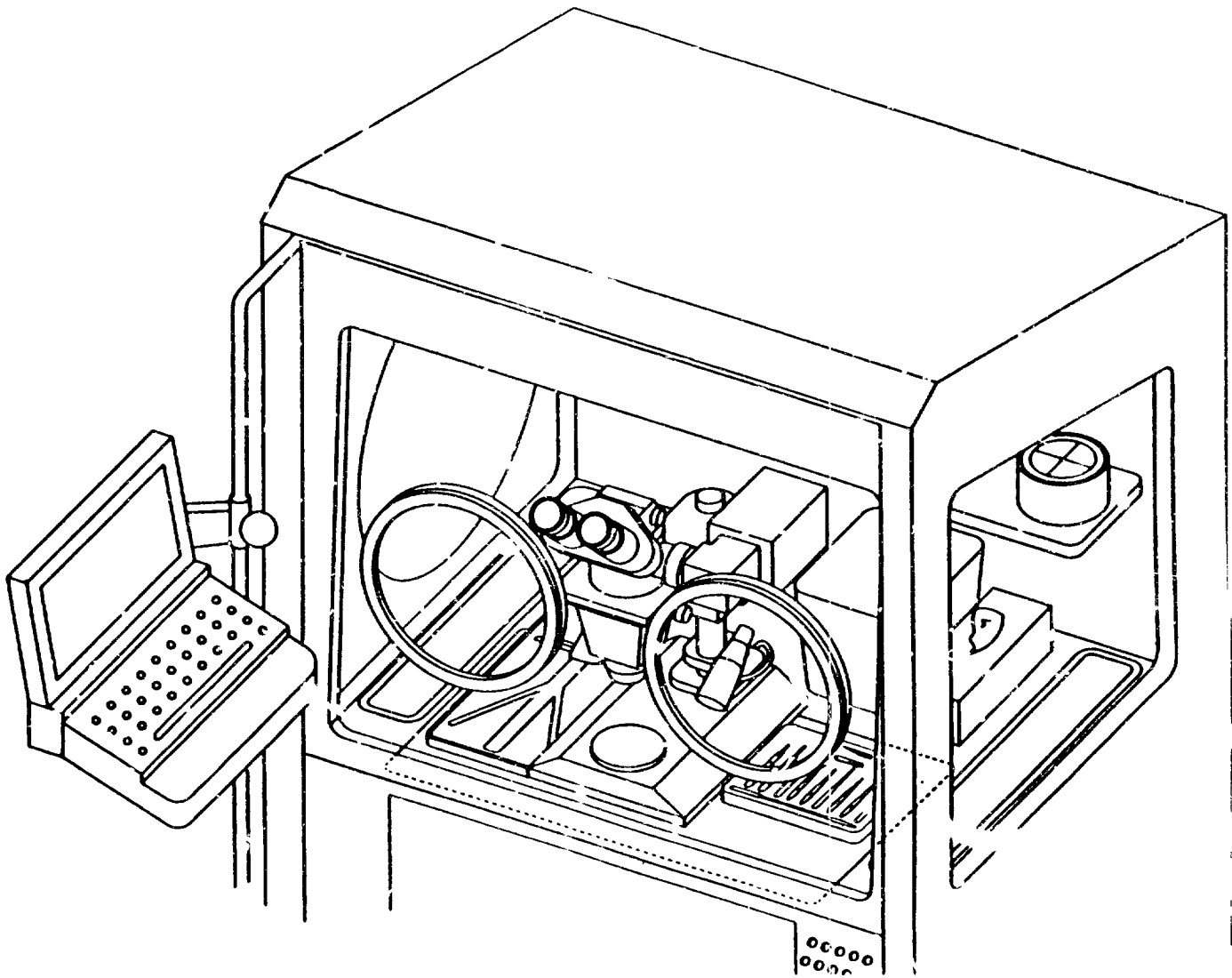

SPACE STATION

LSG - SMMD SCENARIO

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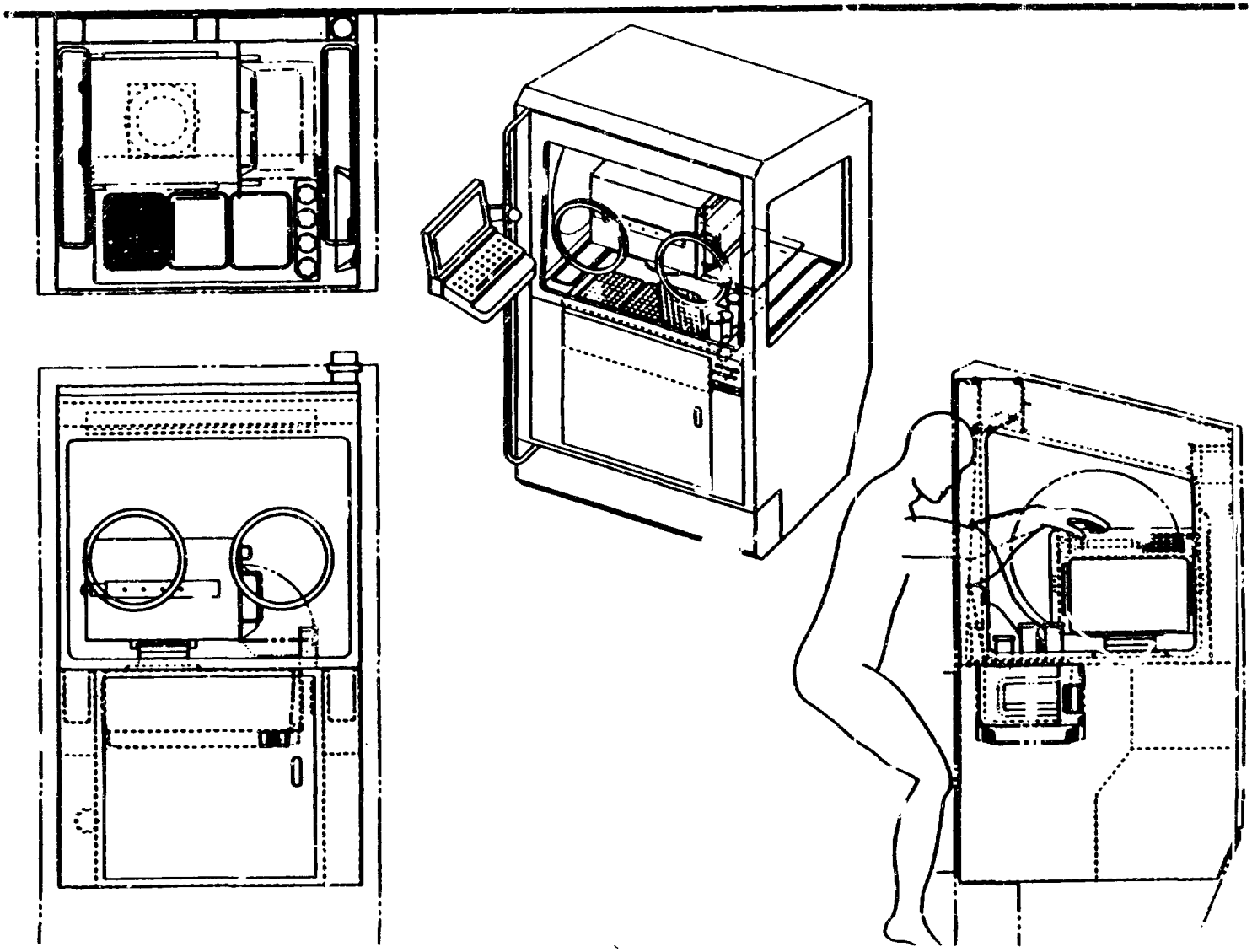

GLOVEBOXES AND WORKSTATIONS

KEY ISSUES AND CONCERNS

ISSUE:

- DEFINITION AND ACCOMMODATION OF USER NEEDS

SOLUTIONS:

- LSG ACCOMMODATION OF MODULAR HABITAT AND SUPPORT EQUIPMENT
- DEVELOPMENT OF A TYPICAL WEEK IN THE LIFE OF LSG
  - TYPICAL EXPERIMENT SCENARIOS
  - TYPE OF CONTAMINANTS AND GENERATION RATES
  - USE LMSC/MSFC COMPUTERIZED CHEMICAL LOAD MODEL

ISSUE:

- HANDLING WIDEST VARIETY OF EXPERIMENTS

SOLUTIONS:

- DESIGN FOR MAXIMUM SYSTEM FLEXIBILITY
- PREFLIGHT SCREENING AND APPROVAL OF EXPERIMENTS
- CUSTOMIZE TCCS CANISTER AND OTHER COMPONENTS BY MISSION

LIFE SCIENCES GLOVEBOX

SUMMARY

- LIFE SCIENCES GLOVEBOX PROVIDES CONTAMINATION CONTROLLED WORK ENVIRONMENT
- LIFE SCIENCES GLOVEBOX MODULAR DESIGN ALLOWS MAXIMUM SYSTEM FLEXIBILITY
- LIFE SCIENCES GLOVEBOX ACCOMMODATES WIDE RANGE OF USER REQUIREMENTS
- NEXT STEP: INTEGRATE USER INPUTS ON THE TYPES AND QUANTITIES OF CONTAMINANTS INTO THE DESIGN PROCESS
- SYSTEM DESIGN INCLUDES HERITAGE OF SPACELAB GENERAL PURPOSE WORKSTATION