OCT 26 1965

JUN 22 1965

TID-21994

TITLE 1 REPORT

MASTER

PRELIMINARY SERVICES

For

SNAP 8

FLIGHT PROTOTYPE TEST FACILITY

BUILDING 056

SANTA SUSANA, CALIFORNIA

RELEASED FOR ANNOUNCEMENT
IN NUCLEAR SCIENCE ABSTRACTS

Prepared For

U.S. ATOMIC ENERGY COMMISSION

CHICAGO OPERATIONS OFFICE

August 1964

BECHTEL CORPORATION
ENGINEERS — CONSTRUCTORS
SAN FRANCISCO LOS ANGELES

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

TITLE 1 REPORT

PRELIMINARY SERVICES

For

SNAP 8

FLIGHT PROTOTYPE TEST FACILITY

BUILDING 056

SANTA SUSANA, CALIFORNIA

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights, or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

RELEASED FOR ANNOUNCEMENT

IN NUCLEAR SCIENCE ABSTRACTS

Prepared For

U.S. ATOMIC ENERGY COMMISSION

CHICAGO OPERATIONS OFFICE

August 1964

BECHTEL CORPORATION
ENGINEERS—CONSTRUCTORS
SAN FRANCISCO LOS ANGELES

TABLE OF CONTENTS

I. INTRODUCTION AND SCOPE

- General
- Justification of Basic Need

II. SUMMARY

III. CRITERIA AND DESIGN PARAMETERS

IV. FLIGHT PROTOTYPE TEST FACILITY

- Site Development
- Architectural
- Structural
- Nuclear
- Handling and Special Equipment
- Mechanical Systems
- Electrical Systems
- Instrumentation and Control Systems

V. RELIABILITY PROGRAM PLAN

- General
- Critical Facility Systems
- Reference Documents
- Definitions
- Program Plan

VI. OUTLINE SPECIFICATIONS

- Civil
- Architectural
- Structural
- Handling and Special Equipment
- Mechanical
- Electrical
- Instrumentation

VII. ENGINEERING AND CONSTRUCTION SCHEDULE

VIII. COST ESTIMATES

IX. DRAWINGS

X. APPENDIX

Review of Soils Investigation
Corrosion Control
Methods of Calculation (Nuclear)
Evaluation of Clean Concrete

I. INTRODUCTION & SCOPE

Table of Contents

	Page No.
GENERAL	1
JUSTIFICATION OF BASIC NEED	1

INTRODUCTION & SCOPE

GENERAL

This report provides conceptual and preliminary design data consisting of narrative concepts, outline specifications, reliability procedures, schedules, and drawings. These data and concepts define a facility design that conforms to the requirements necessary to test the SNAP 8 Flight Prototype and is adaptable to testing future configurations. A preliminary cost estimate is submitted with this report under separate cover.

Conceptual designs and available information were fully utilized during the preparation of this report. In accordance with the intent of the basic contract, Bechtel Corporation has, in addition, exercised its independent technical judgement in all approaches to the basic design.

The basic design concepts have been thoroughly reviewed and analyses have been conducted to adequately define the specific areas of concern and to obtain the optimum overall approach. Design studies and evaluations have been further supplemented by actual visits to the proposed site and by a series of conferences between and among representatives of the Atomic Energy Commission, Atomics International, and Bechtel Corporation.

Acceptance of this report by the United States Atomic Energy Commission will constitute completion by Bechtel Corporation of Title I - Preliminary Services (Phase II), as defined in Modification No. 5 Supplemental Agreement to Contract Number AT(04-4)-12.

JUSTIFICATION OF BASIC NEED

The Snap 8 Flight Prototype will be tested in the facility under simulated flight conditions. Testing will include the following items.

- Startup capability
- Stability of control
- PCS and NS thermal and nuclear capabilities
- Performance
- Endurance

Endurance testing under simulated flight conditions will allow determination and correction of malfunctions and establishment of design modifications contributing to reliability of the flight article. The high cost of performing tests of this nature in actual flight makes the requirement for a preflight ground facility test program mandatory.

At present, there are no available facilities that can fill the requirement of housing the SNAP 8 Flight Configuration Prototype during a continuous 10,000-hour endurance run and capable of limiting nuclear activation to a level permitting re-entry into the vault 45 days subsequent to a test run. Facility design should also provide measures to reduce the hazards arising from the presence of NaK in the facility. A Hazards Summary Report will be issued by others.

II. SUMMARY

The SNAP 8 Flight Prototype Test Facility will be located in the Burro Flats area of North American Aviation's Field Laboratory, Santa Susana, California, on a parcel of land optioned to the Atomic Energy Commission. The facility will be designed to test the flight prototype of the SNAP 8 Electrical Generating System. Testing will evaluate the startup capability, stability of control, Power Conversion System, Nuclear System thermal and environmental compatibility, and the prototype performance and endurance. The EGS will be housed in a vacuum chamber placed in the test vault. The chamber will be connected to apparatus designed to simulate environmental conditions of orbital flight.

The facility will comprise two test vaults and other rooms housing supporting systems which will be provided to make the facility safe, operable, and reliable. Special emphasis has been placed on designing flexibility into the facility for possible future adaption to other configurations. The test vaults are rectangular structures separated by a removable shield wall. At any one time, a test may be prepared in one vault, while a SNAP 8 Flight Prototype EGS is operating in the other. The vault will be lined with aluminum fabricated from a special alloy. This liner will prevent escape of fission products resulting from a reactor accident, and facilitate decontamination of the test vault after completion of a test. The use of special aluminum is necessary to meet the re-entry criteria. The test vault floor slab and walls are constructed of reinforced special concrete. Ceiling of the vault will be made of precast interlocking concrete "logs", the removal of which will permit equipment access. Personnel access will be through two interlocking shielded doors to each test vault. Aggregate and cement will be carefully selected for the test vault with regard to elemental composition to minimize the level of nuclear activation. Embedded aluminum cooling coils will permit circulating water to absorb the heat generated by attenuation of nuclear radiation.

A system of chases and ducts will allow services (power, instrumentation, cooling, and nitrogen) to drop to the vault level and enter the vault through a series of special penetrations.

A 97 percent nitrogen atmosphere shall be provided during testing and disassembly to reduce the potential hazards of test fluids reacting with oxygen. Provisions have been included to further subdivide each test vault into two equal sections. A disassembly area, in which the operating test system may be disassembled, will be located over the test vaults. The

disassembly area crane will be arranged to service the vault area as well. A decontamination coating and attachment clips for a future steel liner will be provided. A nitrogen atmosphere will be provided during disassembly operation. A transfer lock, located in the high bay area will serve to transfer materials and equipment to the disassembly area below through a rolling hatch door. The transfer lock will also serve as a hotcell to permit reactor disassembly. The transfer lock will be lined with a coated steel plate. A bridge crane located in the transfer lock will reach the disassembly area floor. A shield window will be provided for viewing the transfer lock interior. The transfer lock will be furnished with provisions for a nitrogen atmosphere. The high bay area will be located directly over the disassembly area and equipment rooms. The building will have an insulated steel frame and sheet metal siding, mill type structure, with comfort heating and ventilation. This area will serve as a receiving, assembly, and test area. Equipment access to the disassembly area will be by means of a large opening in the high bay floor sealed with interlocking concrete logs. The mechanical, electrical, pump, and vacuum equipment rooms will contain support equipment and switchgear necessary for the operation of the facility. Equipment access will be by means of a series of in-line rectangular openings at each level. Personnel access will be by stairwells at each end of the equipment rooms and by an elevator from the high bay area to the vacuum equipment room. All rooms, except the vacuum equipment room, will be shielded to permit continuous occupancy during test.

The administration and control area will consist of a conventional, single story, concrete block structure adjacent to the high bay building. The major portion will be composed of the control room and a cable spreading area directly below and separated from the control room by a computer type raised floor system. The remainder will comprise health physics rooms, personnel offices, and related services. The area will have separate mechanical and electrical rooms, with the power, lighting, and central air conditioning services located in these rooms. The facility will be shielded to reduce the total neutron and gamma ray dose rate to a level that will permit occupancy of areas adjacent to those containing radiation sources. Occupancy will be based on shifts of 8 hours per day, 5 days per week. Special materials will be used in the test vault to reduce activation of the test vault walls, thus permitting safe re-entry (2.5 mr per hr) into the test vault 45 days after shutdown and removal of the reactor. Radioactive gas and liquid holdup systems will store radioactive fluids until they may be disposed without hazard. Separate shielded vaults will be provided outside the main building to house components of the radioactive holdup systems. In addition, filters will be located in all vault exhaust systems to trap and contain any particulate matter that may be radioactive.

An extensive system of monitors , detectors , and analyzers will monitor possible radioactivity, mercury vapor and percent oxygen in the 97 percent nitrogen atmosphere .

A service cooling water system will provide a means for heat rejection of the entire facility heat load to outdoor evaporative cooling towers .

Power distribution voltage for the facility will be 480 Y/277 volt supplied from a commercial source. Two separate distribution systems will be provided. They are the interruptible power system (interruption of power to the system will not affect the test) and the test essential distribution system, with an uninterruptible power subsystem. The test essential will have a diesel-generator stand-by power source in addition to the commercial power supply. The uninterruptible power subsystem will be supplied by direct-current drive motor-generator sets. The disassembly area will have one remotely operated, heavy duty, bridge mounted, rectilinear manipulator. To provide manipulator service in the test vault, a second manipulator bridge crane will be provided at floor level of the disassembly area. The transfer lock will have one remotely operated, bridge mounted manipulator . In addition, one standard duty and one heavy duty master slave will be provided. These manipulators will be removable and can be installed at either the end wall of the lock or the long interior wall near the view window end wall. A closed circuit television system will be provided as the primary means of viewing remote operation within the disassembly area and test vaults and as a secondary viewing system for the transfer lock. Remote handling equipment will be provided to remotely position television equipment.

A reliability program has been developed and will be conducted through the period of design and construction. The purpose of the program will be to provide an optimum reliability level with respect to facility requirements and economic limitations.

III. CRITERIA & DESIGN PARAMETERS

GENERAL

The Facility will be designed in accordance with the AEC Design Manual, Chapter 0500, Volume 6000, and codes and standards as referenced herein or listed in North American Specification Number NF 7568-90-001.

The above grade building and structure will be designed for a tenure of usage of five years and will be classified as a Group G structure as defined by the Uniform Building Code. Construction will be Type IV (incombustible throughout).

General facilities required are:

- Component receiving and storage
- Component installation and EGS assembly and checkout
- System operational demonstration
- System maintenance and disassembly
- Office, control, and personnel facilities

Remote handling equipment will be required for disassembly. Materials will be selected to minimize nuclear activation of the test vault structure and accessories.

Fencing, lighting, paved storage and access areas, utility connection and fire protection will be included as part of the general facilities.

Air conditioning, heating, and ventilation will be provided to cool the test article, provide a controlled environment for instruments in the control room, provide comfort heating and cooling for the general office areas, and heat the working areas. The direction of air flow will be controlled so that potentially radioactive air always moves from the cleaner area to the exhaust systems. Filters will be installed to intercept airborne particulate and radioactive iodine from exhausting to the atmosphere.

Other mechanical systems will include radioactive gas holdup, liquid waste holdup, cooling, compressed air and nitrogen.

Electrical criteria includes codes and standards as referenced herein and consists of power supply, distribution and backup, lighting, grounding, communications, and alarm systems. Exposure to radiation imparts additional requirements with respect to cables, test vault fixtures, and receptacles.

Biological shielding requirements for the test vault will be based on a shielded SNAP 8 reactor, seven feet from any surface. Activation and shield heating will be based on a bare reactor five feet from any surface. Cooling coils will be provided in all permanent walls, floors and ceilings. Unrestricted re-entry to the test vault by operating personnel on an 8-hour shift basis will be required 45 days after completion of 10,000 hours of continuous reactor operation.

Flexibility for future use will be given consideration throughout the design. The test vault area will be composed of modules or arrangements that are adaptable to future testing programs. Particular attention will be paid to chases used for routing mechanical and electrical runs to facilitate adding to, or revising these runs.

In the development of the preliminary design, particular attention has been given to the following key factors:

- Operational requirements in support of test objectives
- Reliability of the test facility
- Radiation Hazards and safety
- Economy of both initial construction and upkeep
- Adherence to standards
- Recognition of operational requirements imposed upon the facility operator

The resultant facility will represent an optimum combination of the key factors and support systems.

IV. FLIGHT PROTOTYPE TEST FACILITY

Table of Contents

	Page No.
SITE DEVELOPMENT	
General	1
Soils Investigation	1
Site Survey	1
Excavation	1
Finish Grading and Drainage Grading	2
Drainage	2
Paving	2
Fencing	3
Sanitary Sewer System	3
Water Systems	3
Concrete Pipe Trenches and Vault	3
Natural Gas System	4
Other Systems	4
ARCHITECTURAL	
General	5
Test Facility	5
High Bay Area	5
Administration and Control Area	6
Pump Room	8
Vacuum Equipment Room	8
Test Vault Area	9
Disassembly Area	12
Transfer Lock	14
Passenger Elevator	16
General Construction and Materials	16
STRUCTURAL	
General	18
High Bay Area	18
Transfer Lock	18

Test Vault	18
Administrative Area	20
Structural Criteria	20
NUCLEAR	
General	22
Design Criteria	22
Shielding Requirements	24
Activation of Materials	25
Shield Heat Generation	31
Nuclear Hazards	31
Protective Coatings	32
HANDLING AND SPECIAL EQUIPMENT	
General	33
Material Handling Areas	33
Viewing System	34
Material Handling Equipment	34
MECHANICAL SYSTEMS	
General	39
Environmental Control	39
Liquid and Gas Holdup Systems	44
Cooling Systems	45
Service and Instrument Compressed Air System	48
Gaseous Nitrogen Systems	48
Diesel Oil System	48
Plumbing Systems and Miscellaneous	49
ELECTRICAL SYSTEMS	
Power System	50
Lighting	52
Grounding	53
Wiring Methods and Materials	53
Corrosion Control	56
Communication	57
Closed Circuit Television System	58

INSTRUMENTATION AND CONTROL SYSTEMS

High Volume Exhaust System (HVE)	61
Low Volume Exhaust System (LVE)	62
Radioactive Gas Holdup System (RAH)	63
Liquid Waste Holdup System	64
Vault Walls and Vacuum Equipment Cooling System	64
Oxygen Content Control	65
Radioactivity Monitoring	65
Mercury Detection	68
Standby Equipment Startup	68
Standard Automatic Controls	69
Facility Control Board	69

IV. FLIGHT PROTOTYPE TEST FACILITY

SITE DEVELOPMENT

General

Proposed site for the SNAP 8 Prototype Test Facility is located in the Burro Flats area of North American Aviation Nuclear Field Laboratory, optioned to the Atomic Energy Commission, at Santa Susana, Ventura County, California, eight miles northeast of Canoga Park, California, at an elevation of approximately 1800 feet above sea level. Location of the site is shown on Atomics International drawing, Proposed Master Facilities Plan, Figure 1, Spec. NF-7568-90-001.

The proposed site has been partially developed. All necessary clearing, grubbing, and disposal of debris has been accomplished. The excavation shown on Oberg Construction Company as-built drawings will be enlarged to accommodate the SNAP 8 Flight Prototype Test Facility. All fill material within the proposed facility boundary limits has been compacted to 90 percent of maximum density (modified A.A.S.H.O. method of compaction).

Soils Investigation

The Engineer Soils Report, performed for the purpose of obtaining information concerning the subsurface soils, has been reviewed and the existing excavation visually inspected. Results of the review of this report are in the Appendix and will be used as a basis for final design. During development of the final design, geological study of the rock formation will be required to determine stability of the rock mass with regard to lateral pressures on the facility vault exterior concrete walls.

Site Survey

The current topographical survey, Figure 2, Spec. NF-7568-90-001 by Atomics International; and Oberg Construction Company as-built drawings, dated July 18, 1962 and September 11, 1962, showing existing contour lines and all man-made features including the excavation for Phase I, will be used as a basis for the balance of site development work.

Excavation

The existing excavation under Phase I of the project will be utilized to its fullest extent. The excavation is cylindrical in shape, approximately 92

feet in diameter, and 70 feet deep, with a portion excavated to an 80-foot depth.

The SNAP 8 Prototype Test Facility will require an excavation approximately twice as large as the one existing. The excavation will be extended in an easterly direction, deepened to approximately 97 feet below grade and will be rectangular in shape, approximately 140 feet long by 95 feet at the greatest width.

Area of the extended excavation is covered with 2 to 10 feet of overburden over sandstone. It is expected that the entire excavation, with the exception of the upper 5 to 15 feet, will be in hard sandstone. Excavated overburden and properly crushed sandstone may be stockpiled and used as fill material in accordance with the recommendation of the Engineers Soils Report. Excess materials will be disposed of in areas designated by the AEC.

Finish Grading and Drainage Grading

Grading will be accomplished to provide proper subgrade elevation for buildings, structures, and paved areas, and to provide suitable drainage around structures and improvements.

Drainage

Surface areas and finished areas adjoining all improvements will be sheet drained into swales and ditches.

Intercepting channels will be constructed where necessary to divert runoff away from improvements.

All drainage shall be channeled into existing drainage courses. Runoff computations will be based on a 10-year frequency storm, for a rainfall intensity of 1 inch per hour.

Paving

Paving of the entire site to designated lines and grades, including the preparation of subgrade, base course, asphalt finish, side forms, parking barriers, striping, and gravel finish surfacing will be accomplished as shown on the applicable drawings. Selected native material will be used for the subgrade and base course and will be compacted in accordance to the recommendation of the Engineers Soils Report.

All paved areas will be designed for a maximum wheel load of 16,000 pounds (H-20 Truck Loading), using the California Bearing Ratio (CBR) as a basis for design.

Fencing

A security perimeter fence will be provided and tied into the existing AEC security fencing system. In addition, fencing will be provided around the facility electrical substation and potentially hazardous areas. Vehicle and pedestrian gates will be provided. All gates will have six pin tumbler padlocks as manufactured by Best Universal Lock Co., except for any pedestrian gate in the security fencing, which will be equipped with emergency exit hardware in accordance with AI PEM No. 19.010, and will have a magnetic monitoring switch installed as shown in AI Drawing MISC-E19. This switch will be tied into the existing Santa Susana Fire Alarm and Supervisory System through a circuit, as shown on AI Drawings MISC-E10 and MISC-E11. Security fencing will be in accordance with AI Plant Engineering Specification No. 116. During construction, the facility site will remain outside of the existing SNAP security area until completion of the construction.

Sanitary Sewer System

A new gravity-flow underground sanitary sewer line will be installed and connected to the existing sanitary sewer system.

The release from the potentially contaminated liquid waste system, which also connects to the sanitary sewer system, is discussed under the mechanical and nuclear portions of this section.

Water Systems

An underground domestic water and fire protection system will be provided. The existing eight-inch water line currently terminating on the east project boundary line will be extended along the south boundary, in a westerly direction, through the site for future extension. A six-inch lateral will take off at the east end of the site and completely loop the facility to join the eight-inch water line at the southwest corner of the site. Domestic water for the facility will be provided from the lateral. Hydrants and post indicator valves will be protected against damage. The hydrants, valves, and piping will be installed according to AI Drawings MISC-P11 through MISC-P18. PIV's and shutoff valves will be suitable for padlocking by the facility operator. Hydrants will be spaced a maximum of 300 feet apart.

Concrete Pipe Trenches and Vault

Process lines and potentially contaminated waste lines between outdoor equipment facilities and the test facility will be installed in concrete trenches.

The liquid waste tanks and radioactive hold up tanks will be installed in an underground concrete vault. Particulate filters and an iodine trap will be installed in a covered pit in the northwest corner of the building.

Natural Gas System

An underground line will be extended from the existing system at the east boundary line to a pressure reducing station located adjacent to the administration building. This line services the building hot water heating boiler.

Other Systems

Lighting, grounding, fire alarm and protection system, and telephone systems are discussed in the electrical portion of this section.

ARCHITECTURAL

General

The building will be a one-story rectangular structure designed for a maximum tenure of usage of five years. It will be classified, in accordance with the Uniform Building Code, as a Group G occupancy of Type IV construction (incombustible throughout).

The building shall be located and oriented as shown on Drawing C-1. The elevation of the ground floor will provide positive drainage away from the building.

Normal occupancy of the building will be five-men on eight hour shifts, 24 hours a day, seven days a week. The day shift will have seven additional personnel, two of which will be women.

Test Facility

The prototype test facility building will be comprised of the following basic areas:

High Bay Area

Administration & Control Room Areas

Vault Mechanical & Electrical Equipment Areas

Pump Room

Vacuum Equipment Room

Test Vaults

Disassembly Area

Transfer Lock

Exterior Equipment Pads

High Bay Area

The high bay area will extend over the subsurface test vaults, auxiliary equipment areas, and transfer lock. It will include the space above the grade floor and will be enclosed by a high bay, steel-framed, mill type structure, with

insulated metal roofing and siding. A 30-ton capacity bridge crane will be installed in the high bay area to handle equipment, plugs, and hatches. The 30-ton bridge crane installation will be designed to provide maximum coverage within the high bay area and will be capable of reaching either test vault floor.

Administration and Control Area

The administration and control area (and its associated facilities) will be located south and adjacent to the high bay area and will contain the control and data acquisition areas, office areas, instrument repair room, monitoring booth, health physics room, hot change room, locker room, toilet rooms and administrative area mechanical and electrical equipment rooms.

A computer type raised flooring system will be used in the control room. The underfloor area will be used for cable spreading and auxiliary equipment. The cable spreading space will extend the full length of the disassembly area.

This support area will be enclosed by concrete block walls. Functions to be performed in each section of the administrative and control room area are:

Control and Data Acquisition Area

Will have space for control panels used for:

- Performing all tests
- Remote test operating and monitoring systems
- Radiation and mercury detector readouts
- Fire alarm systems
- Facility heating and ventilation mechanical and electrical systems

Office Areas

Will consist of administrative offices, conference room, reception and security office, and visitors lobby.

- Administrative offices will be sized for one desk, chair, and file cabinet. An area for a secretary between the NS and PCS supervisor's office will have space for desk, chair, and filing cabinet.

- Conference room will have a raised area for better visual coverage of the control room; space for a conference table and chairs will also be available.
- Reception and security area will have space for a desk, chair, and file cabinet, with an observation window facing the visitor lobby. Access to the facility will be controlled from this office.
- Visitors lobby will have space for several chairs, a small table, and a lamp.

Instrument Repair Room

Will have space for an instrument repair work bench, storage racks on shelves, and a minimum of 250 square feet working space.

Monitoring Booth

Will have space for electronic and miscellaneous monitoring equipment.

Health Physics Room

Will have space for desk, chair, filing cabinet, and for electronic and miscellaneous monitoring equipment storage.

Hot Change Room

Will have space for changing possibly contaminated garments and will contain monitoring equipment, a clothes hamper, a shower, and a lavatory.

Locker and Change Room (Cold)

Will have locker space for a minimum of 30 employees. This contaminant free area will also have showers for shift personnel.

Men's Toilet Room

Will open to the change room and hallway and will have sanitary accommodations for a maximum day shift of 10 men and 5 visitors. The women's toilet will have sanitary accommodations for two women, including a cot isolated from the other facilities.

Administration Area Equipment Rooms

Will be located at the west end of the administration wing. These two rooms will house all administrative area mechanical and electrical equipment. Access to these rooms will be from the outside.

Vault Mechanical and Electrical Equipment Area

The vault mechanical and electrical equipment area will have space for most vault facility equipment and for test mechanical and process system equipment and piping. Space between the pump room ceiling and high bay floor will be divided by a removable platform forming the vault mechanical and electrical equipment rooms. Access will be by stairways at either end, from the high bay floor above. A two-ton capacity bridge crane will be provided for transfer of equipment and to facilitate maintenance and operation.

Pump Room

A pump room will be located adjacent to the test vaults and immediately above the vacuum equipment room. This room will contain the environmental vacuum system standby and roughing pumps; the PCS seal vacuum roughing pumps; and pumps, equipment valves, piping etc., of the various test systems. Personnel access to the pump room will be by outside stairways from the vault mechanical and electrical area immediately above. These stairways will be located at each end of the pump room.

A two-ton capacity bridge crane will be provided for transfer of vacuum pumps or miscellaneous equipment.

Four, 2-foot clear diameter removable equipment plugs will be provided in the wall between the test vaults and pump room. There will be two plugs per test vault. These plugs will be used for possible future viewing of remote handling equipment furnished by the facility operator. A floor area four feet by four feet will be kept clear in the pump room at the plug locations. The plugs will be designed to maintain the pressure and leak tight integrity of the test vault.

Provisions will be incorporated in the initial design and construction for embedded material to permit future installation of a steel plate liner on all walls, floor and ceiling of the pump room.

Vacuum Equipment Room

The vacuum equipment room will be located adjacent to the test vaults. It will contain the test environmental vacuum system primary diffusion pumps and the PCS seal vacuum system diffusion pumps. Personnel access to the vacuum equipment room will be by outside stairways from the pump room and mechanical or electrical equipment rooms immediately above. The stairways will be at each end of the equipment room and will be accessible to personnel during reactor test operations. Positive locking devices shall be provided at the entrance to the equipment room to prohibit personnel access during reactor test operations.

A two-ton capacity monorail type weight handling system will be provided for transfer of vacuum pumping equipment from the access hatch.

Provisions will be incorporated in the initial design and construction for embedded materials to permit future installation of a steel plate liner on all walls, floor, and ceiling of the vacuum equipment room.

Equipment access to each level will be by removable hatches at all levels. Hatch dimensions will be adequate to permit passage of facility and auxiliary test equipment. A clear vertical lift to the high bay from the vacuum area will be provided.

Test Vault Area

The test vault area will be divided so that each of the two vaults will accommodate the SNAP 8 Flight System Test system and equipment. The two test vaults will be oriented end to end, separated by a shield wall which, when removed, will not affect the structural integrity of the facility.

Personnel Access

Personnel access to each test vault will be through a controlled access passageway from each stairwell leading to the vacuum equipment room. The passageways will be provided with shielding and shield doors leading from the stairwell to permit personnel occupancy of the stairwell during reactor operation. Access passageway to the vault containing an operating reactor will not be accessible to personnel, and a positive locking door will be provided at the entrance to this passageway to prohibit personnel access. The personnel access door to each vault will be capable of maintaining structural and leak tightness integrity of the vault. This door may be seal welded closed before start of the endurance test. Both doors will be interlocked with a monitoring system to indicate the door position. They will be of the mechanically unlocking, "quick-open" type from the vault side.

Equipment Access

Equipment access to the vaults will be from the high bay via the disassembly area. Top of the test vaults will be constructed of removable shield plugs, which will provide an opening the full width of the vault and will be long enough to make full utilization of the disassembly area bridge crane and manipulator. Design of the plugs will allow sections to be individually removed and create a vault access opening as large as required for the particular operation. In addition, the plugs will be designed to permit remote removal

and replacement, utilizing the bridge crane and manipulator in the disassembly area. A removable personnel catwalk, with safety rails to provide longitudinal access over the vault opening will be provided. The catwalk will permit access across any modular vault opening up to 40 feet.

Nuclear Containment

Each test vault will be capable of providing containment in the event of a nuclear incident. The vault will be lined on the interior surfaces with special aluminum to reduce induced activation levels and to provide a smooth surface for decontamination. The vault ceiling portion of the metal liner will be designed so that removal may be accomplished by personnel operating in the disassembly area. In addition, the design will be of a modular nature, to allow individual removal of sections to create a vault access opening as large as required for the particular operation.

Wall Cooling

All permanent (non-removable) walls, floor, and ceiling areas of the test vaults will have a cooling system. The system will, by use of embedded cooling coils, remove heat generated within the concrete from radiation attenuation.

Viewing Systems

A remotely operated TV system will observe operations within either test vault. Detailed requirements for this system are indicated in the handling equipment portion of this section.

Remote Handling Equipment

No permanent remote handling equipment will be provided within the test vault. However, by removing the ceiling access sections, each test vault will be accessible for full width, length, and depth, to remote handling equipment located within the disassembly area. In addition, special portable remote handling equipment may be provided and used by the facility operator inside the vault.

Penetrations

All penetrations through the vault shield walls and liner will be designed to maintain vault integrity and safeguards. All penetrations for mechanical and electrical facilities systems and for instrumentation and controls required

for these systems will be sized and located by the A-E as dictated by final design. In addition, an interconnecting network of chases will be provided for electrical cable and piping as may be required for test purposes.

Two rollout panels as shown on Drawings A-6 and A-8 will be provided in the shield wall between vault and vacuum equipment room for each vault. These panels will be 9 feet wide by 13 feet 6 inches high and will be used by the facility operator for installation of vacuum system lines and test equipment piping. These panels will facilitate installation of the vacuum line and other piping.

Stepped equipment plugs in the shield wall between the vault and pump room will be provided as previously described.

All inserts, sleeves, etc., penetrating the vault walls will be fabricated from special aluminum.

All penetrations into the vault for test systems and equipment will be provided with end caps, seal plates or blind flanges to maintain the leak-tightness of the test vault.

All penetrations from the vault into areas that require personnel occupancy during reactor operation will be designed to comply with the radiation levels specified for occupied areas in the Nuclear Section. Removable type shield plugs or similar precautions will be provided to insure adequate shielding if the penetrations are not utilized

Special Instructions

The following special instructions will apply to the test vault area:

- All materials within or communicating with the vault space must be compatible with, or protected from NaK, mercury, and ET-378.
- Bolts or screws that are driven by a screwdriver blade will not be used within the vault area.

Weight Handling Equipment

No permanent weight handling equipment will be provided within the test vault. However, each test vault will be accessible to the weight handling equipment located in the disassembly area. In addition, special portable weight handling equipment may be provided and used by the facility operator inside the test vaults.

Disassembly Area

A disassembly area will be provided above the test vaults. Removal of the test vault ceiling access sections will completely expose the test vaults to the disassembly area. All weight handling and remote handling equipment will be located within the disassembly area for servicing this area and both test vaults. The disassembly area will be utilized during test installation and test dismantling. No personnel will be inside the disassembly area during test dismantling operations.

Size and Configuration

The length and width of the disassembly area makes available full weight handling and remote equipment coverage for the test vaults below, for handling the access plugs to the test vaults and equipment within the test vaults. A minimum of 32 feet clear height between the disassembly area bridge crane hook and floor will be provided.

Personnel Access

Personnel access to the disassembly area will be via two shield doors communicating to the vault mechanical equipment area and located at each end of the disassembly area. A positive locking device will be provided to prohibit personnel access to the disassembly area during test dismantling.

Equipment Access

Equipment access will be from the high bay through removable access plugs. A minimum opening of 40 feet by the full width of disassembly area will be provided. Design of the plugs will be modular so that sections can be individually removed to create a disassembly area access opening as large as required for the particular operation. During test dismantling, or under emergency conditions, equipment access to the disassembly cell from the high bay will be through the transfer lock. A sliding hatch between the disassembly area and the transfer lock will provide a minimum clear opening of 12 feet by 16 feet.

Nuclear Containment

The design does not consider the operation of a reactor within the disassembly area; however provisions will be incorporated in the initial design and construction to include embedded material that would permit future installation of a steel plate liner. The design of the disassembly area and provisions for sealing all access openings and penetrations will limit leakage to less than

1 percent of the total volume for 24 hours at a differential pressure of 3 inches W.G. The disassembly area floor, walls and ceiling will be covered with carbolene, a gamma radiation resistant coating capable of repeated decontamination.

Weight Handling Equipment

The disassembly cell will be provided with a 20 ton minimum capacity bridge crane. The crane will be proof tested to ASA standards. The crane equipment will have mechanical and electrical stops to limit the travel of the bridge, trolley and hoist.

Viewing System

A remotely operated TV system will be provided to observe operations within the disassembly area. Additional information concerning this system will be found in the Handling and Special Equipment Section of this report.

Remote Handling Equipment

A heavy duty, remotely controlled bridge mounted rectilinear manipulator will be provided for use in the disassembly area. The manipulator will also provide full service to the test vaults below.

Penetrations

All penetrations through the disassembly area shield walls will be designed to comply with the radiation levels specified for occupied areas in the Nuclear Section of this report. All penetrations for mechanical and electrical facilities systems, and instrumentation and control required for these systems, will be sized and located as dictated by facility requirements. In addition, conduit, piping and other penetrations will be provided for use by the facility operators for test purposes.

Four periscope ports in the high bay floor will be provided as shown on Drawing A-2. A detail of periscope port is shown on detail sheet Drawing A-9.

Special Instructions

The following special instructions will apply to the disassembly area:

- All materials within or communicating with the disassembly cell must be compatible with, or protected from NaK, mercury and ET-378.

Transfer Lock

Transfer lock will be located in the high bay area to provide a controlled atmosphere and shielding for:

- Transfer of remote handling tools into disassembly area.
- Examination and/or packaging of disassembled parts of the test prototype (including an entire power conversion system).
- Transfer of a 10 ton shipping cask (4 feet diameter by 7 feet, 6 inches high) from the transfer lock to the high bay for shipment of radioactive materials.
- Remote maintenance of disassembly area and vault equipment.

The transfer lock will be located over the disassembly area. Clear width will be 16 feet, length shall be nominally the same width as the disassembly area, and clear height will be predicated on a lock bridge crane hook height of 15 feet, 6 inches above the lock floor, or 12 feet, 6 inches clear height to the retracted manipulator, whichever is greater.

Personnel and Equipment Access

Personnel and equipment access to the transfer lock will be provided by various plugs, doors, etc., as indicated on Drawing A-1 and A-4. Included is a shield door (8 feet wide by 13 feet high, minimum), opening to the high bay floor. The door will permit the removal of the disassembly area manipulator on a service stand. A removable lock roof access plug 12 feet diameter, and miscellaneous equipment plugs will be provided as shown on the drawings. A rolling hatch will provide access from the transfer lock to the disassembly area and will provide clearance for the disassembly area manipulator, test equipment and components. This hatch will be 12 feet wide by 16 feet long.

Radiation Shielding

The transfer lock structure and material will be shielded for direct gamma radiation. A discussion of shielding requirements is contained in the Nuclear Section of this report.

Liner

The interior of the transfer lock will be lined with steel plate and coated with carbolene, a gamma radiation resistant coating capable of repeated decontamination. The transfer lock seals will afford a leak tightness of less than 1 percent of the volume with a differential pressure of 3 inches WG for 24 hours.

Weight Handling Equipment

A full coverage bridge crane will be provided for the transfer lock. Capacity will be 5 tons and hook height will be 15 feet, 6 inches above transfer lock floor. The crane hook will reach to the disassembly area floor. Additional information on the bridge crane is contained in the Handling and Special Equipment Section of this report.

Viewing System

The transfer lock will be provided with a shielded viewing window and provisions for installation of closed circuit TV. Additional information on the viewing systems is included in the Handling and Special Equipment Section of this report.

Remote Handling Equipment

The transfer lock will be provided with a rectilinear manipulator and two master slave manipulators. Additional information on this equipment is included in Handling and Special Equipment Section of this report.

Penetrations

All penetrations through the transfer lock shield walls and liner will be designed for leak tightness and in accordance with the requirements as outlined in the Nuclear Section of this report. All penetrations for facility mechanical and electrical systems, and controls for these systems will be sized and located as dictated by facility requirements. In addition, conduit and equipment penetrations will be provided for test use by the facility operators.

Concrete Chases & Tunnel Complex

An interconnecting system of concrete chases and tunnels will be provided as a means for routing facility and test system wiring, and piping.

The lower portion of the chases opening to the test vaults will be lined with special aluminum. The material will be the same as the vault aluminum liner. The electrical chases will be sealed off from the test vault by a connector plate through which all electrical cable will penetrate. The connectors will preserve the leak tightness and will be made from aluminum to reduce induced activation.

The chases will open into tunnels which completely encircle the test facility below the vault floor slab. The chases run vertically on the exterior side of both the north and south walls for the distribution of wiring and piping to the various rooms and levels.

Passenger Elevator

A passenger elevator for the operating facility personnel will be provided. The elevator will service all five levels from the high bay floor to the vacuum equipment floor.

The capacity will be 2000 pounds with a maximum speed of 200 fpm. Automatic operation of the car and hoistway doors will be provided, including automatic self leveling controls. The car will comply with the State of California Code for Elevators.

General Construction and Materials

Vault, Transfer Lock, and High Bay

The bottom slab, floors and walls of the vault facility, and auxiliary areas below grade will be constructed of reinforced concrete with thickness as necessary to meet structural and shielding requirements.

All exterior walls below grade will be waterproofed, including chases, tunnels and vault bottom slab.

Shield doors to the vault will be concrete, lined with aluminum. All other shield doors not exposed to neutron radiation will be concrete and steel.

The transfer lock walls and ceiling will be conventional concrete with steel lined inner faces. The high bay walls will be insulated metal siding. Concrete block will be used for the common wall between the administration and high bay areas.

The roof will be 10 year rated asphalt felt and gravel over a metal decking and will be provided with vapor barrier insulation.

Doors will be flush hollow metal with a view section of wire glass. The steel rolling door will be face mounted and power operated.

Ferrous metals will receive a finish coat of paint in addition to a rust inhibitive primer. Non-ferrous metals and factory finish items will not be painted. The walls, ceiling and floor of the disassembly room and transfer lock will be painted carbolene.

Administrative Area

All floors in the support area will be as shown on Drawing A-1. The Control Room will have a raised computer type floor system to provide space for cable distribution to instruments and control panels. The computer floor adjustable jacks will be supported on a structural steel frame.

All exterior walls will be concrete block.

All interior walls will be drywall on metal studs.

Roofing will be 10 year rated asphalt felt and gravel over a metal deck and will be provided with vapor barrier insulation.

All doors will be flush hollow metal.

Ferrous metals will receive a finish coat of paint in addition to a rust inhibitive primer.

Non-ferrous metals and factory finished items will not be painted.

STRUCTURAL

General

The SNAP 8 Flight Prototype Test Building is a rectangular building comprised of four main areas with structural requirements as follows.

High Bay Area

The Enclosed area above the test vault and transfer lock will be a mill type steel frame building, consisting of steel columns, supporting tapered steel girders, purlins, and a steel insulated metal roof decking. The side wall steel girts support an insulated metal siding. A 30-ton capacity overhead traveling crane with a 5-ton auxiliary hoist will be supported from the building steel columns.

Transfer Lock

The transfer lock will be of massive reinforced concrete construction with the thickness determined by shielding requirements, and all inner surfaces of the lock will be lined with steel plate. Walls and seals will be tested to a leak tightness of less than 1 percent of the volume in 24 hours with a differential pressure of 3 inches of water. A 5-ton capacity bridge crane and a 5000-pound capacity rectilinear manipulator will be provided within the transfer lock. A remotely operated, motor-driven hatch rolling door will be provided between the transfer lock and disassembly area.

Test Vault

General

The test vault will be a massive reinforced concrete, rectangular shaped structure, with wall and slab thickness determined by structural and/or shielding requirements.

The aggregate, cement, and mix design used in the test vault bottom slab, walls and ceiling logs will be carefully controlled. The concrete will be developed from components tested to produce a concrete acceptable structurally and having good shielding and low residual activation properties. A detailed discussion of the special requirements is covered in the nuclear portion of this section. Concrete for the remainder of the structure will be conventional concrete and will also be carefully controlled.

Steel reinforcing will not be placed within 18 inches of the inner face of the test vault. Any reinforcing conduit or pipe placed within this 18 inches of concrete will be of an aluminum alloy compatible with the nuclear requirements specified in the nuclear portion of this section.

An additional requirement for the concrete is that no additives will be permitted to be used in the concrete mix, with special emphasis on the elimination of the use of chlorine or its compounds. This also applies to their use as a cleaning compound in contact with concrete and aluminum.

The vault liner shall be of a special aluminum alloy which will have a low concentration of those elements which when activated would result in excessive radiation after the 45-day decay period. These requirements are discussed in the nuclear portion of this section.

The liner will not be required to support loads nor will it be required to perform any structural function, consequently, the mechanical properties will not be in the higher structural aluminum alloy range. Nevertheless, the alloy will have good structural properties and will be required to have good welding characteristics.

The wall aluminum liner will be shop fabricated in sections, shipped to the site, and erected in incremental lifts. The liner plate will have welded stiffeners on the concrete side in two directions at modular intervals to provide plate stiffness and a means of anchoring the liner plate to the concrete. The two sides of the wall will be formed in the typical construction manner except that there will be no direct ties between the two wall forms, because the liner plate will be placed flat against the inner vault wall form and concrete poured directly against it. Tying aluminum to steel reinforcing bars will not be permitted, nor will metal to metal contact between any aluminum and steel be permitted.

One personnel door will be provided for access to each test vault. The door and its mechanism will be fabricated from special aluminum. Compression or pneumatic type seals will be installed along the door frame. During operation, seal plates will be provided and seal welded all around the door. The door will be hinged to open away from the vault so that during operation, the negative pressure will tend to seal the door more tightly. The vault door and the vault passageway door will be interlocked with a monitoring system, to indicate the door position, and will be of the "quick-open" type from the vault side.

Equipment access to the vaults will be from the high bay through the disassembly area. The top of the test vault will be constructed of removable shield plugs that will be the full width of the vault. The plugs will be of a

modular nature and will be handled by the disassembly area 20-ton crane. The plugs will be designed to support their own weight, plus equipment and live load requirements of the disassembly area. The vault structure will be designed to withstand an internal pressure of 1.0 psig and an external lateral soils pressure of 500 psf, in accordance with the recommendation of the soils investigation report, Foundation Investigation by Dames and Moore, dated March 13, 1962.

During final design, the above criteria will be reevaluated after geological study of the rock formation and recommendations are made. Hydrostatic pressure on the design of the pit walls will be neglected because a collection system will be provided around the facility and any water collected will be pumped out before it can rise an appreciable amount.

The test vault support areas, vacuum room, pump room, mechanical and electrical room, and disassembly area will be constructed of conventional concrete and steel reinforcing bars. Steel embeds will be provided on ceilings, walls and floors of the vacuum room, pump room, and disassembly area for future installation of a steel liner in these areas.

The vault will be designed for all dead and equipment loads and material handling loads, in addition to the live loads as specified in the structural design criteria. The allowable soil bearing loads will be in accordance with the recommendations of the foundation investigation report.

Two, underhung, two-ton, hand chain driven crane, single I-beam bridge, with a 2-ton electric hoist, will be provided for the mechanical and electrical rooms and the pump room and will be supported from the concrete ceilings above. A two-ton monorail system, with electric hoist and hand chain driven trolley, will be supported from the vacuum room ceiling.

Administrative Area

This area shall consist of reinforced concrete block bearing walls supported on continuous reinforced concrete footings. An asphalt felt, tar, and gravel roof on steel metal decking will be supported by light structural steel framing and pipe columns on spread footings.

Structural Criteria - Design Loads

Structures will be designed to meet the codes and standards as specified herein and listed below.

Live Loads

1. Roofs	20 psf
2. Platforms, working	100 psf
3. Platforms, access	50 psf
4. Floors	
a. High bay area	AASHO H20 - S16
Truck Loading or 30-ton
capacity fork lift or
straddle carrier
b. Disassembly Room	500
c. Electrical Platform	125
d. Mechanical Room	250
e. Pump Room	500
f. Vault & Vacuum Rm	500
Bottom Slabs	
g. Control Room	100
h. Administrative Area	100

Wind Load Wind-pressure Map Area 20, Uniform Building Code.

Seismic Zone 3 Uniform Building Code.

Snow Load None.

Soil
Pressures Allowable soil pressures shall be in accordance with
the recommendations of the Engineers Soil Report.

In addition to the above loads, concentrated equipment loads and crane wheel loads will be considered in design of the facility.

NUCLEAR

General

This section discusses nuclear design of the SNAP 8 Flight Prototype Test Facility. A brief outline of the nuclear methods of calculation used for the test facility appears in the Appendix.

Included in this section is a discussion of nuclear design criteria developed during Title I work. In addition, all biological shielding requirements are outlined for the test facility.

Neutron activation of materials is important in the design of the test facility. Materials in the test vault, having long-lived radioactive decay schemes, will hinder re-entry into a test vault 45 days after completion of a full power, 10,000-hour, test run and may affect future test programs planned for the facility.

Concrete and special aluminum alloy will be used to minimize the activation problem in the test vault, permitting safe re-entry into the test vault 45 days after completion of a test run.

Other areas of concern are shield heat generation, nuclear hazards, and protective coatings.

During Title I analysis of the shielding requirements for the various components of the radioactive waste holdup system, difficulty was encountered because of a lack of adequate source data. To perform Title II analysis on the radioactive waste holdup system, it will be necessary to obtain a detailed breakdown of the fission product inventory released to the test vault at the time of a maximum credible accident.

Design Criteria

The source data and design criteria presented in the referenced Atomic International technical specification were used in all calculations. Design criteria pertinent to the nuclear design of the SNAP 8 facility are:

- Neutron and gamma radiation source data are to be considered an isotropic point source.
- Biological shielding for the test vaults shall be provided for the case of a shielded SNAP 8 reactor, operating at 600 kw, located 7 feet from the inner face of the shield.

- Shield heat generation and activation of materials shall be based on a bare SNAP 8 reactor, operating at 600 kwt, located 5 feet away.
- All permanent (non-removable) walls, floor, and ceiling areas of the test vaults shall be provided with a cooling system capable of removing heat generated within the concrete by radiation attenuation.
- For all biological shielding, the combined neutron and gamma ray dose rate shall be less than 2.5 mr per hr at the outside surface of the shield in areas that will be occupied by personnel on an eight-hour per day, five days per week basis.
- In order to reduce activation which may result from presently unforeseen changes in test system size, configuration, or orientation, special neutron absorbing materials shall be located at all wall, ceiling, and floor surfaces in the test vault.
- For activation of materials, the design criteria are:
 - a. Personnel access shall be required 45 days after shutdown from a 10,000-hour period of reactor operation at full power.
 - b. Personnel access shall be required 5 days after shutdown from a 10-hour period of reactor operation.

In both cases, it is necessary that neutron induced radioactivity in the test vault walls, floor, ceiling, and aluminum liner be sufficiently low to permit unrestricted re-entry to the test vault by operating personnel on an 8-hour a day, 5-day a week shift basis.

During the progress of Title I design work it became necessary for Bechtel to develop additional nuclear design criteria to supplement the Atomic International technical specification. These design criteria are:

- Since there are no data available on soil or ground water activation requirements, it is assumed that a thermal neutron flux less than 10^6 neutrons per $\text{cm}^2\text{-sec.}$ causes no appreciable groundwater activation.
- For shielding design of the radioactive liquid waste and radioactive gas holdup systems, two radiation sources should be considered. The first is that the saturation activity of the noble gases released during a maximum credible accident is available for holdup in the gas storage tanks. The second is that the 15,000 curies of liquid waste consists of 30-day old fission products and will be transported to the holdup tanks by the facility operator.

- Disassembly area biological shielding will be designed for a test reactor, 30 days after shutdown from a 10,000 hour period of operation at full power, located 5 feet from the inner face of all shield surfaces.
- Transfer lock biological shielding will be designed for a test reactor, 30 days after shutdown from a 10,000 hour period of operation at full power, located 2 feet from the inner face of all shield surfaces.
- To increase the test facility flexibility, all penetrations, where practical, will be designed for a bare SNAP 8 reactor, operating at 600 kw, located 5 feet away from the opening.
- The high bay floor slab will be designed to permit the test vault to be uncovered three days after the completion of a full power 10,000 hour test run.

Shielding Requirements

Results of the shielding calculations are discussed in detail below. Concrete ($\rho = 2.32 \text{ gm/cm}^3$) is used for biological shielding.

Test Vault

The concrete wall between the test vault and the pump and vacuum equipment room, the test vault ceiling and the removable dividing wall, which are used as biological shields, will be 7 feet thick.

Side walls and floor will be 5 ft 6 in. thick to limit neutron activation of groundwater.

Disassembly Area

The concrete wall between the disassembly area and the mechanical and electrical equipment rooms, and the disassembly area ceiling, which are used as biological shields, will be 4 ft 3 in. thick.

Transfer Lock

The walls, roof, and floor of the transfer lock will be 4 ft 6 in. thick. The roof thickness may be reduced to 3 feet if it is made a restricted area when the reactor is in the transfer lock.

Penetrations

Penetrations extending from areas containing a radiation source and leading to areas where personnel access is required will be provided with a sufficient number of bends and auxiliary shielding to prevent radiation streaming.

Miscellaneous Shielding

Ceiling of the vacuum equipment room will be 3 ft 6 in. thick. A 4 foot thick concrete end cap will be placed on the electrical conduit penetrating the test vault.

The exhaust duct from the transfer lock will be encased in 3 feet of concrete to prevent radiation streaming.

The liquid waste and radioactive gas holdup tanks will be in a sub-grade vault, with a 3 foot concrete roof.

The filter cassettes for the radioactive holdup system will be encased in 6 inches of steel and placed in a sub-grade vault with a 2 foot concrete roof located at grade for ease of removal by remote methods in the event of a reactor accident.

Shield doors will provide access from the equipment rooms to the disassembly area and test vaults. The doors will be designed to prevent radiation from streaming into the equipment rooms and to maintain the leak tightness integrity of the test vaults and disassembly area.

Activation of Materials

Description

The test vault configuration is rectangular, with the concrete structural elements clad with 1/4 in. thick special aluminum plate. The activation analysis studied two combinations of the concrete and aluminum cladding.

For the first case (Case I) it was assumed that the aluminum liner plate would be backed by a layer of borated special concrete (Atoms International technical specification paragraph 3.4.1.5.3.1) which, in turn, would be backed by conventional structural concrete. The second case (Case II) assumed that the liner would be backed only by the special concrete, without any boron included in the mix.

— Case I

For the analysis of this case it was first necessary to determine two factors—the dose rate contribution from the 1/4 inch aluminum liner and the required thickness of the borated special concrete layer.

Aluminum

The activation analysis of the aluminum plate was performed using assumed concentrations of elements in the alloy and the criteria established for the 10,000 and 10-hour runs. After the dose rate had been determined with the assumed values, the concentrations were adjusted to yield a dose rate of approximately 1.5 mr per hr. The resulting elemental composition of the aluminum is as follows:

TABLE IV-1
1/4 INCH ALUMINUM PLATE

<u>Element</u>	<u>% Composition (by weight)</u>
Chromium	0.001
Iron	0.01
Cobalt	0.000002
Zinc	0.0002
Tantalum	0.000002
Copper	0.001
Nickel	0.001
Titanium	0.04
Cadmium	0.001
Tin	0.0001
Scandium	0.000001
Aluminum	Remainder

Borated and Conventional Concrete

The use of borated special concrete interposed between the neutron source and the concrete permits the use of the more economical conventional concrete to satisfy criteria for structural support and biological shielding. The thickness of the borated layer was determined by establishing the depth required to attenuate induced radioactivity in the conventional concrete to a nominal level at the aluminum surface. This thickness was found to be 16 inches. The borated special concrete and conventional concrete elemental composition used for the analysis was as follows:

TABLE IV-2
SPECIAL CONCRETE (2.0% BORON ADDED FOR CASE 1)

<u>Element</u>	<u>% Composition (by weight)</u>
Hydrogen	0.6
Oxygen	57.20
Silicon	2.46
Aluminum	0.726
Magnesium	5.33
Sodium	0.027
Potassium	0.012
Sulfur	0.23
Calcium	33.6
Iron	0.02
Copper	0.0002
Chromium	0.00003
Zinc	0.0002

<u>Element</u>	<u>% Composition (by weight)</u>
Nickel	0.0005
Cobalt	0.000002
Cadmium	0.001
Tantalum	0.000002
Scandium	0.000001

TABLE IV-3
CONVENTIONAL CONCRETE

<u>Element</u>	<u>% Composition (by weight)</u>
Hydrogen	0.56
Oxygen	49.56
Silicon	31.35
Aluminum	4.56
Calcium	8.26
Magnesium	0.24
Sodium	1.71
Potassium	1.92
Sulfur	0.12
Iron	2.00
Copper	0.005
Chromium	0.00003
Zinc	0.002

<u>Element</u>	<u>% Composition (by weight)</u>
Nickel	0.0005
Cobalt	0.000002
Cadmium	0.001
Tantalum	0.000002
Scandium	0.00001

— Case 2

Analysis of the second case, using the aluminum liner plate and monolithic special concrete with the elemental composition as shown in Tables IV-1 and IV-2, provided data for comparison with the composite section of Case 1. The values resulting from this analysis were high in comparison with borated special concrete due mainly to the contribution of the 1.1 Mev gammas from zinc and scandium (thermal reactions). Also, these data were used to determine that a 2 percent elemental boron concentration was necessary for the 16-inch borated concrete layer in Case 1.

Results

— Aluminum

Since the 1/4 in. aluminum plate is the same for both cases, only one analysis was necessary. The maximum allowable concentrations in the alloy are listed in Table IV-1. These values were predicated on the 10,000-hour criteria and satisfied the 10-hour re-entry criteria for several radiation cycles. The total dose rate contribution from the liner is nearly 1.6 mr per hr.

— Case 1

Borated and Conventional Concrete

The total dose rate of the composite section is 2.5 mr per hr at the surface of the aluminum plate. This value is the sum of the 1.6 mr per hr from the aluminum, .75 mr per hr from the borated special concrete, and .24 mr per hr from the conventional concrete. The dose rate from the borated special concrete is based on a 2.0 percent (by weight) boron concentration. The 2.0 percent value is the minimum amount required to reduce the thermal neutron flux to levels which will permit the use of the conventional structural concrete.

— Case 2

The results of the Case 2 analysis show a total dose rate of 7.85 mr per hr, with 6.25 mr per hr being contributed by the special concrete, and 1.6 mr per hr by the aluminum. As was mentioned earlier, there is a significant contribution (3.5 mr per hr) from zinc and scandium resulting from thermal reactions.

It should be noted that all of the above dose rates are the result of gamma radiation. No attempt has been made to determine the beta dose rate at the aluminum surface since its effect should be negligible.

Discussion of Results

The activation analyses were based on preliminary data in the Atomic International technical requirements or from data which was developed from information available in the technical requirements document. Results of the analyses are largely dependent on the derived neutron flux distribution and the compatible activation cross-sections. While the results are not considered to be exact, they may be assumed conservative within the limits of the original source data and yield results consistent with a Title I level of effort.

Values established in Tables IV-1, -2, and -3 for the aluminum and concrete are maximum allowable concentrations of the listed elements that will satisfy the criteria for both the 10,000 and 10-hour full power runs. For the initial investigations, the concentrations used to determine the dose rates were taken from data of actual sample compositions (developed during Phase I) known to be locally available. Any subsequent adjustments in the element concentrations were made within limits of commercial assay capability.

The tables are not intended to imply that some unlisted elements can be tolerated in any large concentrations. It is suggested that after the selection of a particular aluminum alloy or concrete aggregate that neutron activation analyses be performed to verify that dose rates will be within the tolerable levels.

It was determined that all reinforcing steel or miscellaneous steel embedded in the concrete shield must be kept 18 inches away from the inner face of the test vault shield to keep neutron activation of the steel to a minimum.

Although no effort was made to investigate other permanent items in the test vault, such articles as aluminum pipes may be subject to the bare reactor flux. If this is the case, it may be necessary to specify the same elemental composition as that required for the aluminum liner plate.

Of the two cases analyzed in this section, Case I (borated special concrete) is considerably more expensive than Case II, due to the addition of boron, as discussed in detail in the Appendix. A testing program was initiated during the Title I design phase of work to develop a special aluminum alloy and special concrete which does not contain boron. Based on preliminary results it appears feasible that a special aluminum and concrete can be developed that will meet the test vault re-entry criteria.

Shield Heat Generation

Calculations for the temperature rise in the permanent concrete shields, due to absorption of nuclear radiation, have been made to determine if cooling coils should be embedded in the concrete to keep the temperature below 150 F. Results indicate that for the case of a bare SNAP 8 reactor, operating at 600 kw, located 5 feet away from the shield cooling coils are required to cool the shield. Details of the cooling system are discussed in the Mechanical portion of this section.

Shield cooling coils are not required when the reactor is shielded and located 7 feet away from the shield.

Nuclear Hazards

As stated in paragraph 3.3.3.1 of the Atomics International Technical specification, "The safeguards analysis for the facility will be conducted by the facility operator concurrently with the design by the A-E."

Therefore, definitive safeguards design work was not performed during the Title I phase of work, however, some of the more important areas of this subject were investigated and are discussed below:

- The flow of personnel in the test facility will be, briefly, as follows, persons entering the high bay and vault spaces will do so from the locker room where they will obtain appropriate protective clothing. Under plant operating conditions, all doors to the high bay or vault area, other than those from the hot change room and locker room will be lock-closed from the outside. Persons will leave the high bay and vault spaces by proceeding to the hot showers area where they will monitor themselves for radioactivity and mercury.
- Provisions are included in the facility design to facilitate decontamination. However, no specific systems are provided to accomplish the decontamination process since they are within the scope of the facility operator.

- Clips will be embedded in the concrete walls to permit future installation of steel or aluminum liners in the vacuum equipment room and in the disassembly area.
- The possibility of contaminating the surrounding area, due to the release of argon-41 generated during test operation was investigated. It was found that the maximum concentration of argon-41 in the surrounding air is well below the 10-CFR-20 maximum permissible concentration.
- The radioactive gas and liquid holdup systems are discussed in detail in the Mechanical portion of this section and biological shielding for these systems are discussed under Shielding Requirements in this section.

Protective Coatings

A protective coating, such as Phenoline-AE 605 manufactured by the Carbolem Company, which will facilitate decontamination, will be furnished in the disassembly area and transfer lock. The possibility of also using this coating for the test vault was investigated, however, because of the neutron activation problem and, since the aluminum coating is easily decontaminated, no coating will be used in the test vault.

HANDLING AND SPECIAL EQUIPMENT

General

Material handling and viewing equipment will be considered as special equipment. Although the majority of items that are assembled to make a complete unit are standard, the use, conditions, environment and method of operation place these items in a special equipment category.

Most of this equipment will be remotely operated and will perform not only delicate and intricate operations but heavy duty operations and they will handle heavy objects.

The material handling equipment will be augmented by remote viewing equipment when operating remotely from a control console. A TV screen will be located outside the areas of operation. Since the TV camera and traverse carriage assembly are portable and normally stored outside the vault during test operation, remote handling equipment will be used to remotely install the television camera and plug into outlets located in the walls of the vault and disassembly areas.

Material Handling Areas

Test Vault and Disassembly Area

Permanent remote handling equipment will not be provided in the test vault, however, the test vault space will be accessible the full length, width, and depth to the material handling equipment located in the disassembly area directly above the test vault.

The disassembly area will be provided with one 20-ton capacity, top riding, bridge crane and one remotely operated, heavy duty, bridge mounted, rectilinear manipulator. To provide manipulator service in the test vault, a second manipulator bridge crane will be provided at floor level of the disassembly area.

Transfer Lock

The transfer lock will be provided with one five-ton capacity, top riding, bridge crane and one remotely operated, bridge mounted manipulator. In addition, one standard duty and one heavy duty master slave will be provided. These manipulators will be removable and can be installed at either the end wall of the lock or the long interior wall near the view window end wall.

High Bay Area

The high bay area will be provided with a 30-ton capacity, top riding, double box girder, bridge crane and will be equipped with an auxiliary hoist of five-ton capacity. The heavy hook will be used for the heavier loads, such as removal and replacement of the ceiling logs and heavy equipment. The smaller hook will be used for the lighter loads and will have a hoisting speed of twice the speed of the heavy hook. Since the majority of loads lifted will be less than 5 tons, the smaller hook will be used to a greater degree due to its faster maximum speed.

Viewing System

The disassembly area and test vault will have positioning equipment to remotely position the TV cameras. The equipment will comprise a portable electric driven traverse carriage on which the TV cameras are mounted, horizontal wall mounted tracks, and TV electrical components. The camera and electrical units are discussed in the Electrical portion of this section.

The transfer lock will be provided with a track and connector plugs only, for use with TV equipment now in use in other AEC facilities on the site. The transfer lock will also be provided with a viewing window at the east end wall for direct viewing into the lock. A high density glass will be installed with a thickness equivalent to the end wall concrete thickness for biological shielding.

Provisions will be made for periscope viewing devices in the transfer lock from the high bay area, disassembly area from the high bay area, and test vault from the pump room area. These openings will have concrete shield plugs and sealed tight until the facility operator inserts a periscope to view objects on the far side of the walls or floor.

Material Handling Equipment

High Bay 30-Ton Crane

The high bay crane will be a four-motor, double box girder, bridge crane spanning the full width of the building with hook coverage over the entire high bay area. The main 30-ton hoist and 5-ton auxiliary hoist will have a hook travel from the vault floor to a point 40 feet above the high bay floor, a total travel of approximately 132 feet. The 30-ton hook will be used to lift all the heavier loads, such as the access logs of the disassembly and vault areas as well as the heavier equipment loads.

The 5-ton hook will be used for the lighter loads and will have a maximum speed of approximately 30 fpm, double the speed of the 30-ton hook. All motions of the crane will be five-step variable speed, and will be controlled from the high bay floor anywhere along the bridge by a pushbutton pendant.

Both hooks will have access to the various equipment levels, the vault, the disassembly area and the top of transfer lock.

Limit switches will be provided to limit travel of hoists, trolley, and bridge. The hoist hooks will be of the safety gate type. All electrical conductors will conform to the California Electrical Code and General Industrial safety orders. A footwalk will be provided spanning the bridge length on the bridge motor drive side.

Disassembly Area 20-Ton Crane

The disassembly area crane will be a 20-ton capacity, double I beam, three-motor crane, with a span of approximately 36 feet - 6 inches. The hook will clear 32 feet above the disassembly floor and will be capable of reaching the vault floor for a total vertical hook travel of approximately 80 feet. This crane will be five-step variable speed and will be controlled from either a pushbutton pendant located on the crane or from the portable control console, which can be located inside or outside the disassembly area. The trolley and bridge will be provided with instrumentation for remote location positioning when operating from the control console.

Disassembly Area Rectilinear Manipulator

Directly below the 20-ton crane, one 5000-pound capacity, heavy duty, rectilinear manipulator mounted on a bridge crane, will be provided. This manipulator will be capable of servicing the entire disassembly room. The shoulder hook will retract and clear a point 21 feet above the disassembly area floor. The equipment will clear the 32-foot mark to pass under the 20-ton crane. The number of arm motions shall be a minimum of five. The manipulator will be operated from a control console.

To service the test vault below, a second traveling bridge rail will be provided at floor level in the disassembly room. The manipulator will service all four walls and floor of the test vault.

The arm and trolley assembly, consisting of the bridge riding trolley, telescoping tube system, and mechanical arm, will be designed to allow remote removal and replacement of the assembly by vertical movement onto and off the bridges. Actuation will be by overhead cranes viewed by the closed circuit television system.

A dolly will be provided on which the manipulator and trolley assembly can be moved and stored. This unit will be used to move the equipment in and out of the disassembly area and the transfer lock.

Transfer Lock 5-Ton Crane

The transfer lock crane will be a 5-ton capacity, 3-motor, double I beam, top riding, bridge crane, with a span of approximately 18 feet. The hook will clear a height of 16 feet and will reach the disassembly area floor for a total hook travel of approximately 60 feet. This crane will be equipped with position transmitters for generating signals to indicators located on the transfer lock control console. The crane will also be controlled from a pushbutton station located outside the transfer lock door.

This crane will be used for remote removal and replacement of the disassembly manipulator onto and off the bridge crane or special dolly for removal from the area through the transfer lock.

Transfer Lock Rectilinear Manipulator

A rectilinear manipulator riding on the same runway track as the crane will also be provided. The lifting capacity will be 5000 pounds at the shoulder hook. The shoulder upper arm pivot will extend to within 24 inches of the transfer lock floor and retract to an upper position of 12 feet 6 inches above the floor. The number of arm motions will be a minimum of five.

Instrumentation will be provided on the console to indicate all movements of the bridge, trolley, and mechanical shoulder arm for remote operation of not only the manipulator but also of the 5-ton crane. This manipulator assembly will be remotely removable and replaceable by vertical movement onto and off the bridge by means of the high bay overhead crane. To accomplish this operation, the transfer lock ceiling plug must be removed during the operation.

Equipment Room Cranes and Monorail

A two-ton capacity, single I beam, underhung, one motor, chain-driven crane will be provided in the electrical room and pump rooms. The hoist in each room will have a 4000-pound capacity, with a total vertical lift of approximately 38 feet for the electrical room hoist and 18 feet for the pump room hoist. Each crane will have a hand chain geared trolley bridge movement. The hoist will have a push type trolley. The hoist will have two speeds, floor controlled from a pushbutton pendant suspended from the hoist.

The vacuum room will have a 2-ton capacity monorail system. The rail will be a standard I beam and the hoist will have a capacity of 4000-pounds, having a geared hand chain trolley for motion on the monorail. The hoist will be two-speed, floor controlled from a pushbutton pendant suspended from the hoist.

Master Slave Manipulator

Two master slave manipulators will be provided, one standard duty and one heavy duty. The mounting will be made such that the manipulators are interchangeable in the steel tube embedded in the transfer lock walls. Shielding and air flow restrictions will be provided and the manipulator will be designed to maintain the pressure and leak tightness of the transfer lock.

The manipulator will have slave end motions in the X, Y, and Z directions, and will be equipped with motion locks. Remotely interchangeable tongs and load hooks as well as changing fixtures will be provided. The manipulator will be capable of being installed and removed from the operating side of the shielded wall. The slave ends of the manipulators will be provided with booting to completely seal the in cell equipment.

Television Camera Traverse Equipment

The disassembly area and test vault television traverse equipment will consist of, but shall not be limited to, the following components:

- Motorized carriage
- Horizontal wall tracks
- Cabling
- Carriage electrical components
- Remote plugs

Ten complete systems, consisting of traverse carriages, cabling, and remote plugs will be provided.

The motorized carriages will be equipped with motorized units for horizontal motion on the wall mounted tracks and vertical motion of the camera support on the carriage.

Horizontal wall rails will be provided on all four walls of the disassembly area and test vaults. Three rails will be provided on each wall for maximum flexibility in viewing within the designated areas. The system will be designed to operate on two tracks at any one time and can be remotely raised or lowered onto the third track as desired. The traverse system will be provided with limit switches to limit travel in the horizontal and vertical direction.

Cabling will be flexible and will terminate in special remote plug as specified by AI and as now in use in other facilities on the site.

The television and electrical components are discussed in the Electrical portion of this section.

Transfer Lock Radiation Shielding Window

The transfer lock radiation shielding window will allow viewing of various operations inside the transfer lock. Equipment to be furnished will include one shield glass window, all the metal shielding slabs fitted thereto, the window housing, gaskets, liquid fill, expansion tanks, and wall sleeve to comprise a complete unit for installation in a shield wall.

The window will be of the oil filled laminated dense glass type and may have glasses with different densities and a cover glass on each face of the assembled window. The cover glass on the hot side will be of the non-browning tempered type.

The window design, type of glass used, type of oil or liquid filling, and expansion system will be such that the window in service will have a maximum of trouble free usefulness and light transmission and a minimum of browning due to radiation, reflection and clouding or fogging tendency.

The window depth may be less than the wall thickness with the cold side approximately flush with the wall and recessed on the hot side with the wall opening bevelled.

MECHANICAL SYSTEMS

General

The mechanical systems will provide heating, ventilation, cooling, air conditioning, waste disposal and holdup, cooling water, and purge systems. Provisions will be incorporated to analyze, store, and dispose of potentially radioactive gas, liquid, and particulate matter.

All utilities will be provided and consist of compressed air, gaseous nitrogen, diesel fuel, natural gas, domestic water, and plumbing.

Environmental Control

Air Conditioning

The following areas will be provided with year-round air conditioning:

- Control Room, including the adjoining instrument repair room and health physics room (air conditioning unit AC-1).
- Office Area, consisting of conference room, lobby, reception room and security office, three private office rooms, corridor and secretary's corner (AC-2).
- Transfer Lock (AC-4)
- Disassembly Area (AC-5)
- Test Vaults (AC-6A, 6B, 7A, 7B)
- Vacuum Equipment Room (AC-8)

With the exception of the vacuum equipment room system AC-8, all of the above systems will be capable of maintaining a temperature of 75 degrees $\pm$ 2 degrees F, with outside design temperatures of 105 degrees F.D.B. and 72 degrees W.B. in summer and 30 degrees F.D.B. in winter. Temperature of the vacuum equipment room will not exceed 115 degrees F.

Relative humidity will not exceed 50 percent and will be maintained at 45 ± 5 percent in the control room.

1. Control room supply unit AC-1 will consist of a packaged air handling unit comprising filters, water-sprayed direct expansion cooling coil, hot water preheat and reheat coils, fan, and a water-cooled condenser-compressor unit. The unit will be installed in the mechanical equipment room of the administration building.
2. Office area supply unit AC-2 will be a multizone unit with filters, direct expansion cooling coil, hot water heating coil, and mixing damper section. The unit will provide mixtures of cold and hot air to each of the three zones. Cooling will be provided by a factory packaged condenser-compressor unit. The assembly will be installed in the adjoining mechanical equipment room.
3. Transfer lock supply unit AC-4 will be a package unit consisting of a fan, a direct expansion cooling coil, and a condenser-compressor unit, mounted in an adjoining space in the high bay area. This unit will be capable of functioning under two separate operating conditions.
 - Comfort Control. While the transfer lock is occupied by facility personnel, the supply unit will maintain comfort conditions and supply filtered outside air for ventilation. The outside air will be ducted to the mixing box. A preheat coil will temper the air when required.
 - Temperature Control. While the transfer lock is being used under conditions of 3 percent oxygen atmosphere, the unit will, by recirculation, maintain a temperature below 100 degrees F. The fresh air duct will be closed by a remote operated valve.
4. Disassembly area unit AC-5 will be similar to AC-4. Installation will be in the vault mechanical equipment room.
5. Test vault supply units AC-6A, AC-6B, AC-7A, and AC-7B will be utilized to air condition or cool the test vaults and are operated similarly to AC-4. One unit, with a standby, is utilized for each vault. For safety, maintenance, and optimum length of ducts, all four units will be installed in the pump room.
6. Vacuum equipment room air handling unit AC-8 will maintain the vacuum equipment room below 100 degrees upon cessation of the ventilation system. The service cooling water system will provide 85 degree water to the cooling coil. A fresh air duct with filters, hot water coil, and remote operated shutoff valve will be connected to the supply unit. For maintenance accessibility, the unit will be installed in the pump room.

7. Balancing. Air flow rates in the supply and exhaust systems of the control room and office areas will be balanced for positive pressurization with respect to atmosphere.

All other air conditioned areas (transfer lock, disassembly area, test vaults, and vacuum equipment room) will be maintained by exhaust dampers at a negative pressure with respect to atmosphere.

Heating

1. General. The following areas will be heated by means of hot water convectors:

- Toilet Rooms
- Air Lock
- Locker Room
- Hot Change Room

The convector units will be equipped with manual temperature control valves. An air temperature of 75 degrees F will be maintained.

2. Hot Water System. Hot water will be circulated through the convectors and hot water heating coils. Hot water will be supplied by a package type, FIA approved, gas-fired boiler installed in the administration building mechanical equipment room. A hot water circulation pump, with a standby, will circulate the water.

Ventilating

The following areas shall be provided with a supply of filtered outside air.

- Cable spreading area (Supply Fan S-1)
- Administrative electrical equipment room (S-3)
- Administrative mechanical equipment room (S-4)
- Vault electrical and mechanical equipment room, pump room, and vacuum equipment room (S-5)

Air will be supplied to maintain the temperature below 115 degrees F under the most adverse probable combination of conditions.

1. The cable spreading area supply unit S-1 will act as standby during operation of instrument rack exhaust E-5. Unit S-1 will be installed suspended from the ceiling of the cable spreading area.
2. The administrative electrical and mechanical rooms, supply units S-3 and S-4 will be installed in the space served. Exhaust will be through the roof-mounted gravity exhausters.
3. The supply unit S-5 serving the vault electrical and mechanical equipment rooms, pump room, and vacuum equipment room will be installed on one end of the high bay area. The supply duct will incorporate provisions for remote-manual isolation of the vacuum equipment room from the system.

Heating and Ventilating

The high bay area will be equipped with two air supply units consisting of filters, and hot water heating coils and fans, installed within the high bay area. The air flow rate will be determined on the basis of 10 degrees F maximum temperature rise in summer, or 25 fpm minimum air velocity through open equipment hatches between the high bay area and the disassembly area, whichever is greater. The hot water coils will maintain a temperature of 60 degrees F in the space with winter design conditions.

Exhaust

The following areas will be provided with positive means of exhausting the required quantities of air:

- Cable spreading area (Exhaust Fan E-1)
- High bay, vault electrical and mechanical equipment room, pump room, vacuum equipment room, transfer lock, disassembly area, and test vaults (through the High Volume Exhaust system, which utilizes fans E-2A, B, and C)
- Transfer lock, disassembly area, test vaults, vacuum equipment room, (through the Low Volume Exhaust system, which utilizes blowers E-3A and B)
- Toilet rooms and janitor's closet in the administration building (Exhaust fan E-4)

- Instrument racks in the control room (Exhaust Fans E-5A and B)
 - Locker room and hot change room (Exhaust Fan E-6)
1. Cable spreading area exhaust fan E-1 will be sized to provide temperatures below 115 degrees F under all conditions.
 2. High volume (HVE) and low volume (LVE) exhaust Systems. The HVE and LVE systems exhaust the disassembly area, transfer lock vaults, and vacuum rooms. In addition, the HVE system will exhaust the pump room and the mechanical and electrical room. Air flow will be toward the area of greatest potential radioactive hazard. When all hatches are closed, the LVE will maintain negative pressure in the areas, which will become increasingly negative in the areas with the greatest potential hazard, (i.e., high bay area at 1/8 in. w.g., vault mechanical and electrical room at 1/4 in. w.g., disassembly area at 3/8 in. w.g., pump room at 3/8 in. w.g., transfer lock at 1/2 in. w.g., vacuum equipment room at 1/2 in. w.g., and test vaults at 5/8 in. w.g.). Pressures will be maintained with differential pressure controllers operating volume dampers.

When hatches are opened between areas, the quantity necessary to maintain the desired direction and velocity of air flow is above the capacity of the low volume exhaust system. The additional capacity will be met by the high volume exhaust system and by manual remote shutoff valves. The HVE valves will be remote manually opened, thus providing the proper air flows for the particular area.

The low volume exhaust system will have two blowers, B-3A and B, and filter assembly sets with both pre-filters and high efficiency absolute filters on each room or area exhaust. All air will be filtered before passing to atmosphere. One blower will act as standby. The low volume exhaust system will also be used to exhaust the mixture in the vault complex during the nitrogen purge cycle.

The high volume exhaust system will have three fans, E-2A, B, and C, and filters F-1A, B, and C, with any two capable of exhausting and filtering the full capacity of the system. Headers with shutoff valves will be provided to permit diversion of air from any filter set to any fan inlet. Each filter set shall include both pre-filters and high efficiency absolute filters. All air before passing to atmosphere, will be filtered. One fan shall act as standby.

Upon a signal from the radiation detectors indicating an abnormal level of radioactivity, the LVE and HVE ducts to the suspected area will be automatically closed.

3. The toilet rooms and janitor's closet exhaust fan E-4 will be mounted on the roof of the administration building.

It will be sized for 12 air changes per hour, or to maintain a temperature difference between the rooms and the air conditioned space not greater than 20 degrees F. Air will be taken from the corridor.

4. The instrument rack exhaust fans E-5A and E-5B will maintain less than a 30 degrees F temperature rise in the cooling air across the instrument racks. The instrument cabinets and panels will be connected with flexible ducts to the underfloor exhaust ductwork, with the fans ceiling-suspended in the cable spreading room below. One fan (E-5A) will blow air directly into the exhaust duct leading to the outside; the other (E-5B) will deliver air to the cable spreading room serving as the ventilation unit. If fan E-5B is inoperative, Unit S-1 will start.
5. The lockers and hot change rooms exhaust fan E-6 will be roof-mounted on the administration building, and will maintain identical temperature differentials as in the toilet room. The air will flow from the corridor into the locker room, into the hot change room, and then exhausted.

Liquid and Gas Holdup Systems

Radioactive Gas Holdup System

The following areas will be connected to the radioactive gas holdup system (RAH):

- Transfer Lock
- Disassembly Area
- Test Vaults
- Vacuum System Outgassing Line

The radioactive gas holdup system will be designed to operate whenever the exhaust radiation sensors detect an abnormal level of radioactivity. Each connection will have a high efficiency absolute filter and an activated charcoal

filter (iodine trap). Upstream of the filter elements will be a normally closed valve opened by a signal from its radiation sensor. All connections will enter a common header that will go to the suction side of the gas compressors. There will be two equal capacity compressors, GC-1A and B, one acting as a standby. One compressor will start automatically upon receiving a signal from any exhaust radiation detector to maintain a constant suction pressure. A compressor bypass will be installed with a suction pressure regulating valve. The compressor discharge will be piped to two gas holdup tanks, T-1A and B, piped in parallel. The gas outlet from the tanks to the stack will be regulated to provide the required dilution.

Retention capacity of the high efficiency and charcoal filters will be determined by the quantity of particulate matter and iodine released during the maximum credible accident. The gas compressors will compress the in-leakage, vault complex nitrogen instrument exhaust, and will have additional capacity available to maintain a negative pressure of approximately 1/2 in. W.G. with respect to the surrounding building areas. The holdup tanks will hold 45 days of pumping.

The gas compressors and the holdup tanks will be located in an underground concrete vault outside of the facility main area.

Liquid Waste Holdup System

Contaminated or potentially contaminated liquid waste will be collected into two holdup tanks located in an underground concrete vault with the gas holdup tanks.

The tanks will store 15,000 gallons from the facility operator's systems, plus approximately a 15 day discharge from the hot change room shower and wash sink, high bay area floor drains, outside emergency showers and eye wash units, and vault mechanical equipment room floor drains. A collection sump with a vertical pump, P-6, will be located in the vault mechanical equipment room. The tanks will have flange mounted vertical pumps, P-7A and B, located on top of tanks. The effluent may either discharge into the sanitary sewer or into trucks. The tank will be vented through the dispersion stack.

Cooling Systems

Vault Wall and Vacuum Equipment Cooling System

The vault wall and vacuum equipment cooling system will be a closed system circulating demineralized water. Demineralized water will be circulated by pumps P-2A and B and will reject heat to the service cooling water through

heat exchangers HE-2A and B. A side stream through mixed bed demineralizers DM-1 and 2 will remove dissolved or ionized solids in the water, which would tend to become radioactive when circulated through areas of nuclear radiation. To allow for thermal expansion of the water and pressurization of the system, an expansion tank will be connected to each pump suction.

Two shielded areas within the mechanical and electrical room will protect operating and maintenance personnel from radioactivity created by this system during vehicle testing. Each shielded area will contain a pump, demineralizer, heat exchanger, expansion tank, valves, and interconnecting piping for operation as one unit. One unit will serve as a standby. Conventional concrete will be used for shielding each unit, with shield doors allowing access to the components. In addition, a shadow shield will be located between the demineralizers and the remainder of the unit equipment to allow maintenance.

Pump P-8 and storage tank T-3 will be located on grade to provide makeup water to the cooling system.

Corrosion resistant materials, such as aluminum and stainless steel, will be used for all surfaces wetted by the demineralized water.

1. Cooling Required. The vault wall and vacuum equipment cooling system will absorb the heat rejected from the following areas and equipment:

- Floor and permanent concrete walls of the test vaults.
- Environmental vacuum diffusion pumps DP-1 through DP-10 and DP-12 through DP-21.
- Seal vacuum diffusion pumps SDP-1 through SDP-8.
- Seal vacuum roughing pumps SVPR-1 through SVPR-4.

In addition, future provisions will be made for absorbing the thermal radiation from a bare reactor.

2. Cooling Coils. Vault wall and floor cooling coils will be fabricated of a special aluminum alloy formulated to reduce the quantity of elements that become activated by nuclear radiation.

The cooling coils embedded in the floor and walls of the test vaults will be sized, spaced, and arranged in a manner to insure maximum local temperatures in the concrete, due to the internal heat generation caused by neutron and gamma radiation of the bare reactor at 5 foot distance, do not exceed 160 degrees F at any point in the concrete mass.

Vacuum Chamber Jacket and Reactor Shield Cooling System

The system will be a kerosene circulating system furnished and installed by the facility operator. The equipment will consist of evaporative coolers, CT-1A, B, and C, circulating pumps, P-5A, B, and C, standby heat exchanger, HE-1, piping instrumentation, and accessories.

Piping connections will be provided from the service cooling water system to the standby heat exchanger, HE-1, sized for 80 gpm of water at 85 degrees F.

Service Cooling Water System

1. General. The system will consist of three cooling towers, CT-2A, B, and C, manifolded to three pumps, P-3A, B, and C. Each tower and pump will be sized for 50 percent of the total system requirements. The towers will be provided with water treatment, and be located on concrete pads in the yard area. The pumps will be located adjacent to the cooling towers.
2. Cooling Required. The service cooling water system will absorb the heat rejected by the following equipment:
 - Package Air Conditioning Units - Refrigerant Condensers within AC-1, 2, 4 to 7.
 - AC-8 Cooling Coil.
 - Air and gas compressors aftercoolers, C-1 and 2, GC-1A and B.
 - Heat Exchangers, vault wall and vacuum equipment HE-2A and B, and vacuum chamber jacket and reactor shield cooling systems HE-1.
 - Vacuum diffusion pumps DP-11 and DP-22.
 - Vacuum roughing pumps VPR-1 through VPR-6.
 - LN₂ loop vacuum roughing pump SVPR-5.
 - Mercury vacuum system roughing pumps SVPR-6.

The cooling capacity of the system will be determined on the basis of simultaneous operation of AC-1, 2, 4 to 8, C-1 and GC-1A plus 1200 kw as required by the facility operator for process cooling and future additions.

Service and Instrument Compressed Air System

A compressed air system will be provided for instrument and plant service air and will consist of two air cooled compressors, receivers, water-cooled aftercoolers, piping, and accessories.

Receivers will connect to a common header, which shall then feed both the instrument air line and the service air line. One compressor will be connected to the test essential bus. The service air line will be equipped with a back pressure regulator to maintain a minimum pressure in the instrument header. The instrument air line will have a dual desiccant type dryer and a connection from the gaseous nitrogen system. A pressure regulating valve will permit nitrogen to enter the instrument air system should line pressure fall below a predetermined level.

Gaseous Nitrogen Systems

The gaseous nitrogen system will consist of a vacuum insulated storage tank and a vaporizer unit. Output pressure will be 100 psig, and the nitrogen will be used for;

- Inflatable Seals
- Instrument Air Backup
- Establishing and maintaining environmental conditions within the test vaults, disassembly area, transfer lock and vacuum chambers.

The unit will be installed on an equipment pad on grade adjacent to the High Bay area.

The liquid nitrogen system, used for the diffusion pump cold traps, will be installed by the facility operator.

The storage capacity will permit purging of one test vault and the transfer lock without the addition of liquid. Vaporizing capacity will permit purging of the disassembly area within 48 hours.

Diesel Oil System

The diesel oil system will provide underground storage of diesel oil and transfer piping to the emergency power generators. The storage tank will contain oil for two days of continuous operation.

Plumbing Systems and Miscellaneous

The plumbing system will comprise:

- Domestic water system, connected to the existing main will provide cold water to the administration building and makeup water for the hot water boiler, and cooling towers.
- Natural gas, connected to the existing natural gas main, will provide gas for the boiler and domestic water heater.
- Sanitary sewer, connected to the existing sewer line.

ELECTRICAL SYSTEMS

Power System

The power system consists of the facility power center, test essential and interruptible switchgear, uninterruptible power supply, emergency power system, and power and lighting distribution equipment. Figure IV-1 depicts the interconnection of the various components and subsystems.

General

Primary power for the facility will be supplied from an existing 4160-volt, 3-phase, overhead distribution system. Two outdoor transformers will be provided to transform 4160 volts to the 480/277-volt, 3-phase, 4-wire, 60-cycle, building distribution voltage. An available short circuit of 120,000 at the 4160-volt side of the Southern California Edison Company, Burro Flat substation that feeds the area distribution system will be used as the basis for determining the interrupting rating of all circuit protection devices.

Facility Power Center

The facility power center will consist of two outdoor type, liquid-filled, self-cooled transformers, each close-coupled to an incoming line section, containing a fused load-interrupter switch. A throat connection will be furnished on the low voltage side of each transformer to a connection point on the Test Essential and Interruptible switchgear.

Test Essential and Interruptible Power Switchgear

The test essential and interruptible power switchgear will consist of outdoor, low voltage, metal enclosed, dead front, and dead rear assembly containing a main circuit breaker, generator bus circuit breaker, metering section, and branch molded case circuit breakers to distribute power to the various electrical loads. Not less than 25 percent spare space and bus capacity will be furnished in each switchboard.

Test Essential Switchgear

The test essential switchgear distributes power to the electrical loads that, during a test, can be interrupted only momentarily without affecting the test.

POWER SYSTEM BLOCK DIAGRAM

LEGEND

———— PRIMARY PATH ———

----- SECONDARY PATH -----

NOTE: DOUBLE LINES
INDICATE REDUNDANCY

FIGURE IV-1

Uninterruptible Power System

The uninterruptible power system will supply power to the electrical loads which, during a test, cannot tolerate any loss of power. The system will consist of two independent subsystems, one of which will supply the loads which are sensitive to electrical transients and noise. This subsystem is called the "noise free bus". The second subsystem will supply the remainder of uninterruptible loads, including power for auxiliary lighting in the control room during a power failure. This subsystem is called the "critical bus". The system has been selected to maximize reliability, based upon available vendor data. As further data becomes available, it will be incorporated into Title II.

— Noise Free and Critical Buses

The noise free and critical buses will each be a double bus, with each bus energized independently by an individual 250-volt, direct current driven, 208Y/120-volt, 3-phase, 4-wire output, motor generator set. The motor generator sets will be similar except that the sets for the noise free bus will be equipped with a flywheel to reduce electrical transients. Each motor generator set, for both the noise free and critical system, will have the capacity to operate its entire bus load. In addition, both buses will have an unregulated supply through transformers fed from the interruptible power switchboard.

— Direct Current System

The direct current to drive the motor-generator set will be supplied from two direct current buses, tied together by a manually operated circuit breaker. Each bus will be energized by a rectifier fed from the test essential switchboard and will be backed up by batteries capable of operating the motor generator sets a minimum of five minutes at rated capacity. Each of the d-c buses will feed a different motor generator set on both the noise free and critical systems.

Standby Power System

Standby power to operate the test essential electrical loads will be provided from three diesel generator sets. Upon failure of the primary power system, all three units will automatically start, synchronize, and pick up the loads in that order. When primary power is restored, the load will be manually transferred to the primary power source. Two generator sets will carry the load temporarily in the event minor maintenance requiring shutdown is necessary on the third unit. Auxiliaries for the generation system will be designed so that failure of one unit will not affect the operation of the other two.

Motor Control Centers

Motor control centers will consist of metal enclosed, dead front, dead rear assembly, containing circuit breakers, starters, contactors, relay, pilot light, pushbutton switches, and related equipment. Not less than 25 percent spare space and bus capacity will be provided. Magnetic starters will be equipped with overload relays in all phases. Individual control transformers will be provided for each starter or contactor.

Lighting

Indoor Lighting

General lighting information for all indoor areas is listed in Table IV-1. Fluorescent lighting will be used in all areas with the exception of toilets, closets, and the control room plenum auxiliary lighting. All fluorescent lights will have a utilization voltage of 277 volts; incandescent lights, 120 volts. The control room will be illuminated by an RF shielded, glare free, luminous ceiling.

— Auxiliary Lighting

Auxiliary lighting, supplied from the test essential source, will be provided in all areas where the primary light source is supplied from the interruptible source. Auxiliary lighting for the control room will be supplied from the uninterruptible power critical bus. The auxiliary lighting system will provide illumination for minimum operation during a power failure.

— Emergency Lighting

Battery powered emergency lights will be provided over principal exits and other locations as required for safety. The units will include a built-in charging circuit which will be connected to a 120-volt test essential source. Failure of the test essential source will turn on the emergency lighting units.

— Disassembly Area and Vault Lighting

Lighting fixtures support will be designed to allow removal and replacement by use of remote handling equipment. Each fixture will be separately switched.

— Transfer Lock Lighting

In addition to the general lighting level shown in Table IV-4, the transfer lock lighting design will provide a minimum of 200 foot candles for viewing through the shielding window. Lighting fixture support will be designed to allow removal and replacement by use of remote handling equipment.

Outdoor Lighting

— Fence Security Lighting

A series lighting circuit will be designed to match the existing fence security lighting. A minimum of 0.04 ft candles will be provided as required by AEC standards.

— Area Lighting

Area lighting will be provided around the periphery of the building and in the area of remotely located equipment. Area lighting will be controlled by time clocks with astronomical dials.

— Work Lighting

Manually controlled work lighting will be provided at all exterior equipment and plug log storage areas.

Grounding

A ground network will be furnished to electrically bond all electrical equipment, raceways, building structural steel, security fence, piping systems, and all ductwork. A separate test system instrumentation grounding system will be provided and will be connected to building ground at one point only. Transformer and generator neutrals will be connected to building ground.

Wiring Methods and Materials

Hazardous Locations

The area around pumps, valves, meters, and similar devices of the kerosene loop portion of the closed circuit coolant system will be classified as a Class I, Division 2, hazardous location.

TABLE IV-4
LIGHTING INFORMATION

<u>Location</u>	<u>Illumination Level Foot Candle</u>	<u>Voltage Source</u>	<u>Lamp Type</u>
Vault	50	Interruptible	Quartz-Iodine
Disassemble Area	50	Interruptible	Quartz-Iodine
High Bay Area	35	Interruptible	Fluorescent
Transfer Lock	50	Test Essential	Quartz-Iodine
Equipment Rooms	35	Interruptible	Fluorescent
Control Room	100	Test Essential	Fluorescent
Cable Spread Room	35	Interruptible	Fluorescent
Offices	70-90	Interruptible	Fluorescent
Health Physics	50	Test Essential	Fluorescent
Instrument Repair	100	Interruptible	Fluorescent
Lobby	30	Interruptible	Fluorescent
Rest, Change & Locker Room	30	Interruptible	Fluorescent
Conference Room	30	Interruptible	Fluorescent
Corridor	20	Interruptible	Fluorescent

Raceways & Cable Trays

— Zinc-coated Rigid Metallic Conduit

Zinc-coated rigid metallic conduit will be used for all conduit runs except those in the test vault.

— Aluminum Rigid Conduit

Aluminum rigid conduit will be used for all conduit runs in the test vault. All conduit in the test vault will be surface mounted. Conduit in the test vaults will be installed in a manner that will allow its removal by the use of remote handling equipment. No aluminum conduit will be embedded in the concrete.

— Cable Trays

A system of aluminum cable trays will be provided in the chase and tunnel system. This system will interconnect the test vaults, control room, cable spreading room, the vacuum equipment room, pump room, vault mechanical equipment room, vault electrical equipment room, high bay area, outside equipment pad, and the disassembly area. Cable trays will also be installed in the tunnel connecting the vault, electrical room and the administration and control electrical room. Separate trays will be provided for power, control, and instrumentation for both facility and test functions. Conduits will be provided in the chase for instrumentation or control cables requiring maximum isolation from other cables.

Wire and Cable

Radiation resistant wire and cable will be used throughout the test vault for all systems. The radiation resistant wire and cable will extend from the test vault to the first junction point outside the vault. All other wire and cable will be insulated with standard materials as indicated in the outline specification.

Receptacles

Receptacles in the process and work areas will be 20 ampere, 120-volt, three-wire, twist-lock grounded type, and in the control and administration areas, 15 ampere, parallel blade, grounded convenience type. Weatherproof receptacles will be provided at all exterior equipment pads. Each indoor area will have at least 20 percent of its receptacles connected to the test essential source, except for offices, toilets, corridors, storage areas, entries, and conference rooms. A minimum of two receptacles on the test essential system will be provided in the control room. Welding receptacles will be located in the pump room, disassembly area, transfer lock, mechanical equipment room, and the outside equipment pad and will be 440-volt, 3-phase, 60-ampere, 4-wing Crouse Hinds AR642.

Motors

Motors rated 1/2 horsepower and larger will be rated 440-volt, 3-phase, 60 cycles. Motors rated 1/3 horsepower and smaller will be rated 115 volts, single phase, 60 cycle, unless otherwise noted.

Cable Entries and Conduit Penetration

— Test Vault

All electrical conductors entering or leaving the test vaults will terminate at a connector plate, located at the entrance to the four electrical chases. Each of the four connector plate assemblies will be a factory assembled, aluminum plate with welded aluminum body hermetic seal connectors. The connector plate assembly will have the capacity to terminate one quarter of the facility and test cables and conductors and will be factory tested for zero leakage in either direction with a differential pressure of 1 psig. No direct conduit penetration of the test vault will be used.

— Disassembly Area

Conduits penetrating the shell of the Disassembly Area will have a minimum of two 90 degree bends contained within the concrete and will be equipped with standard conduit seals on the outside face of the shell.

Corrosion Control

The following design features will be used in the facility design to minimize corrosion and the cost of corrosion protection:

1. No aluminum conduit embedded in concrete.
2. No additives (calcium chloride, etc.) in the concrete mix.
3. Electrically isolate the aluminum liner and embedded aluminum cooling water piping from the reinforcing steel and copper ground system.
4. Provide area paving and drainage to collect runoff water.
5. Protect the subsurface concrete from natural ground water with waterproofing.
6. Install concrete trenches and a vault for the potentially radioactive gas piping, liquid piping, and holdup tanks.

7. Electrically insulate all other buried steel piping and tanks from other subsurface structures.
8. Provide cathodic protection for isolated steel buried piping and tanks.

Communication

Telephone

Conduit with pull wires installed, will be provided from outlet boxes in the high bay area, control room, health physics, and offices to a telephone terminal cabinet located in the administration and control electrical equipment room. The outside telephone system will be extended to these areas by others. Signal wires from the facility security and fire alarm will be extended to the telephone cabinet. Underground conduit will be installed from the telephone terminal cabinet to a telephone pole adjacent to the facility.

Intercommunication System

Two separate two-way intercommunication systems will be provided. The first system will provide communication between process and work areas and the control room and the second system will provide communications between all television and remote handling locations and the control room. Remote communication stations for the process and work area system will be located at the vacuum equipment room, pump room, vault mechanical room, vault electrical room, disassembly area, high bay area, and outside equipment area, with the master unit located in the control room. The television and remote handling system will provide remote communication stations at the test vaults, disassembly area, and transfer lock with the master unit located in the control room.

Alarm and Annunciation Systems

Fire Detection and Alarm System

An automatic fire detection and alarm system will be provided throughout the facility. The system will provide both visual and audible alarms in the control room including indication of the fire area, and audible alarms in the rest of the facility. Fire detection will be from a combination of dual rate of rise and fixed temperature detectors and smoke detectors. Detection devices located in areas that can become inaccessible because of contamination or high radiation levels will be capable of being disabled from outside the area without affecting the remainder of the system. Manual fire alarm boxes will be provided throughout the facility and will be tied to the fire alarm system. The fire detection system will provide via the telephone system, a simultaneous signal to the facility operator's base security headquarters.

Separate fire thermostats will be provided in the facility air conditioning and ventilating systems to automatically stop fans and isolate duct systems.

Evacuation Warning Light and Audible Alarms

Rotating beam colored lights and sirens will be provided at strategic locations both inside and outside the facility to indicate the condition of an operating hazard. The lights and sirens will be separately controlled from the control room. Activation of the siren evacuation alarm will simultaneously signal via the telephone system, the facility operator's base security headquarters. A break glass station will be provided at the exit of the control room to activate the siren system. The system will comply with the requirements of AI SOP B-28.

Annunciation

An annunciator section will be provided on the facility control board to indicate off normal condition in the facility. Annunciator and trouble circuitry will be designed for fail safe operation. Provisions will be made to differentiate the off normal conditions that require immediate corrective action from those that require corrective action within a reasonable period of time.

Closed Circuit Television System

A closed circuit television system will be provided as the primary means of viewing remote operation within the disassembly area and test vaults and as a secondary viewing system for the transfer lock. Remote handling equipment will be provided to remotely position television equipment, and is described in the handling and special equipment portion of this section.

The television equipment will be provided as shown in Table IV-5 and connector box and receptacle for remote cameras will be located as shown in Table IV-6.

TABLE IV-5
TELEVISION EQUIPMENT

<u>Equipment</u>	<u>Quantity</u>
Camera Unit (With 4:1 Zoom Lens)	2
Camera Unit (With 10:1 Zoom Lens)	6
Camera Control Unit	9
Pan-Tilt Unit	10
Monitor, Fixed	9
Monitor, Portable (Double Unit)	1
Video Switching Unit	1
(With 10 Inputs and 12 Outputs)	
Control Console	1
(With 10 Inputs and 3 Outputs)	
Connector Box, Single	8
Connector Box, Dual	16
Connector Box, Triple	2
Receptacles, Camera	46
Receptacles, Monitor (Double Unit)	3

TABLE IV-6
TELEVISION CAMERA CONNECTOR BOX LOCATIONS

	Type of Box		
	Single	Dual	Triple
Vault 1			
Short Wall (Each)		1	
Long Wall (Each)	2		
Vault 2			
Short Wall (Each)		1	
Long Wall (Each)	2		
Disassembly Area			
Short Wall (Each)		2	
Long Wall (Each)		4	
Transfer Lock			
Long Wall			1

Receptacles for the remote monitor will be provided at the three
Disassembly Area Rectilinear Manipulator Remote Console
Locations.

INSTRUMENTATION AND CONTROL SYSTEMS

High Volume Exhaust System (HVE)

Area Pressure Control

To insure air flow or air leakage from an area of lower to an area of higher potential radioactive contamination, the HVE system will control and maintain preset pressures as follows:

- High Bay Area minus $1/8$ in. w.g.
- Vault M & E Equipment Room minus $1/4$ in. w.g.
- Pump Room minus $3/8$ in. w.g.
- Vacuum Equipment Room minus $1/2$ in. w.g.

Requirements will be controlled by means of differential pressure controllers acting on shutoff control dampers (dPC-1, 2, 3, 4 and POD-1, 2, 3, 4). The pressures apply only when all equipment hatches and access openings are closed, i. e., when each area is isolated from the rest of the facility. When the equipment hatches are open, the controllers, with the exception of the highest set point, will not maintain the required set point because the room exhaust system will not have the capacity, however, they will maintain the required face velocity of 25 across the hatch openings. In this way any possibility of air flow or air leakage from an area of lower to an area of higher potential radioactive contamination will be prevented.

The vacuum equipment room will have a transfer switch (RMS-4) to transfer pressure control from the HVE system to the LVE system. In addition, this room will also have a shutoff damper (POD-6) on the equipment cooling air supply duct to stop all cooling air flow if complete containment is required. This damper is remotely operated from the facility board by a two-position switch (RMS-6).

Access doors from the vacuum equipment room to the test vaults will be annunciated on the facility board in the control room.

Air Flow Pattern Control

The HVE connections from the transfer lock, disassembly area, and test vaults will be equipped with ultra-tight shutoff butterfly valves (POV-18, 14, 65, 66) operable by remote-manual switches (RMS-18, 14, 65, 66) from the facility board. Valves for the transfer lock and test vaults will be of

the two-position type, the one for disassembly area will be of the three-position type (open - half open - closed). All the butterfly valves will normally be closed, and will be used only when the equipment hatches from the following are open.

1. High Bay to Transfer Lock, and/or
2. High Bay to Disassembly Area, and/or
3. Disassembly Area to Transfer Lock, and/or
4. Disassembly Area to Test Vault(s)

This will insure positive air flow from the areas of lower to areas of higher potential radioactive contamination. Whenever combinations 2 and 4, or 2, 3, and 4 occur, the disassembly area valve is to be half closed or closed, depending on whether one or two test vaults are connected with the disassembly area in order not to exceed the capacity of the air supply system. Whenever radioactivity in each individual area exceeds a certain limit, the valve exhausting that area will close by override from exhaust duct mounted radiation detector.

Main Header Pressure Control

To compensate for the variable pressure drop of the filter banks F-1A, B & C, and to insure an air flow in the equipment rooms independent of the position of the disassembly area equipment hatches, static pressure in the HVE main header will be maintained at a preset value by means of the pressure controller PC-7 acting on damper POD-7.

Exhaust Fans Control

Exhaust fans E-2A, B & C will each have a stop-start pushbutton station on the facility control board (RMS-37, 38, 39). Fan operation will energize the corresponding dampers (POD-37, 38, 39) to open and to close on stopping, to prevent recirculation of air through an idle fan.

Low Volume Exhaust System (LVE)

Area Pressure Control

As with the HVE system, insuring that air flow or air leakage from an area of lower to an area of higher potential radioactive contamination will also apply to the LVE system. Whenever the areas are isolated from each other, the following pressures will be maintained:

- Disassembly Area minus $3/8$ in. w.g.
- Transfer Lock and Vacuum Equipment Room minus $1/2$ in. w.g.
- Test Vaults minus $5/8$ in. w.g.

This will be accomplished by means of differential pressure controllers (dPC-15, 19, 4, 11, 10) acting on the ultra-tight butterfly valves (POV-15, 19, 4, 11, 10). Each area exhaust will have a radiation detector which will override and close its corresponding pressure-controlled butterfly valve whenever the radioactivity level exceeds a predetermined limit.

Exhaust Blowers Control

Exhaust blowers E-3A and B will each have a stop-start pushbutton station on the facility control board (RMS-35, 36). These switches will energize the corresponding dampers (POD-35, 36) on the discharge lines to open on starting and to close on stopping the blowers, so that there will be no recirculation of air or nitrogen through the idle blower.

Radioactive Gas Holdup System (RAH)

Area Pressure Control

In the event of excessive radioactivity in the transfer lock, disassembly area, and test vaults, each exhaust duct mounted radiation detector will isolate the affected area from the HVE, LVE, and gaseous nitrogen systems by closing corresponding control valves to that system, will simultaneously open corresponding ultra-tight butterfly valves (POV-20, 16, 12, 9) to the RAH system, and will automatically start one gas compressor (GC-1A or GC-1B). It will also be possible to open any one of these valves by the remote-manual switches (RMS-20, 16, 12, 9) on the facility control board. A relative pressure of approximately minus 1 in. w.g., with respect to the atmosphere, will be maintained in the affected areas by means of gas compressors GC-1A and B and the bypass line pressure control valve (PCV-26). The vacuum equipment outgassing line connected to the RAH system will be equipped with a two-position valve (POV-68) operated from the facility control board by the remote manual switch (RMS-68).

Gas Compressors Control

The gas compressors, GC-1 and A & B, will each have a stop-start pushbutton station on the facility control board (RMS-27, 28) and will be started automatically from the transfer lock, disassembly area, and test

vaults radiation detectors. Starting and stopping the compressors will operate the ultra-tight butterfly valves on the suction and discharge lines around each gas compressor (POV-27.1 & 27.2, POV-28.1 & 28.2) to open on starting and to close on stopping the compressor.

Holdup Tanks and Discharge Line Control

The gas holdup tanks, T-1A & B, will each have a pair of ultra-tight butterfly isolation valves (POV-29 & 31, POV-30 & 32) on the inlet and outlet lines. These valves will be operable by remote-manual switches (RMS-29 & 31, RMS-30 & 32) from the facility control board.

The common discharge line leading from the tanks to the dispersion stack will incorporate a discharge pressure control valve (PCV-34) and a flow controller (FC-33) with flow control valve (CV-33). The flow control valve will automatically close on a high radiation signal from the stack gas monitoring system.

Liquid Waste Holdup System

One liquid holdup tank (T-2A or B) will be pre-selected to hold up the potentially contaminated drains by means of a remote-manual switch (RMS-55) on the facility control board acting on a three-way butterfly valve (POV-55).

The discharge lines leading from the tank-mounted pumps P-7A & B to the sanitary sewer will each have a three-way butterfly valve (POV-56, 59) operable from the facility control board (RMS-56, 59), so that each pump can either discharge into the sewer or send the liquid through the bypass line. The bypass line will have a three-way valve (POV-54, 57) operable from the facility board mounted selective switch (RMS-54, 57) so that the liquid diverted from going into the sewer can either be recirculated through the tank or sent through a tank truck connection above the vault for outside disposal. The three-way valves (POV-54, 57) will also permit the operator to have the liquid well agitated or mixed by recirculation before taking samples for radioactivity measurements.

Vault Walls and Vacuum Equipment Cooling System

The coolant suction lines of pumps P2A & B and the service (cooling tower) water outlet lines from heat exchangers HE-2A & B will each be equipped with a two-position valve (CV-71.1 & 71.2, CV-70.1 & 70.2). The remote manual switches (RMS-71, 72) mounted on the facility control board will enable the operator to transfer from the operating to the standby heat exchanger.

Oxygen Content Control

Purging Cycle Control

The transfer lock, disassembly area and test vaults will be individually purged, with gaseous nitrogen when required. The amount of gaseous nitrogen injected will be controlled by a control valve (CV-43, 44, 41, 42) operated from a remote-manual control station (RMC-43, 44, 41, 42) on the facility control board. Each exhaust valve will automatically close when excessive radioactivity is indicated by the radiation detector.

The gaseous nitrogen supply line to each vacuum chamber will be equipped similarly with a control valve (CV-45, 46), operated from a remote-manual control station (RMC-45, 46) on the facility control board. Each exhaust valve will automatically close when excessive radioactivity is indicated by the radiation detector.

Steady State Control

Once the purging cycle of an area has been completed and an oxygen content of 3 percent by volume has been reached, the operator will close the purging cycle valve and activate the oxygen control system. Each of the four control systems will consist of an oxygen analyzer-controller (O₂C-22, 23, 24, 25), and a control valve (CV-22, 23, 24, 25). Each valve will automatically close when excessive radioactivity is indicated by the radiation indicator.

Oxygen Analyzers

Oxygen analyzers will measure the percentage of oxygen in the atmosphere of the test vaults, disassembly area, and transfer lock. To assure that the oxygen content in these areas remains below 3 percent, four analyzers with associated controllers will be furnished, one for each area. Each oxygen analyzer will take a sample from the controlled area and analyze it for oxygen content. The analysis will then be pneumatically transmitted to its recorder and controller.

Radioactivity Monitoring

Stack Gas Monitoring

The stack gas radiation monitor (RE-40) will have a dual channel system, measuring the effluent from the stack for both particulate and gaseous radioactivity. The system will continuously draw off gas samples from

the stack through an isokinetic nozzle and pass the samples through a moving paper tape filter to a gas chamber and exhaust back into the stack. One detector will monitor the moving tape, and the other will monitor the gas chamber. In the control room, both channels will continuously indicate, record, and annunciate on excessive radiation.

This system will be designed to keep operating personnel informed of existing effluent radiation levels and to give a warning before such levels become hazardous or exceed those specified by law the Federal Register, Standards for Protection against Radiation, (10 CFR 20, 4 January, 1961). When there is excessive radioactivity of either gas or particulate matter, the monitoring system will close control valve (CV-33) on the discharge line of the RAH system, and annunciate in the control room.

Area Radiation Monitoring

The area radiation monitoring system will keep operating personnel informed of existing radiation levels and give a warning before such levels become hazardous or exceed those permitted by Parts 20 and 70, Chapter 1, Title 10 of the Federal Register, dated January 4, 1961, Standards for Protection Against Radiation. The area radiation detectors will be located in the following areas:

1. Control Room
2. Hot Change Room
3. Cable Spreading Area
4. Administrative Area Mechanical Equipment Room
5. Administrative Area Electrical Equipment Room
6. High Bay Area
7. Transfer Lock
8. Disassembly Area
9. Vault Mechanical Equipment Room
10. Vault Electrical Equipment Room
11. Pump Room

12. Vacuum Equipment Room

13. Vault Access Stairwells

14. Radioactive Liquid and Gas Holdup Vault

The above detectors will be sensitive to gamma radiation, those in the areas from 1 through 6 inclusive in a lower intensity range, and those from 7 through 14 in a higher intensity range.

Indicators mounted in the control room will have a high control point adjustable over full-scale range by a knob on the indicator front and which actuates a contact to a common remote annunciator. The contact will also flash a local light and a remote light and buzzer. One indicator will be furnished for each channel or detector, with ranges to match the detector.

Radiation monitoring control stations will be located in the control room. A common annunciation in the control room will indicate any off-normal condition. In addition, provisions will be made for extending the common annunciator signal to the facility operator's base security headquarters in accordance with the facility operator's requirements.

Room Exhaust Radiation Monitoring

In the exhaust connection from the transfer lock, disassembly area, and test vaults there will be installed a continuous radioactive gas monitoring system. The purpose of this monitoring system is to isolate and contain any of the above areas in the event of excessive effluent radioactivity.

Action of the monitors on excessive radioactivity detected in the exhaust gas will be:

- To give alarm on the facility annunciator.
- To close automatically the valves in the HVE, LVE, and gaseous nitrogen system, which are connected to the contaminated area.
- To close automatically the valve in the fresh air duct to the air conditioner serving the contaminated area.
- To open the valve to the RAH system from the contaminated area and start the RAH gas compressor.

The detectors will be sensitive on gamma and beta radiation, and will be installed directly in the exhaust duct. The signals will be preamplified in the detector and sent to the ratemeter mounted on the remote control panel in the control room. The high control and alarm set point will be adjustable.

Mercury Detection

To protect facility personnel from mercury vapor, a mercury leak detection system will be provided, consisting of a mercury vapor detector located in the high bay, a multipoint record on the facility control board, and sniffer detector tubes located in the following areas:

- Test Vaults
- Disassembly Area
- High Bay Area
- Vault Electrical and Mechanical Equipment Room
- Pump Room
- Transfer Lock
- Vacuum Equipment Room
- Vault Access Stairwells
- Cable Spreading Area

These sniffer tubes will draw off air samples from the indicated areas; the samples will then be sequenced to the detector for measurement. The high alarm set point on the detector will be adjustable. Should any mercury vapor be detected, the instrument will initiate an alarm in the control room.

Standby Equipment Startup

The following equipment will be interlocked to insure automatic startup of the standby units on failure of the operating units:

- Test Vault 1 Air Conditioners AC-6A & B
- Test Vault 2 Air Conditioners AC-7A & B

- HVE Fans E-2A, B & C
- LVE Fans E-3A & B
- Hot Water Pumps P-4A & B
- Cooling Water Pumps P-2A & B
- Cooling Tower Pumps P-3A, B & C
- Air Compressors C-1, 2

All other equipment will be started manually by stop-start pushbutton stations from the facility control board and/or locally near the equipment.

Standard Automatic Controls

The hot water boiler and the refrigeration compressors will be supplied with factory-mounted packaged automatic controls. These controls will be mounted on the equipment or close by in suitable panel. In addition, the air conditioners will have automatic control panels locally mounted.

The start-stop stations will be installed on the locally mounted control panels, and will be duplicated, where required, on the facility control board. Pilot lights and alarms will be installed locally and, where required, duplicated on the facility board.

Facility Control Board

In the control room, control board will be furnished and installed, on which will be mounted the recording and indicating instruments, the remote-manual and automatic control stations, the alarms, the annunciator lights, and the electrical pushbutton stations required by the operator to evaluate the status of the facility and to operate individual equipment. This board will be of the vertical type and will utilize graphic presentation for all of the facility air moving systems.

V. RELIABILITY PROGRAM PLAN

Table of Contents

	Page No.
GENERAL	1
CRITICAL FACILITY SYSTEMS	1
REFERENCE DOCUMENTS	1
DEFINITIONS	2
PROGRAM PLAN	
General	3
System Analysis	3
Data Collection	4
Reliability Engineering	4
Titles III, IV, and V	4

V. RELIABILITY PROGRAM PLAN

GENERAL

This plan is intended to serve as the planning and control document for the facility system reliability program.

Reliability is the prediction of the probability that an apparatus, component, system, or facility will perform a specified function for a given length of time without experiencing a failure that requires cessation of the function.

The reliability goal to be approached is 0.99 for 10,000 hours of continuous service. Since, during Title II design, 0.99 may prove economically infeasible, the program as outlined is intended to establish an approach by which the optimum combination of economics and reliability may be established.

CRITICAL FACILITY SYSTEMS

The critical facility systems as outlined in AI Specification NF 7568-90-001 A are listed below:

- Facility Service Cooling Water System.
- Electrical Power System.
- Test Vault Cooling System.
- Gas Holdup System (Low Volume Vault Exhaust).
- Control Room Cooling System.
- Vault Pressure Control System.
- Safety and Alarm Systems.

As the program progresses the above systems may be amended as required.

REFERENCE DOCUMENTS

The following regulations and standards will be utilized:

Regulation

AR 705-25 Reliability Program for Material and Equipment,
 paragraphs 7 and 8

Atomics International

Spec. NF 7568-90-001, Technical requirements for the revised SNAP 8
Rev. A Prototype Test Facility

Military Standards

MIL-STD-721A (DOD) Definition of Terms for Reliability Engineering
 2 August 1962

M-REL-M-131-62 Reliability Engineering Program Provisions for
 Space System Contractors

MIL-STD-829 (USAF) Terms and Definitions for Maintainability,
 12 September 1962

MIL-STD-756 Procedure for Reliability Prediction

DEFINITIONS

The following definitions will apply in this report and throughout the course of the program.

Critical Failure - Any failure condition which does not permit the system to successfully complete its mission.

Failure Analysis - The study of an actual failure to determine the circumstances causing the failure and to arrive at a course of corrective action.

Failure Effect Analysis - Study of potential failures which might occur in any part of a system to determine the probable effect of each on all other parts of the system.

Failure Mode Analysis - The study of the system and working interrelationships of the parts thereof under various anticipated conditions of operation to determine probable mechanism by which failure occurs.

Maintainability - Probability that any failure will be repaired within a specified time after a failure occurs.

Reliability - Probability of performing without failure a specified function under given conditions for a specific period of time.

Reliability Apportionment - The assignment of reliability goals to systems or subsystems which will result in meeting the over-all facility reliability requirements.

Reliability Assessment - An analytical determination of the numerical reliability of a system or portion thereof. Such assessments usually employ mathematical modeling, estimated reliability figures of merit, and tests.

System - One of the principal functioning entities comprising the facility and related operational services within the facility. A system can be considered as the first major subdivision of the facility.

Subsystem - A major functioning entity within a system.

PROGRAM PLAN

General

The program plan will consider and evaluate the reliability characteristics of the critical SNAP 8, Flight Prototype Test Facility Systems with respect to the achievement and assessment of system reliability during the test period. The reliability program will consist of three steps accomplished in conjunction with design:

1. System Analysis
2. Data Accumulation
3. Reliability Engineering

System Analysis

After a determination of the critical systems, each system will be analyzed with respect to type, nature, and location of possible failures. A system reliability goal will be established and by apportionment the system reliability

will be utilized to establish the required reliabilities for the subsystems or equipment in the subsystems. Mathematical models will be developed for the apportionment of the system as well as to assist in the evaluation of alternate combinations.

During system analysis all facility system equipment will be identified and classified.

Data Collection

Data consisting of failure rate or a mean time to failure for system equipment will be collected from the manufacturer. Where a data file, maintained by the architect engineer, is available; this data may be used during the course of system analyses.

Reliability Engineering

Engineering judgment will be utilized in developing the systems to obtain realizable reliability goals consistent with project funding. The collected data will be utilized to establish a projected overall reliability, using the previously developed mathematical models. The following functions contributing to the overall reliability of the system will also be investigated.

Failure Mode Effect and Criticality Analyses - A determination of the critical failure areas and the effect upon the system.

Economic Analysis (Trade off Studies) - Determination of the economic penalty necessary to obtain a given degree of reliability.

Design Reviews - Internal design reviews will be conducted from time to time throughout the course of design to assure achievement of reliability goals.

During the review period reliability engineering will be the mechanism whereby the effect of equipment and system equipment selection on reliability may be determined.

Titles III, IV, and V

The reliability program will be continued during the Titles III, IV, and V phases of the work. Purpose of the program will be to update the reliability projections to reflect design or construction changes or equipment substitutions. The result of this effort will be a final "as built" reliability report.

VI. OUTLINE SPECIFICATIONS

Table of Contents

	Page No.
CIVIL	
Excavation	1
Finish Grading and Drainage	1
Roads and Paved Areas	2
Fencing	2
ARCHITECTURAL	
Building Construction and Materials	3
Plumbing Fixtures and Accessories	6
Finish Hardware	7
Painting	8
Pipe Identification	9
STRUCTURAL	
Concrete	10
Structural Steel	11
Aluminum	11
Welding of Aluminum	11
HANDLING AND SPECIAL EQUIPMENT	
General	13
High Bay Area Crane	13
Transfer Lock Crane	14
Disassembly Area Crane	15
Vault Electrical Area and Pump Room Cranes	16
Vault Vacuum Equipment Room Monorail	17
Disassembly Area Rectilinear Manipulator	17
Transfer Lock Rectilinear Manipulator	20
Master-Slave Manipulators	22

Transfer Lock Radiation Shielding Viewing Window	24
Passenger Elevator	26
Disassembly Area and Test Vault Camera Traverse	
Equipment and Remote Connectors	26
Transfer Lock Television Provisions	28

MECHANICAL

General	30
Heating, Ventilating and Air Conditioning	30
Plumbing	36
Demineralized Water System	36
Compressed Air System	37
Liquid Nitrogen System	37
Piping	37

ELECTRICAL

Electrical Work - Exterior	44
Electrical Work - Interior	47

INSTRUMENTATION

General	60
Special Instruments	60

VI. OUTLINE SPECIFICATIONS

CIVIL

Excavation

Excavation will be done carefully to lines and elevations to be specified. Surplus excavated earth may be used on the site if properly spread and compacted as noted under Finish Grading and Drainage.

The contractor will provide and maintain dewatering equipment for removal and disposal of any surface and ground water entering excavations, and will keep each such excavation dry until the structure is completed to the extent that no damage from hydrostatic pressure, flotation, or other sources will result from contact with such water.

Bottom of the pit excavation will be cleaned of all loose materials and grouted to provide a smooth surface for a waterproofing membrane, which will be applied before placing any concrete for the test vault.

Finish Grading and Drainage

Grading

Finish grading will conform to the finish elevations and contours shown on Drawing C-1. All finish areas will slope uniformly between the grade joints without voids or pockets and will maintain the elevation shown within ± 0.10 foot.

Backfill in general areas will be compacted to 90 percent of the maximum density for the material as determined by the modified A. A. S. H. O. method. Backfill within building areas will be compacted to 95 percent of the maximum density.

Drainage

Culverts will be corrugated metal or reinforced concrete pipe and will be installed in accordance with California State Highway Department Standard Specifications.

Roads and Paved Areas

All surfacing for roads and parking areas will be flexible bituminous (asphaltic concrete), State of California Type A plant mixed. Stabilized base course will consist of either crusher run rock, pit run gravel, or cement treated local soil, and will be compacted to 95 percent of the maximum density for the material as determined by the modified A. A. S. H. O. method.

Fencing

The security fence will be 7 feet high, 2-inch diamond mesh chain link, No. 11 gage, galvanized wire, with 3 strands of 4-point barbed wire on a 45 degree, 17-inch outrigger. Steel pipe posts will be set in concrete. Personnel gate will be 3 feet single swing type, with chain link mesh on steel pipe framing, complying with AEC standards.

ARCHITECTURAL

Building Construction and Materials

Metal Roof Deck

Roof decking will be Type FK as manufactured by H. H. Robertson, Type "D" as manufactured by Fenestra Inc., or "PIRIB" as manufactured by Pacific Iron and Steel Corp. The deck will be formed from steel sheets conforming to ASTM Specification A-245.

Roofing

Roofing will be 10-year rated asphalt felt and gravel over a metal decking.

Metal Siding

Metal siding will be a V-beam or ribbed, galvanized steel or aluminum panels. Metal siding will be furnished complete with eave and gable trim, flashings, closure and filler strips, corner flashings and other items necessary to insure a weatherproof and watertight installation.

Insulation

The roof will be provided with a vapor barrier and one layer of Fiberglas insulation applied over the vapor barrier.

The metal siding will be insulated with a flexible type Fiberglas material, with vinyl vapor barrier on one face and furnished with tabs on one end for sealing.

Masonry

All materials and workmanship will conform to the requirements of the Concrete Masonry Association. Masonry units will be Grade A lightweight aggregate concrete blocks, gray in color.

Waterproofing

Waterproofing will be of the asphalt saturated felt membrane system, using an asphalt primer and mopping cement, applied to concrete surfaces. Pipes, conduits, and other projections passing through the waterproofing will be properly flashed and waterproofing applied in such a manner to provide a water-tight joint.

Carpentry

Carpentry work covering wood shelving will be construction grade Douglas Fir or pine, and will be 1-inch stock.

Windows

All interior windows will be provided with pressed metal frames, with removable metal stops for glass replacement.

Glass and Glazing

All windows will be glazed with 1/4 inch polished plate glass. Glass will be set in neoprene or felt glazing channels.

Door glazing will be 1/4 inch polished plate wire glass.

Mirrors will be A quality, 1/4 inch plate glass. Mirrors will be hermetically sealed by a coating of copper electroplated over a heavy film of silver. Mirrors will have a polished chrome frame.

Doors and Frames

Pressed metal frames of the unit type and not less than 16 gauge will be provided for all doors. Metal frames will rest on and be anchored to the floor.

Hollow metal doors will be of the flush type, 1-3/4 inch thick. Glass panels and louvers will be provided as required. All doors will be provided with a sound deadening insulation. Astragals will be provided at meeting stiles of all exterior double doors. All exterior doors will be weatherstripped.

Metal thresholds will be provided for all exterior doors. Thresholds will be of 4 inch width, Type 109, as manufactured by the Wooster Products, Inc., Wooster, Ohio, or approved equal.

Steel Rolling Door

The steel rolling door will be a wall face mounted type, with power operation. The door opening to be served will be 25 feet wide by 30 feet high. The rolling steel door will be weatherstripped on all sides to prevent air leakage and infiltration. Curtain slats will be interlocking and not less than 20 gauge. The steel rolling door will be of the type as manufactured by the Kinnear Manufacturing Company, the Lawrence Steel Company, or approved equal.

Drywall

Steel studs for interior partitions will be of the nailable type as manufactured by the Stran-Steel Corporation, Detroit, Michigan, or approved equal. Opening sills, headers, and base and head channels will be provided as required.

Gypsum wallboard with recessed edges will be 5/8 inch thick "Firecode" as manufactured by U. S. Gypsum, or approved equal. All joints will be taped. The wallboard will be applied horizontally and be attached to the steel studs with cement coated nails.

A prefinished wallboard wainscot at the urinal will be Marlite as manufactured by the Marsh Wall Products, Inc., Dover, Ohio, or approved equal. The prefinished wallboard will be applied over gypsum wallboard, using adhesive method. Metal mouldings will be installed at all joints and edges of the panel.

Floor Coverings

All concrete floors will have a smooth finish, and a liquid hardener will be applied to the finished surface.

Pure vinyl tile will be 1/8 inch thick, 9 x 9 inch size, and of marbleized pattern.

Asphalt tile will be 1/8 inch thick, 9 x 9 inch size, color group C.

Metal or plastic edging strips will be provided at all exposed edges of flooring terminating on concrete finished floors.

A 4-inch high top set rubber base will be installed around walls where floor covering is installed.

Removable Floor

The removable floor in the Control and Data Acquisition Room will consist of a series of modular vinyl tile covered panels, supported by a rigid grid system of pedestal supported stringers, which support and position the panels on all sides. The removable floor system will be as manufactured by Liskey Aluminum, Inc., Glen Burnie, Maryland, or as manufactured by the Floating Floors, Inc., New York, or approved equal.

Sheet Metal Work

Sheet metal work will be fabricated of galvanized metal or as otherwise indicated. The work will consist of gravel stops, flashings, counter flashings, gutters, downspouts, scuppers, louvers, and such other items as are required to complete the work.

Plumbing Fixtures and Accessories

Toilet Partitions

Toilet partition will be "CO-HA-CO" floor mounted, flush non-metallic type, with a "Plastallux" finish, as manufactured by the C. H. C. Manufacturing Company, San Gabriel, California, or approved equal. Urinal screens will be as specified for the toilet partition. Partition and screen will be furnished complete with all fastenings, fittings, and hardware.

Toilet Accessories

A stainless steel shelf 5 x 18 inches will be provided under each mirror. All brackets and exposed fasteners will be chrome plated.

Miscellaneous toilet room accessories, such as paper and soap dispensers, will not be furnished.

Plumbing Fixtures

Water Closets will be American Standard F. 2223-8 "Madera" vitreous china, siphon-jet action elongated bowl, Sloan Royal 110FYV flush valve, and Church 9500 white Mol-tex seat, or approved equal.

Urinals will be American Standard F6230-1 "Casal" vitreous china washout urinal with extended shields, and Sloan Royal 180YV flush valve, or approved equal.

Lavatories will be American Standard "New Ledgewood" No. P4300-40, 19 in. x 17 in., cast iron AR enamel, supply and drain fittings No. N 2109 1-1/2 in. x 1-1/4 in. chrome trap, 1/2 in. stop and flanges to wall or approved equal.

Service Sink will be American Standard P7701-1, 24 in. x 20 in. "Argo" cast iron, acid-resisting enamel inside, R4430 single faucets, R4551-1 strainer, P7798 enameled inside adjustable trap; standard outlet, threaded 2 in. inside, or approved equal.

Drinking Fountain

Haws bottle type drinking fountain, Model HB CFS water cooler, with air cooled condenser.

Lockers

Single tier type lockers, 12 in. wide by 18 in. deep and 60 in. high, with sloping top enclosure and miscellaneous trim, provision for locks or keys, as manufactured by Berger Mfg. Division, Republic Steel, or approved equal.

Locker Benches

Locker benches 9-1/2 in. wide by 1-1/4 in. thick and 4 ft long, with maple tops painted with two coats of clear varnish as manufactured by Berger Mfg. Division, of Republic Steel, or approved equal.

Shower Cabinets

Shower cabinet-dressing enclosure combination will be as manufactured by the Fiat Metal Manufacturing Company, Los Angeles, California, or approved equal, and will be equipped as follows:

- Fiat "Ensign" shower cabinets with receptor, complete with trim and curtain, or approved equal.
- Fiat "Duro" dressing enclosure, complete with seats, doors, fittings and hardware, or approved equal. Dressing enclosure will be fabricated of galvanized bonderized steel.

Finish Hardware

General

Finish hardware will be of the heavy duty type. Locksets, latchsets, and dead bolts will match existing hardware in finish and quality. All lockset cylinders will be 6-pin tumbler type, as manufactured by the Best Universal Lock Company, and will conform to Atomics International Plant Engineering Manual, Section PEM 19.010 Door Locks and Latches.

Keying

Keying will be in accordance with AEC Master Site Security Plan.

Exterior Doors

Exterior doors will be provided with lockset, weatherstripping, metal threshold, door stop, flush bolts, and closer.

Interior Doors

Interior doors will be provided with a latchset, flush bolts, door stop, and closer.

Change, Locker, and Toilet Room Doors

Change, Locker, and Toilet Room doors will be provided with push, pull, kick plates, and closers.

Fire Extinguishers

Dry Chemical Fire Extinguishers

Dry chemical 20-pound size, "Met-L-X" 30-pound size, and 150 lb Met-L-X on wheels, as manufactured by the Ansul Chemical Company, or approved equal, will be provided.

CO₂ Fire Extinguishers

Fifteen pound CO₂ fire extinguishers, as manufactured by the Walter Kiddie Company, or approved equal, will be provided.

Painting

General

Painting will conform to Atomics International Plant Engineering Manual Section 5.402, Paint Control Standards, and Section 5.401, Revision 1, Piping Coding. Colors shall conform to Atomics International Standards.

Exterior Painting, Exposed Steel Surfaces

All exposed steel surfaces will be painted with two finish coats of exterior oil paint.

Miscellaneous Exterior Surfaces

Exhaust stack, roof duct work, vents, and piping above roof will be painted with two finish coats of aluminum paint. The exhaust stack will receive special markings for the upper 10 feet, in accordance with Obstruction Marking, as published by the National Standards of Air Coordinating Committee, Washington, D. C.

Exterior Concrete Surfaces

Concrete surfaces will not be painted unless specified.

Exterior Aluminum and Stainless Steel Finishes

Aluminum or stainless steel surfaces will not be painted.

Interior Painting

Interior areas to be painted will include all wood, metal (except aluminum or stainless steel metals), gypsum wallboard, and concrete (where specified), shall be painted with two finish coats.

- Interior concealed piping will not be painted.
- All items of machinery and equipment not factory finished will be painted with two finish coats of machinery enamel.
- All factory finished items will not be painted.

Pipe Identification

Pipe identification will be provided in conformance with Atomics International Plant Engineering Manual Section 5.401, Identification of Piping System.

STRUCTURAL

Concrete

Design and construction of all concrete will conform to the requirements of the Uniform Building Code and the recommendations of the American Concrete Institute, Building Code ACI 318.

Two types of concrete will be used:

- Conventional concrete for all structures except the test vault.
- The test vault will be constructed of special concrete, which when exposed to a neutron field will limit the induced activation to permit personnel reentry to the vault. To achieve this result, the concrete constituents will have an elemental composition as outlined in the nuclear section of this report.

Cement will comply with the Standard Specifications for Portland Cements, ASTM Designation C-150, and be Type II for conventional concrete.

White cement for the special concrete will comply with the Standard Specification for Portland Cement, ASTM C-150, Type II, except that the elemental composition will be compatible with that outlined in the nuclear section of this report.

Steel reinforcing will be new billet steel intermediate or hard grade deformed bars conforming to ASTM Designation A-15, A-16, A-408, A-305. Welded wire mesh will conform to ASTM Designation A-185. Welding of rebar will conform to AWS D 12.1.

Aluminum reinforcing will comply to requirements for the special aluminum outlined under Aluminum in this section of the report.

Minimum ultimate compressive strength of concrete at 28 days will be:

<u>Location</u>	<u>Strength</u>
Slabs on grade and walls above grade	2500 psi
Foundations, footings, piers, beams, supported slabs vault walls, and vault bottom slab	3000 psi

Structural Steel

Structural steel will conform to Standard Specifications for Structural Steel for Buildings and Bridges, ASTM Designation A-36.

Detailing, fabrication, and erection of all structural steel will conform to AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.

Welding will conform to American Welding Society "Code for Arc and Gas Welding in Building Construction", using welding electrodes as per ASTM Specification A-233.

Aluminum

Aluminum for the vault liner will be a special aluminum, developed specifically for this project to limit induced activation. The alloy will have an elemental composition as specified in the nuclear section of this report. The alloy will have good structural and welding characteristics. Filler alloy for welding the special aluminum will also be limited in those same elements.

Aluminum, other than the special aluminum alloy, will be 6061-T6 aluminum alloy, conforming to the following ASTM Designation B209-61, Aluminum Alloy Sheet and Plate and B211-61, Aluminum Alloy Extruded Bars, Rods and Shapes.

The filler metal will conform to the requirements of ASTM Designation B285-61, Specification for Aluminum and Aluminum Alloy Welding Rods and Bare Electrodes. The recommended filler alloys for TIG and MIG welding for the 6061-T6 series base metals are 4043 and 5356.

The "Boral" plate, which will be used at the bottom of the electrical chases, is a sandwich type plate which consists of a core that is 0.084 inch (minimum) in thickness and aluminum cladding on both sides, with a 0.125 inch (minimum) 1100-0 ASTM Designation. The core will be boron carbide (B_4C) crystals suspended in cast aluminum. The B_4C concentration in the core will be a minimum of 35 percent by weight.

Welding of Aluminum

The general recommendations and regulations of the American Welding Society Specification D1.0-46, "Code for Arc and Gas Welding in Building Construction" shall apply to welded aluminum structures.

Welding will be done by either the metal inert gas process (MIG) or the tungsten inert gas process (TIG). The MIG process will be used where possible and automatic welding is preferred where feasible. Both inert gas processes can be used for all position welding—flat, vertical and overhead. The shielding gas will be argon or helium or a combination of both.

HANDLING AND SPECIAL EQUIPMENT

General

Outline specifications for the handling and special equipment and associated devices are grouped together in the following paragraphs to facilitate analysis and review and to present the over-all design concept of the handling procedures.

High Bay Area Crane

The high bay area will have a 30-ton capacity with a 5-ton capacity auxiliary hoist, four motors, single trolley, double box girder overhead traveling crane for intermittent service, Class 2. The span will be approximately 72 feet centerline to centerline of rails, with a hook lift of approximately 134 feet. Lowest level to be served will be approximately 92 feet below ground floor elevation. Power will be 440 volts, 3-phase, 60 cycles, a-c. The crane will be controlled from ground floor by a 4-motor, multiple speed, pushbutton pendant master switch. Controls will be magnetic five-step for variable speed hoists, trolley, and bridge motors. Speeds will be:

Main Hoist — 30-ton — 5 fpm minimum to 15 fpm maximum

Auxiliary Hoist — 5-ton — 5 fpm minimum to 30 fpm maximum

Trolley — 5 fpm minimum to 60 fpm maximum

Bridge — 5 fpm minimum to 125 fpm maximum

Hoists will have a multidisc load brake and a solenoid electric disc brake. Both trolley and bridge drives will have electric brakes.

Upper and lower travel limit switches will be provided for the hoists and travel limit switches for the trolley and bridge.

The crane will have bullard type safety gate hook.

Electrical conductors for the bridge crane and crane runway will be of the enclosed type to meet the California Electrical Code and General Industrial safety orders.

There will be a footwalk spanning the entire bridge length on the motor drive side.

Transfer Lock Crane

The transfer lock will have a 5-ton capacity, variable speed, three motor, double I-beam, top riding overhead traveling crane for intermittent service, Class 2.

The remotely controlled bridge crane, hoist, and rails, will be required to operate within a concrete enclosure 16 ft wide by 37 ft long. A recess into the walls will be provided for the track support and for the space required for bridge and carriage.

Equipment within the enclosure will be subjected to gamma radiation.

The clear hook height of the crane system above the transfer lock floor will permit handling of the disassembly area manipulator mechanical arm and carriage assembly on a dolly.

Hook of the crane will reach the disassembly area floor. The crane will have a bullard shaped safety hook.

The crane bridge, carriage, and hoist will be equipped with position transmitters for generating signals to the indicators located on the transfer lock manipulator control console.

Crane system design will include provisions for allowing mechanical overriding of the motions of the bridge, carriage, and hoist from outside the radiation environment.

The crane will be controlled from switches located on the transfer lock manipulator control console.

Design of the crane carriage and bridge will allow the carriage to be removed and replaced by lifting vertically from the bridge.

Crane hoist will be reeved to prevent lateral movement of the crane hoist during raising and lowering of the crane hook.

The crane manufacturer will furnish electrical equipment necessary to supply bridge power and control from a junction box near the ceiling of the transfer lock to the crane. Tag-line type feed will be acceptable. A portable pushbutton station, with approximately 10 feet of flexible cable, fitted with

a plug-in connector for connection on the outside face of the transfer lock door, will also be furnished. These controls will be in addition to the controls at the manipulator control console. Controls will be five-step for variable speed hoist, trolley, and bridge motors. Control voltage will be 110 volts at pushbutton station or control console. Speeds will be:

Hoist — 5-step variable speed 5 fpm to 30 fpm

Trolley — 5-step variable speed 5 fpm to 30 fpm

Bridge — 5-step variable speed 5 fpm to 60 fpm

Hook travel will be a total of 60 feet, with a clearance of 16 feet above the transfer lock floor.

Safety features:	Mechanical and electrical stops will be provided to limit travel of the bridge, trolley, and hoist.
------------------	---

Power supply:	440-volt, 3-phase, 60-cycle alternating current.
---------------	--

Disassembly Area Crane

The disassembly area will have a 20-ton capacity, variable speed, three motor, double I-beam top riding overhead traveling crane for intermittent service, Class 2.

The clear hook height of the crane hook will be a minimum of 32 feet above the disassembly floor.

The hook will be capable of reaching the test vault floors, for a total hook travel of 80 feet. The crane hook will be a bullard shaped safety hook.

The crane bridge and carriage will be equipped with position transmitter for generating position signal readouts. The signals will be transmitted to instrumentation located on the disassembly area manipulator control console.

Control of the crane will be possible from two locations — inside the disassembly area by means of a removable, 5-step pushbutton control pendant, or from the disassembly area manipulator control console, to be located at any one of the following three positions:

— High bay, adjacent to transfer lock view window.

— Either end of the disassembly area.

The control to be used will be selected by means of a selector switch on the console. Interlocking circuitry will prevent interference with the rectilinear manipulator.

Control will be five-step for the variable speed hoist, trolley, and bridge drive motors. Control voltage at the pushbutton station for control console will be 110 volts. Speeds will be as follows:

Hoist — 5-step variable speed 5 fpm to 15 fpm

Trolley — 5-step variable speed 5 fpm to 60 fpm

Bridge — 5-step variable speed 5 fpm to 150 fpm

Hoist will have a multiple disc load brake and a solenoid electric disc brake. Both trolley and bridge drives will have electric brakes.

Upper and lower limit switches will be provided for the hoist and travel limit switches for the trolley and bridge.

Electrical conductors for the bridge crane and crane runway will be of the enclosed type to meet the California Electrical Code and General Industrial Safety Orders.

Vault Electrical Area and Pump Room Cranes

A two-ton capacity, underhung, geared, hand chain driven, single I-beam crane will be provided in each vault electrical and pump room area. The crane will span the width of the designated areas and will cover the full length of the building. The cranes will have a two-ton capacity, single speed, electric hoist suspended from a push type trolley. The hoist will have an upper limit switch, mechanical load brake and electric brake and be controlled from a pushbutton pendant suspended from the hoist. Tag line electrification will be provided for the crane bridge. Power outlets will be provided at intervals along the entire length of the building to provide power to the hoist.

The lifting speed will be 15 fpm with an overall hook lift of 38 feet for the electrical room crane and 18 feet for the pump room crane. Power shall be 220/440 volts, 3 phase, 60 cycles a-c, with 110 volts at the pushbutton control station.

Vault Vacuum Equipment Room Monorail

A two-ton capacity monorail and hoist system will be provided in the vacuum equipment room.

The monorail will consist of a standard industrial track extending the full length of the building. The hoist and trolley will be a two-ton capacity, single speed, electric hoist suspended from a push type trolley. The hoist will have an upper limit switch, a mechanical load brake and electric brake, and will be controlled from a pushbutton pendant located on the hoist. Power will be a-c 220/440 volts, 3 phase, 60 cycles, with 110 volts at the control pushbutton station. The lifting speed will be 15 fpm with an overall hook lift of 18 feet.

Disassembly Area Rectilinear Manipulator

The disassembly area rectilinear manipulator will consist of, but not be limited to the following major components— mechanical arm, telescoping tube and carriage assembly, upper bridge, lower bridge, and control console.

The mechanical arm will be a "Programmed and Remote Systems Corporation Model 6000 manipulator", as described in their Bulletins No. 4 and 5, dated May 1962. It will have a lifting capacity of 5000 pounds at the shoulder hook.

The mechanical arm, consisting of shoulder, arm sections, and hand, will have a minimum load capacity (at the hand) of 400 pounds, regardless of position of the arm.

The number of arm motions will be a minimum of five.

The hand will have a parallel jaw grip with at least 8 inches maximum opening. The hand will be capable of exerting a grip of at least 500 pounds. Opening and closing velocity shall be 20 inches per minute.

The mechanical arm will be equipped with a wrist extension feature with a minimum range of 6 inches. Reach of the mechanical arm will be a minimum of 56 inches from the shoulder axis.

The arm and carriage assembly, consisting of bridge riding carriage, telescoping tube system, and mechanical arm, will be designed to allow remote removal and replacement of the assembly by vertical movement onto and off of the bridges. Actuation will be by means of overhead cranes viewed by closed circuit television.

The lower bridge will be designed to allow remote removal and replacement of the bridge by vertical movement onto and off the floor level tracks. The bridge will be stored in the disassembly area when the removable shielding over the test vault is in place. Following removal of the shielding, it will be possible to lower the bridge onto tracks mounted on the disassembly area floor, allowing the manipulator to be lowered onto the bridge thus providing coverage of the test vault(s). The bridge will be handled by the 20-ton crane, with possible assistance of the manipulator. Bridge moving operations will be viewed by closed circuit television.

Any necessary remote handling devices, such as lifting fixtures, required to enable an overhead crane to remotely engage position and release the lower bridge will be provided as part of the manipulator system.

The lower bridge will be equipped with some means of supporting the structure when it is not resting on the test vault tracks overhead. The support will either be attached to the bridge structure or provided as a separate stand.

A dolly will be provided to store or move the disassembly area manipulator mechanical arm and carriage assembly. This structure will be utilized to move the mechanical arm and carriage assembly in and out of the transfer lock and as a work stand.

The mechanical arm and carriage assembly will be sized and the upper bridge located to permit the shoulder hook to retract and clear a point a minimum of 21-feet above the disassembly area floor, and the manipulator structure will be limited so as not to extend above 32 feet from the disassembly area floor. The mechanical arm and carriage assembly, when mounted on the lower bridge, will provide sufficient coverage for the shoulder hook to clear a point a minimum of 40 feet above the test vault floor when retracted and, when extended, the shoulder pivot of the mechanical arm to reach a point a maximum of 12 inches above the test vault floor.

The manipulator will be designed so that the mechanical arm hand (with wrist retracted) can touch all walls of both test vaults when the mechanical arm and carriage assembly are mounted on the lower bridge.

Means will be provided for remotely or automatically making and breaking power and control circuits to the lower bridge. Viewing of this operation will be limited to closed circuit television.

Means will be provided for remotely and/or automatically making and breaking power and control circuits between the arm and carriage assembly and the bridges. Viewing of this operation will be limited to closed circuit television.

A control console, consisting of a mobile cabinet, will be provided from which all motions of the mechanical arm, telescoping hoist, carriage, and the bridge in use will be controlled. Control will be by means of pistol grip or Joy-stick type handles. Instruments will be provided on the console to indicate in feet and inches horizontal position of the manipulator bridge when in use; horizontal position of the manipulator carriage; vertical position of the mechanical arm shoulder in relation to the full-up or retracted position of the telescoping tubes; horizontal position of the disassembly area 20-ton crane carriage; and horizontal position of the 20-ton crane bridge.

Instrumentation and circuitry will be included to check continuity and power load of control circuitry and/or motor systems.

Circuitry will be provided in the console to de-activate all motions of the bridge, carriage and telescoping tube hoist assembly, when a carriage, bridge, or up and down travel limit is reached. A button or other means will be provided on the console to override the lockout circuitry, permitting manipulator operation to continue except in the direction of the tripped limit switch that deactivated the system. Switches will be provided on the console for controlling the direction of rotation and speed of tools receiving power from the tool receptacles located on the mechanical arm.

The circuitry will be provided with interlocks so that the 20-ton crane hoist block, and manipulator mounted on the lower bridge cannot be moved to less than 10 feet from each other. A button or other means will be provided on the console to override the interlock circuitry, permitting crane or manipulator operation to continue.

Space will be provided on the control console for control switches for controlling the disassembly area 20-ton crane.

Crane control switches will be of the lever type.

Circuitry and a switch will be provided on the control console to enable the operator to select either the control console crane control switches or the crane control pendant located in the disassembly area as the means of controlling the disassembly area 20-ton crane.

Manipulator bridge travel speed will be continuously variable to a maximum speed of 15 fpm.

Carriage travel speed will be continuously variable to a maximum speed of 15 fpm.

Hoist (telescoping tube) speed will be continuously variable to a maximum speed of 15 fpm.

Means will be provided to mechanically override the motions of the carriage, bridges, and telescoping hoist from positions outside the radiation environment.

All motions of the mechanical arm will be protected against overload by slip clutches or similar devices.

A lifting hook (shoulder hook) will be attached to the underside of the mechanical arm shoulder.

The electrical and control system will provide a minimum of 3 stations into which the control console can be plugged to activate and operate the manipulator system. Stations will be located at (1) the transfer lock (left of window near floor), (2) at transfer lock end, of disassembly area, and (3) at opposite end of disassembly area. Sufficient flexible cable will be provided between the plug and console to allow some degree of flexibility in positioning the console.

Adjustable limit switches will limit travel of the carriage, bridge, and up and down motions of the telescoping tube.

Two, four conductor, tool power receptacles will be mounted on the mechanical arm; one receptacle mounted on the wrist housing and the second receptacle mounted vertically on the side of the shoulder housing. The receptacles will be wired in parallel. Conductors between the receptacles and control console will be rated for a minimum of 15 amps.

Transfer Lock Rectilinear Manipulator

The transfer lock rectilinear manipulator will consist of, but not be limited to, the following major components — mechanical arm, telescoping tube and carriage assembly, bridge riding on transfer lock crane rails, and control console.

The mechanical arm will be a Programmed and Remote Systems Corporation Model 3000 manipulator as described in their Bulletin No. 2, dated March 1962, with a lifting capacity at the shoulder hook of 5000 pounds.

The mechanical arm, consisting of shoulder, arm sections and hand, will have a minimum load capacity (at the hand) of 160 pounds regardless of position of the arm.

The number of arm motions will be a minimum of 5.

The hand will have a parallel jaw grip with at least 4 inches maximum opening. The hand will be capable of exerting a grip of at least 200 pounds. Opening and closing velocity will be 20 inches per minute.

The mechanical arm will have a wrist extension feature with a minimum range of 4 inches. Reach of the mechanical arm will be a minimum of 40-1/2 inches from the shoulder axis.

The arm and carriage assembly, consisting of bridge riding carriage, telescoping tube system and mechanical arm will be designed to allow remote removal and replacement of the assembly by vertical movement onto and off of the bridge. Actuation will be by means of overhead cranes viewed by closed circuit television or a lead glass viewing window.

The bridge will be designed with one fixed crossbeam and one swinging or pivoted crossbeam. The swinging beam will provide sufficient clearance, when swung open to allow the carriage and arm assembly to be lowered between the beams.

A control console consisting of a mobile cabinet will be provided from which all motions of the mechanical arm, telescoping hoist, carriage and bridge will be controlled. Control will be by means of pistol grip or Joy-stick type handles.

Instruments on the console will indicate, in feet and inches, horizontal position of the manipulator carriage and manipulator bridge, vertical position of the mechanical arm shoulder in relation to the full up or retracted position of the telescoping tubes, horizontal position of the transfer lock crane carriage and crane bridge, and vertical position of the crane hook.

Instrumentation and circuitry will be included to check continuity and power load of control circuitry and/or motor systems. Space will be provided on the control console for transfer lock crane controls.

Crane controls will consist of lever type switches.

Circuitry in the console will deactivate all motions of the bridge, carriage, and telescoping tube hoist assembly, when a carriage, bridge, or up and down travel limit is reached. A button or other means will be provided on the console to override the lockout circuitry, permitting manipulator operation to continue except in the direction of the tripped limit switch which de-activated the system.

Bridge travel speed will be continuously variable to a maximum of 15 fpm.

Carriage travel speed will be continuously variable to a maximum speed of 15 fpm.

Hoist (telescoping tube) speed will be continuously variable to a maximum speed of 15 fpm.

Verticle travel of the mechanical arm will be sufficient to permit the shoulder-upper arm pivot to extend to within 24 inches of the transfer lock floor and retract to an upper position of 12-1/2 feet above the transfer lock floor.

Means will be provided to mechanically override the motions of the carriage, bridge, and telescoping hoist from a position outside the radiation environment.

All motions of the mechanical arm will be protected against overload by slip clutches or similar devices.

A lifting hook (shoulder hook) will be attached to the underside of the mechanical arm shoulder.

Adjustable limit switches will be provided to limit travel of the carriage, bridge, and up and down motions of the telescoping tube.

Two, four conductor tool power receptacles will be mounted on the mechanical arm; one receptacle will be mounted on the wrist housing and the second receptacle will be mounted vertically on the side of the shoulder housing. The receptacles will be wired in parallel. Conductors between the receptacles and control console will be rated for a minimum of 15 amps.

The bridges and runway will be provided with positive travel stops.

Master-Slave Manipulators

Two, thru-wall master-slave manipulators will be provided for use in the transfer lock for detail remote operations. One manipulator will be of the heavy duty type and the other standard duty.

Heavy Duty Master-Slave Manipulator

The manipulator will be of the latest model of the Central Research Laboratories, Inc., Model F rugged-duty, extended reach master-slave manipulator.

The heavy duty ("rugged-duty") manipulator will be interchangeable in mounting with the Model 8 standard duty manipulator. (Refer to 3.8.1.2.1, AI Specification NF 7568-90-001).

Shielding and air flow restriction provisions will be provided in the wall thru-tube.

The manipulator will have electrically actuated azimuth and lateral motion controls for adjusting the slave end in relation to the master end.

The manipulator will have motion locks for X, Y, and Z motions.

The manipulator will be of a design to adequately maintain the pressure leak tightness integrity of the transfer lock.

Manipulator tongs will be of the remotely interchangeable type. Tong changing fixtures will be supplied.

The manipulator and installation shall be so designed that the manipulator can be removed from the operating side (outside) of the shielded wall.

The length of the thru-wall tube will be as recommended by the manipulator manufacturer (Central Research Laboratories, Inc.). Length of tube and slave pivot to inside wall dimensions will be optimized for the thickness of the transfer lock end wall (wall with window).

Standard Duty Master-Slave Manipulator

The manipulator will be the latest model of the manipulator, identified as the Model 8 Master Slave manipulator, manufactured by Central Research Laboratories.

The standard duty Model 8 manipulator will be interchangeable in the mounting with the heavy duty master-slave manipulator.

The wall thru-tube will have shielding and air flow restriction provision.

The manipulator will have motion locks for X, Y, and Z motions.

The manipulator will be equipped with electrically actuated azimuth and lateral motion control for adjusting the slave end in relation to the master end.

The manipulator will be of a design to adequately maintain the pressure and leak tightness integrity of the transfer lock.

Manipulator tongs will be of the remotely interchangeable type. Tong changing fixtures will be supplied.

A 60 pound capacity, remotely interchangeable load hook, which attaches to a sleeve on the outside of the booting, and a changing fixture will be provided.

The manipulator and installation will be designed so that the manipulator can be removed from the operating side (outside) of the shielded wall.

Length of the thru-wall tube will be as recommended by the manipulator manufacturer (Central Research Laboratories). Length of tube and slave pivot to inside wall dimensions will be optimized for the thickness of the transfer lock end wall (wall with window).

Transfer Lock Radiation Shielding Viewing Window

A shielding window will be provided to allow viewing of operations being performed with the manipulators and general viewing of the inside of the transfer lock. The shielding window will meet the following requirements:

- The shielding window will be a non-browning, lead glass, oil filled type, with a viewing angle of 58 degrees up and down and 65 degrees left and right.
- The shielding window assembly will consist of, but not be limited to the following major components: sealed window unit, wall thimble (cast in, or otherwise a permanent part of the wall), cover glasses, and oil fill and drain piping.
- The required window dimensions will be determined from the necessary viewing angles in all directions. The out-of-cell side of the window will provide sufficient width to allow two operators to view through the window simultaneously.

- The lead glass composition, number of slabs required and dimensions will be determined to give the equivalent radiation shielding protection as the cell walls. With the maximum dose rate for the various energies of gamma radiation expected, the shielding will not allow exposure to operators in excess of allowable levels.
- The glass specifications for number of inclusions, transmission properties, non-reflective surface coatings, etc., will conform to the lead glass specifications as standardized by the Argonne National Laboratory (ANL).
- The sealed window assembly will contain the materials, protective coatings, etc., to withstand maximum radiation exposure and minimize any reactions with the window oil.
- Design of the sealed window casing will have sufficient clearance between the bottom side of the casing and wall thimble to install a shielding block and roller-plate assembly for installing and removing the window unit.
- The sealed window assembly will be installed in a wall thimble and be made removable from the out-of-cell side.
- Oil drain grooves will be provided in each section of the window casing to allow free oil flow under the lead glass slabs and lead sheet cushions.
- Two drain lines will be provided, one on each side of the casing at the lowest drain points, and terminated with valves on the out-of-cell side to provide for in-place window draining and flushing.
- The window drain and fill lines will terminate on the out-of-cell side with the necessary expansion tanks, bladders, shut-off and valves.
- A protective cover glass installed in a removable frame will be installed on the in-cell side of the window thimble.
- The protective cover glass assembly and out-of-cell sealed window enclosure will be made for gas-tight seal installation.
- A separate plate and seal will be provided to seal between the window assembly and thimble approximately 8 inches in from the operating gallery side of the window assembly.

Passenger Elevator

The passenger elevator will be a 2000-pound capacity, electrically operated unit, servicing five levels of the facility, from grade to the lower vacuum area level (vertical distance of approximately 90 feet). Hoisting equipment will be located at the top of the elevator shaft. The platform will be approximately 6 feet by 5 feet and will be provided with automatic self leveling devices, including automatic power operated car and hoistway doors for all five levels. The speed will be 200 fpm. Power supply will be 440/220-volt, a-c, 3 phase, 60 cycles. Car position indicators will be provided. Guides for the car and counterweights are part of the elevator equipment.

Disassembly Area and Test Vault Camera Traverse Equipment and Remote Connectors

TV traverse camera positioning equipment will be used to remotely position the television cameras during remote handling operations. The traverse carriages will be portable and will normally be stored out of the cell complex or in the disassembly areas during reactor operation. Cabling and remote plugs will be provided for plugging the cameras in remotely into connection boxes in the disassembly area and test vaults. The equipment will meet the following requirements:

The disassembly area and test vault traverse equipment will consist of, but not be limited to the following major components: motorized carriage, horizontal wall storage tracks, cabling, carriage electrical components, and remote plug. Stationary TV connector boxes, with necessary receptacles and wiring to the control console, are also included as components of this equipment.

Ten systems, consisting of complete traverse carriages, cabling, and remote plugs, will be provided. Ten units provided for a spare system.

The traverse system equipment will incorporate applicable features shown on AI Drawings 7568-85017 and 7568-85018.

Hooks, brackets, or similar means, will be provided as part of the traverse carriages for storage of flexible cabling and remote plug during remote storage, installation of, and/or moving of a camera carriage.

The traverse system will be equipped with limit switches for limiting vertical travel of the camera and horizontal travel or the indication of an obstruction to horizontal travel of the carriage.

Horizontal wall rails will be located to provide maximum vertical coverage of the disassembly area and the test vaults.

Horizontal wall rails will be mounted on all four walls of disassembly area and test vaults.

Multi-conductor flexible cable will be provided between carriages and remote plugs.

Cabling will have sufficient conductors of adequate gage and will be shielded as required, for power and control of carriage drive motors, limit switches, motor braking, pan-tilt units with centering indicator switches, and camera circuits. In addition, each cable will include four number 16 AWG and two number 18 AWG spare conductors for future requirements.

Flexible cabling will terminate in a special remote plug as shown in AI Drawing 7568-85015. The remote plug housing will be made of aluminum. The plug will be wired in accordance with AI wiring schedules.

Television connection boxes similar to those shown on AI Drawing 7568-85016 will be provided to mate with the remote plugs. Housings of the connector boxes will be of aluminum.

Connector boxes will be of three types: single, dual, and triple. Single boxes will contain a single receptacle; dual connector boxes will contain two receptacles; triple connector boxes will contain three receptacles.

Each connector box will be equipped with receptacles, guide fences, and guide pin holes.

Six connector boxes providing eight receptacles will be located in each test vault. Boxes will be located to be accessible to the manipulator for remote plugging in and unplugging of the remote plugs.

Connector boxes will be located to allow a minimum restraint on the traverse camera carriages and minimum flexible cable lengths.

Connector boxes will be located as follows: one dual box will be located adjacent to each vault end wall and two single boxes will be located adjacent to each side wall. Single boxes will be separated as required.

Twelve connector boxes providing 24 receptacles will be located in the disassembly area. Boxes will be located to be accessible to the manipulator for remote plugging in and unplugging of the remote plugs.

Connector boxes will be located to allow a minimum restraint on the traverse camera carriages and minimum flexible cable lengths.

Connector boxes will be located in the disassembly area as follows: two dual boxes will be located adjacent to each side wall above each test vault (total of four dual boxes on each disassembly area side wall), and two dual boxes will be located adjacent to each end wall.

Cabling or groups of conductors providing, as a minimum, the same number and type of conductors as contained in the flexible remote plug to traverse unit cables, will run from each receptacle. Conductors from connector box receptacles will terminate adjacent to the receptacles in the rear of the TV control console.

Conductors will be of a type and have insulation capable of resisting radiation exposure.

Two free standing temporary storage fixtures will be provided on which a traverse carriage, with cabling and remote plug, can be lowered by a crane. The fixtures will be transportable by crane either empty or when supporting a traverse carriage.

The fixtures will be inserted through the roof of a test vault and set on the floor loaded or unloaded so that the manipulator can pick up the traverse unit and set the unit on the horizontal wall tracks.

If the weight of a complete traverse unit with camera, cable, and remote plug exceeds 400 lbs (capacity of manipulator arm), a fixture will be provided for remotely placing a traverse system on the horizontal wall tracks.

The fixture will be capable of being supported and manipulated by a crane hook and/or shoulder hook of the manipulator.

Transfer Lock Television Provisions

Equipment will be provided in the transfer lock so that in addition to the shielded window, television equipment can be used for viewing. The equipment will meet the following requirements:

The transfer lock television equipment will consist of, but not be limited to the following: TV connection boxes, and traverse system tracks (horizontal only). Horizontal only type traverse carriages are not part of this specification.

The traverse system tracks will be suitable for use with existing TV equipment. The design will incorporate applicable features shown on AI Drawing 7512-22538.

One track will be located on each side wall and across the rear (wall at opposite end of cell from window) wall. Total of three tracks will be provided.

Two triple (3 receptacle) connection boxes (Ref. 3.8.2.1.2 (K), providing six receptacles will be located in the transfer lock.

One connection box will be located adjacent to each side wall of the transfer lock. Box locations will be between the lock to disassembly area opening and lock rear.

Wiring of transfer lock connection boxes will be identical with disassembly area and test vault boxes.

MECHANICAL

General

All equipment will be standard, commercially available items, factory assembled and tested.

Heating, Ventilating and Air Conditioning

1. Air Conditioning Unit AC-1 will be a packaged sprayed coil conditioner and will operate under the following design conditions:

CFM — 6800

<u>Cooling</u>	<u>WB° F</u>	<u>DB° F</u>
Air In	70.2	99
Air Out	51.4	53

Heating

Preheat	39° to 75°
Reheat	53° to 80°

Coils

Cooling — Direct Expansion

Heating — Hot Water

Fan 2-1/4 in. w. g. , 5 hp

Compressor/Condenser — 40 hp, Water Cooled, 34 Tons Capacity

Filters High Efficiency
Automatic Roll Type
Face Velocity 250 fpm

2. Air Conditioning Unit AC-2 will be a package air conditioning unit and will operate under the following design conditions:

CFM — 3280

<u>Cooling</u>	<u>WB[°]F</u>	<u>DB[°]F</u>
Air In	67	89
Air Out	51.5	53

Heating — 53 to 85

Coils

Cooling — Direct Expansion

Heating — Hot Water

Fan 2-1/4 in. w.g., 2 hp

Compressor/Condenser — 15 hp Water Cooled, 13 Tons Capacity

Filters High Efficiency Type
Face Velocity - 200 fpm

3. Air Conditioning Unit AC-4 will be a package air conditioning unit and will operate under the following design conditions:

CFM — 800 cfm Air or 720 cfm Nitrogen

<u>Cooling</u>	<u>WB[°]F</u>	<u>DB[°]F</u>
Air In	65.5	84
Air Out	53.5	55
Nitrogen In		100
Nitrogen Out		60

Cooling Coil — Direct Expansion

Preheat Coil — Hot Water

Fan 1-1/4 in. w.g., 1/3 hp

Compressor/Condenser — 3 hp, Water Cooled, 2.4 Tons Capacity

4. Air Conditioning Unit AC-5 will be a package air conditioning unit and will operate under the following design conditions:

CFM — 4400 Air or 4300 Nitrogen

<u>Cooling</u>	<u>WB °F</u>	<u>DB °F</u>
Air In	62.5	76
Air Out	53.5	55
Nitrogen In		100
Nitrogen Out		77

Cooling Coil — Direct Expansion

Fan 1-1/2 in. w.g., 2 hp

Compressor/Condenser — 10 hp, Water Cooled, 10 Tons Capacity

5. Air Conditioning Units AC-6A, AC-6B, AC-7A, and AC-7B will be package air conditioning units and will operate under the following design conditions:

CFM — 3000 Air or Nitrogen

<u>Cooling</u>	<u>WB °F</u>	<u>DB °F</u>
Air In	62.7	76
Air Out	53.5	55
Nitrogen In		100
Nitrogen Out		59

Cooling Coils — Direct Expansion

Fan 1-3/4 in. w.g., 2 hp

Compressor/Condenser — 10 hp, Water Cooled, 10 Tons Capacity

6. Air Conditioning Unit AC-8 will be a fan coil unit and will operate under the following design conditions:

CFM — 9500

<u>Cooling</u>	<u>WB °F</u>	<u>DB °F</u>
Air In		115
Air Out		100
<u>Cooling Coil</u> — 85°F Water with 10°F Rise		
<u>Fan</u>	1-3/4 in. w.g., 5 hp	

7. Outside air preheat coils for units AC-4, AC-5, AC-6A, AC-6B, AC-7, AC-7B, and AC-8 will be hot water coils sized to heat 200 cfm from 30 to 85 F.
8. Filters
 - a. Outside air filters will have 85 percent efficiency, using the NBS discoloration test and atmospheric dust. Initial pressure drop will be .10 in. w.g. The filters will have a replaceable media prefilter pad, strainer mat, and high efficiency extended area filter.
 - b. High efficiency air conditioning filters will have 80 percent efficiency, using the NBS Cottrell precipitate test.
 - c. Absolute filters will have 99.97 percent efficiency with the DOP smoke test and will have prefilters.
 - d. Activated charcoal filters will be a special element type rated to remove 99.99 percent of all iodine in the air stream.
 - e. Prefilters will be rated at 35 percent efficiency by the NBS discoloration test.
9. Coils

Water coils will be extended surface coils, with 5/8 in. OD, with copper tubes, aluminum fins, and cast iron headers.

Direct expansion coils will be copper extended surface with aluminum fins.
10. Convectors will be conventional finned type copper convectors with covers. Capacities will be as follows:

Air Lock — 1200 Btu/hr

Hot Change Room — 3520 Btu/hr

Locker Room — 2 units 4000 Btu/hr (each)

Men's Toilet — 4820 Btu/hr

Women's Toilet — 2 units 1800 Btu/hr (each)

11. Supply units will be package ventilating sets with heating coils and/or filters as follows:

<u>Design</u>	<u>Type</u>	<u>CFM</u>	<u>In. W.G.</u>	<u>HP</u>	<u>Air Temp. Rise Coil °F</u>	<u>Filters</u>	
						<u>Face Velocity FPM</u>	<u>Type</u>
S-1	SWSI Cent.	2,600	1	1	-	375	High Eff.
S-2A & S-2B	DWDI Cent.	21,500	1-1/4	10	30 - 65	350	High Eff.
S-3	SWSI Cent.	870	7/8	1/3	-	310	High Eff.
S-4	SWSI Cent.	2,500	3/4	3/4	-	340	High Eff.
S-5	DWDI Cent.	43,000	1-1/2	20	-	345	High Eff.

12. Exhaust Fans will be as follows:

<u>Design</u>	<u>Type</u>	<u>CFM</u>	<u>In. W. G.</u>	<u>HP</u>
E-1	Vent. Set	2,600	3/4	3/4
E-2A, E-2B E-2C	{ SWSI Cent.	43,000	5	50
E-3A, E-3B	{ SWSI Cent.	1,200	6	2
E-4	Roof Exhauster	530	1/4	1/8
E-5A, E-5B	Vent. Set	2,600	1-1/2	1-1/2
E-6	Roof Exhauster	770	1/4	1/8

13. Low Volume Exhaust Filter Sets will consist of a prefilter and air absolute filter. Each set will be sized for 200 cfm.
14. High Volume Exhaust Filter Sets will consist of prefilters and absolute filters housed in a steel plenum. The capacity will be 43,000 cfm.
15. The Boiler will be a gas-fired package unit, with a net output of 2,400,000 Btu/hr. The boiler will heat 240 gpm of water from 160° F to 180° F with natural gas. Rating will be at 1800 ft above sea level and will be FIA approved.
16. Pumps P-4A and P-4B will each circulate 240 gpm of hot water at 180° F against 80 ft head. The pump will be a 7-1/2 hp close coupled centrifugal pump.
17. Radioactive Holdup Gas Compressors will be single-stage diaphragm type, with a capacity of 10.65 cfm of nitrogen. Discharge pressure will be 150 psig and suction pressure 0 psig. The compressor will be equipped with a 5 hp motor, belt drive, and an aftercooler.
18. Radioactive Gas Holdup Tanks will each have a capacity of 2500 cubic feet water volume. Each tank will be 22 ft by 12 ft diameter and operate at 150 psig. The vessels will be constructed in accordance with ASME Code for Unfired Pressure Vessels.

19. Cooling Towers CT-2A, CT-2B, and CT-2C will be package type units, hot dipped galvanized after fabrication. Basin will be concrete and decking will be redwood, cypress, or pressure treated fir. The units will have a capacity of 540 gpm from 95 F to 85 F at a wet bulb of 75 F. Each unit will be equipped with a chemicator feeder.
20. Service Cooling Water Pumps P-3A, P-3B, and P-3C will be 10 hp centrifugal close coupled pumps. Pumps will be rated 540 gpm at a head of 60 ft.

Plumbing

Material and installation will be in accordance with the Uniform Plumbing Code.

1. Liquid Waste Holdup Tanks T-2A and T-2B will be 9 ft diameter, 20 ft long, and 9750 gallon steel tanks.
2. Mechanical Room Sump Pump P-6 will be a vertical 1-1/2 hp centrifugal, with a capacity of 25 gpm at a head of 60 ft.
3. Liquid Waste Holdup Tank Pumps P-7A and P-7B will be flange mounted 1-1/2 hp vertical wet sump pumps. Capacity will be 75 gpm at a head of 40 feet.
4. Emergency shower and eyewash units will be walk-in type with enameled shields, 12 nozzles, and push type valve. Eyewash unit will deluge the whole face and will have a stainless steel bowl.

Demineralized Water System

1. Demineralized water pumps P-2A and P-2B will be stainless steel 25 hp centrifugal pumps and will deliver 514 gpm against a head of 130 ft.
2. Expansion tank will be an aluminum vessel, 320 gallons capacity, 3 ft in diameter and 6 ft long. The tank will be designed in accordance with the ASME Code for Unfired Pressure Vessels for a working pressure of 50 psig.
3. Storage Tank T-3 will be a vented horizontal welded aluminum storage tank with a capacity of 320 gallons.

4. Distilled Water Pump P-8 will be a 1-1/2 hp stainless steel centrifugal pump. The pump will deliver 10 gpm against a head of 80 ft.
5. Demineralizers DM-1A and DM-1B will be mixed bed type and will be suitable for a flow of 10 gpm. The demineralizer will be designed for 100 psig working pressure and will be lined with an epoxy coating.
6. Heat Exchangers HE-2A and HE-2B will be shell and tube and will cool 514 gallons of demineralized water from 99.5 F to 95 F. Entering temperature of the cooling water will be 85 F and 232 gpm will be used. The exchanger will be aluminum designed for a working pressure of 50 psig.

Compressed Air System

1. Air Compressors C-1 and C-2 will be factory assembled, self contained compressors with receiver, aftercooler, controls, and safety devices. The unit will supply 100 scfm at 100 psig and be equipped with a 20 hp motor.
2. Air Dryer AD-1 will be an automatic desiccant type dryer, rated for a flow of 100 scfm at 100 psig. Discharge air will have a maximum dew point of -30 F.

Liquid Nitrogen System (LN₂)

LN₂ tank will contain 250,000 scf of nitrogen (2700 gal liquid), and will be a dewar designed for 50 psig operating pressure. The tank will be equipped with an atmospheric vaporizer capable of continuously generating 7800 scfh of GN₂ at 100 psig.

Piping

Piping will be in accordance with the following specification sheets:

SPECIFICATION A — Low Volume Purge, High Volume Purge, and Gas Holdup Systems.

PIPE — A.S.T.M. A-53, Grade B, steel, seamless, Sch. 40.

FITTINGS — 2-Inch and Smaller
A.S.T.M. A-105, Grade II, forge steel, 2000 lb, socket weld.

2-1/2-Inch and Larger
A.S.T.M. A-234, Grade B, steel, butt weld, Sch 40.

FLANGES — 2-Inch and Smaller
A.S.T.M. A-105, Grade II, forged steel 150 lb, R.F. socket weld.

2-1/2-Inch and Larger
A.S.T.M. A-105, Grade II, forged steel, 150 lb, R.F. weld neck.

BOLTING — Continuous thread stud bolts, A.S.T.M. A-193, Grade B7.
Hex nuts, A.S.T.M. A-194, Grade 2H.

GASKETS — Compressed asbestos, 1/16-inch thick.

VALVES — 2-Inch and Smaller
A.S.T.M. A-105, Grade II, cast steel 600 lb, socket weld, bolted bonnet, O.S.&Y.

2-1/2-Inch and Larger
Butterfly — steel body, 150 lb.
Check — A.S.T.M. 216, steel, 150 lb flanged, horizontal swing.

SPECIFICATION B — Vault Cooling Water System and All Piping
Penetrating Test Vaults.

PIPE — A.S.T.M. B-345, Type 3003-H14, Sch. 40.

FITTINGS — 2-Inch and Smaller
A.S.T.M. B-361-WP3003, aluminum socket weld.
2-1/2-Inch and Larger
A.S.T.M. B-361-WP3003, aluminum, butt weld, Sch. 40.

FLANGES — 2-Inch and Smaller
A.S.T.M. B247-3003, aluminum, 150 lb, F.F., socket
weld.
2-1/2-Inch Thru 12-Inch
A.S.T.M. B247-3003, aluminum, 150 lb, F.F., weld neck.
14-Inch and Larger
A.S.T.M. B247-3003, aluminum, 150 lb, F.F., slip-on.

BOLTING — Continuous thread stud bolts or hex head, machine bolts and
hex nuts A.S.T.M. B316-6061-T6.

GASKETS — Compressed asbestos, 1/16-inch thick.

VALVES — 2-Inch and Smaller
150 lb packless diaphragm valve, unlined aluminum body,
with buna

N - Diaphragm and disc insert, screwed.

2-1/2-Inch and Larger
150 lb Weld end, aluminum, O.S.&Y., with extended stem
and yoke, A.S.T.M. B-26-60T, Grade 2 C 81A.

Check

150 lb Weld end, aluminum, horizontal swing, A.S.T.M.
B-26-60T, Grade 2 C 81A.

SPECIFICATION C — Cooling Tower Water System and Diesel Oil System.

PIPE — A.S.T.M. A-53, Grade B, steel, seamless, Sch. 40.

FITTINGS — 2-Inch and Smaller
300 lb Malleable iron, screwed.

2-1/2-Inch and Larger
A.S.T.M. A-234, Grade B, steel, butt weld, Sch. 40.

FLANGES — 2-Inch and Smaller
A.S.T.M. A-105, Grade II forged steel, 150 lb R.F. socket weld.

2-1/2-Inch and Larger
A.S.T.M. A-105, Grade II, forged steel, 150 lb R.F. weld neck.

BOLTING — Continuous thread stud bolts, A.S.T.M. A-193, Grade B7.
Hex nuts, A.S.T.M. A-194 Grade 2H.

GASKETS — Compressed asbestos, 1/16-thick.

VALVES — GATE
2-Inch and Smaller
150 lb Screwed, bronze, rising stem, union bonnet, solid wedge disc, A.S.T.M. B-62.

2-Inch and Larger
125 lb Flanged, non-rising stem, iron body, bronze trim, A.S.T.M. A-126B.

GLOBE
2-Inch and Smaller
200 lb, Screwed, bronze, union bonnet, plug type disc, A.S.T.M. B-61.

2-1/2-Inch and Larger
125 lb, C. I., Flanged, I. B. B. M. O. S. & Y. bolted bonnet, A.S.T.M. A-126, Class B.

CHECK
2-Inch and Smaller
200 lb, Screwed, bronze, Y pattern, horizontal swing, A.S.T.M. B-61.

2-1/2-Inch and Larger
125 lb, C. I., Flanged, I. B. B. M., A.S.T.M. A-126 Class B.

SPECIFICATION D — Gaseous Nitrogen and Compressed Air Systems

<u>PIPE</u>	A. S. T. M. A-53, Grade B, Galvanized, Sch. 40.
<u>FITTINGS</u>	<u>2-Inch and Smaller</u> A. S. T. M. A-105, Grade II, Forged steel. 2000 lb, screwed, galvanized.
<u>FLANGES</u>	<u>2-Inch and Smaller</u> A. S. T. M. A-105, Grade II, Forged steel. 150 lb, R. F. threaded, galvanized.
<u>BOLTING</u>	Continuous thread stud bolt, A. S. T. M. A-193, Grade B-7. A. S. T. M. A-307, Grade B. Hex nuts, A. S. T. M. A-194, Grade 2H.
<u>GASKETS</u>	Compressed asbestos, 1/16-inch thick.
<u>VALVES</u>	<u>2-Inch and Smaller</u> <u>Globe</u> - 200 lb, Screwed, bronze, union bonnet, plug type disc, A. S. T. M. B-61. <u>Check</u> - 200 lb, Screwed, bronze, Y pattern, horizontal swing A. S. T. M. B-61.

SPECIFICATION E — Potentially Contaminated Liquid Waste System

PIPE — A.S.T.M. A-53, Grade B, Steel, seamless, Sch. 40.

FITTINGS — 2-Inch and Smaller
A.S.T.M. A-105, Grade II, Forged Steel, 2000 lb, socket weld.

2-1/2-Inch and Larger
A.S.T.M. A-234, Grade B, Steel, butt weld, Sch. 40.

FLANGES — 2-Inch and Smaller
A.S.T.M. A-105, Grade II, Forged steel, 150 lb, R.F.,
socket weld.

2-1/2-Inch and Larger
A.S.T.M. A-105, Grade II, Forged steel, 150 lb, R.F.
weld neck.

BOLTING — Continuous thread stud bolts, A.S.T.M. A-193, Grade B-7.
Hex nuts, A.S.T.M. A-194, Grade 2-H.

GASKETS — Compressed asbestos 1/16-inch thick.

VALVES — 2-Inch and Larger
Butterfly - 150 lb, C.I. Body.

SPECIFICATION F — Domestic Water

PIPE — Above Ground
A.S.T.M. A-120, Steel, galvanized, Sch. 40.

Below Ground
A.S.A. A-21.6, Class 150, C.I. with mechanical joints.
1/16-Inch seal coated, cement lining.

FITTINGS — Above Ground
300 lb, Malleable iron, screwed, galvanized.

Below Ground
A.S.A. A-21.10, For short body fittings, Class 250 lb.

VALVES — 150 lb, Bronze gate, screwed post indicator valves, under-
writers approved type.

SPECIFICATION G — Natural Gas

PIPE — A.S.T.M. A-120, Steel, Sch. 40.

FITTINGS — A.S.T.M. A-277, Malleable iron, screwed.

VALVES — 175 lb, Steel, flanged, lubricated plug cocks or 150 lb bronze gate valve screwed. Check valve 200 lb bronze screwed.

SPECIFICATION H — Sanitary Sewer

PIPING 2-Inch and Smaller - Above Ground
Pipe A.S.T.M. A-120, steel, galvanized Sch. 40, with
durham fittings.

2-1/2-Inch and Larger - Above Ground
A.S.A. A-40.1, Tar coated, standard weight, cast iron
soil pipe, and fittings.

ELECTRICAL

Electrical Work - Exterior

Scope of Work

Furnish and install a 4160-volt, 3-phase, 60-cycle primary distribution system, outdoor power centers, fence security lighting, grounding, and the low voltage distribution system for power and lighting of all externally located equipment with the exception of electrical equipment located on the facility exterior walls.

Codes

Installation will comply with applicable sections of the State of California Electrical Safety Orders, and Rules for Overhead Line Construction, General Order No. 95.

4.16 kv, 3-phase, Primary Distribution System

— General

The existing overhead primary distribution system is a 4.16 kv 3-phase, 3-wire, 60-cycle system.

— Primary Feeder

The 4.16 kv primary feeder will be run overhead from the existing 4.16 kv primary distribution system along the south side of the fenced project line, and will be run underground from the project line to the incoming cubicle of one of the new power centers located near the facility on the west side. Overhead construction will include modification of existing poles and furnishing and installation of new poles, crossarms, insulators, disconnects, lighting arrestors, hardware, conductors, etc. Underground construction will include furnishing and installation of all conduit, including riser at pole, pot head, bushings etc.

Outdoor Power Centers

Furnish and install two complete outdoor power centers. One will provide power to the test essential equipment, while the other will provide power to the interruptible equipment.

Power centers will be of the outdoor type suitable for use on a 4.16 kv, 3-phase, 60-cycle system, and will consist of an incoming line section, a transformer, and low voltage distribution switchgear.

Incoming sections will consist of a two-position air interrupter switch, rated 600-ampere continuous, power fuses, cable terminations and space heaters, all housed in all outdoor weatherproof housing, close connected to the transformer. One of the incoming sections will be provided with double lugs for the incoming primary feeder.

Transformers will be oil-insulated and rated 1000 kva, 3-phase, 60-cycles, 55 degree C temperature rise, 4.16 kv, delta primary, 480/277 volts wye secondary, with full capacity neutral brought out. High voltage windings will be provided two 2-1/2 percent taps above and two 2-1/2 percent taps below normal, fully rated and externally operated by a manual tap changer arranged for pad locking in each position. Design will be such that taps may be changed only when the transformer is de-energized. Wiring and provisions will be provided for future addition of forced ventilation.

A suitable throat will be provided for connection from the transformer to back of the low voltage switchgear.

The low voltage distribution switchgear will be of an outdoor, weatherproof, metal enclosed assembly. Each switchgear will consist of a metering compartment, a main circuit breaker, and molded cases for branch feeder. Switchgear will be arranged adjacent to one another, but will not be electrically tied together. Switchgear will have provisions for rear connections to their respective transformers. Secondary feeders will be armored cable, as specified in the paragraph entitled Wire and Cables. Provisions will be made in the test essential switchgear for connections to the emergency power. The metering section will have a kilowatt-hour meter, ammeter, voltmeter, current transformers and switches. The main breaker will be an air circuit breaker rated at 480 volts, with a minimum interrupting rating of 50,000 symmetrical rms amperes. Feeder breakers will be molded case circuit breakers with a minimum interrupting rating of 25,000 symmetrical rms amperes. Switchgear buses will be braced for 50,000 symmetrical rms amperes.

Fence Security Lighting

Fence security lighting will be a series lighting system similar to the existing fence security lighting. Series lighting luminaires will be Westinghouse Type AK-10 with automatic latch and hinge, with refractors for asymmetrical I. E. S. Type II Distribution, or equal.

Constant current transformer will be rated at 10 kw with a 20-ampere secondary. Primary voltage will be 4160 volts tapped from overhead line feeding new power center.

Control will be by time clock with astronomical dials located in the facility.

Installation will include all pole, brackets, cable, and conduit necessary for a complete installation.

Grounding

— System Grounding

The neutral bus of the substation will be connected to the facility ground bus (see paragraph entitled Electrical Work-Interior) by a No. 4/0 bare copper ground wire.

— Equipment Grounding

All metallic conduits, junction boxes, and all non-current-carrying part of metallic parts of equipment will be grounded by connection to the facility ground bus.

Low Voltage Distribution for Power and Lighting

— Conduit

All conduit to electrical equipment located outside the facility will be run underground. Conduit will be a 3/4 inch minimum ID, zinc coated rigid steel, with two coats of No. 50 Bitumastic paint before installation and encased in a minimum of 3 inches of red concrete all around.

— Flexible Conduit

All connections to motors, solenoids, and other vibrating equipment will be with liquid tight flexible conduit a minimum of 12 inches long.

— Lighting

All fixtures at outdoor work areas will be of the vapor proof, industrial, incandescent lamp type design.

— Cable

Cables will conform to the paragraph entitled Electrical Work Interior, Wires and Cables.

Electrical Work - Interior

Scope of Work

Furnish and install the interior electrical system complete, including low voltage distribution, lighting, control, grounding, special power sources, telephone, television communication, fire alarm, and warning systems, etc.

Codes

Installation will comply with applicable sections of the State of California Electrical Safety Orders.

Grounding

— General

Furnish and install two separate ground systems, one for the facility and one for instrumentation.

— Facility Ground System

The facility grounding system will consist of a No. 4/0 bare copper ground bus run underground around the periphery of the building and driven ground rods. Unless otherwise specified, all exposed non-current carry metallic parts of electrical equipment, raceway system, building steel, and neutrals or wiring systems will be directly or indirectly electrically connected to the ground bus as required. Resistance to ground at any building column will not exceed five ohms.

— Instrumentation Ground System

A separate ground system will be installed in the facility for the test system instrumentation. This system will be connected to the facility ground at one point only.

Raceways and Conduit

— Conduit

All conduit, with the exception of that run in the test vaults, will be zinc coated, rigid steel, 3/4 inch minimum ID. Conduits run underground or embedded in concrete will be given two complete coats of No. 50 Bitumastic paint before installation.

Rigid aluminum conduit, 3/4 inch ID minimum will be run in the test vault. Under no circumstances will rigid aluminum conduit be embedded in concrete or run underground.

Exposed conduit will be supported a minimum of every 10 feet, and will be run perpendicular or parallel to walls, structural members, and ceilings. Expansion fittings will be used to provide for expansion and contraction where conduits cross expansion joints.

All conduit runs to motors, solenoid valves, or other vibrating equipment will be terminated by liquid tight flexible metal insulated type grounding. Bushings will be installed at the end of each conduit run, terminating under switchboards and motor control centers.

— Cable Trays

Furnish and install a complete cable tray system in the chase and tunnel system. Trays will be of the ladder type, with cross channels spaced not more than six inches on centers. Minimum inside depth will be 3 inches. Trays will be fabricated from not less than 0.081 inch-thick No. 5052 aluminum alloy.

— Wireway (Or Lay-In-Duct)

Wireway will be of the size as indicated. Wireways will be provided with a front mounted hinged cover. Wireways will be fabricated of a minimum 14 gage sheet steel.

— Conduit Penetrations and Cable Entries

Conduits will not penetrate the test vault walls. Conduits carrying cable to the test will be terminated outside test vault wall; cables will be extended to connector for termination. Conduits to the disassembly area will be provided with two 90-degree bends within the concrete wall and will be provided with standard conduit sealing fittings on the outside face of the wall.

— Connector Plates Assemblies

Each connector assembly plate will be fabricated from aluminum plate. Aluminum body hermetically sealed connectors, will be welded to the aluminum plate. The connector assembly plate will be factory tested for zero leakage in either direction, with a differential pressure of one psig.

Wire and Cable

— Building Cable

Insulation for power and lighting cables will be rated at 600 volts. Cables from outdoor switchgear to motor control centers, and other loads, will be interlocked armor cable, varnish cambric insulated.

With exception of the test vault, 277-volt and 120-volt lighting circuits and 120-volt branch receptacle will have TW insulation.

480-volt or 277-volt branch power feeder, and control circuits for control equipment, etc., will be the type RHW insulation with a neoprene jacket.

— High Voltage Wire

High voltage cable for 4160-volt feeder will be single conductor Rate 5 kv, rubber insulated general purpose, shielded with a neoprene jacket, and will conform to IPCEA Specification 19-81.

— Radiation Resistant Wire

All cable used in test vault will be radiation resistant and will have concentric, stranded, bare annealed copper wires. The primary dielectric will be reinforced Mica comprised only of inorganic materials. The overall jacket will consist of an impregnable glass braid. The wire will be Micatemp RSS 5-300, as manufactured by Rockbestos Wire and Cable Company, or approved equal.

— Test Control and Instrumentation Cables

Wire and cable to be used for control and instrumentation will be provided by the facility operator.

Receptacles

Receptacles in work and process areas will be rated 120 volts, 20 amperes, 3-wire, twist-lock grounded type.

Receptacles in office area and control room will be 15-ampere parallel blade convenience type.

Welding receptacles will be 440-volt, 3-phase, 60-ampere Crouse Cat. No. AR 462 or approved equal.

Receptacles at outside work areas will be provided with NEMA 3 weather-proof enclosures.

Wall Switches

Wall switches will be rated at 120-277 volts, 20 amperes, a-c.

Distribution and Lighting Panel Boards

— General

Panelboards will be of the dead front, circuit breaker safety type. They will have 3-phase, 4 wire mains with the number of single, double, or triple-pole breakers required. Panel boards will be surface-mounted.

— Noise Free and Critical Bus Panel Boards

Panel boards will be provided with a double bus. Each load served by the panel board will be connected to both busses through individual circuit breakers. Each circuit breaker will be provided with a shunt trip device, and will be electrically interlocked with the main circuit breaker for the bus with which it is connected.

Motor Control

— General

Motors, 1/2 horsepower and larger will be 480-volt, 3-phase, 60-cycle. Motors 1/3 horsepower and smaller, will be 120-volt, single phase, 60-cycle, unless otherwise noted. Motor control will be 120-volt, 60-cycle and magnetic motor starters will be equipped with 480/120 volt control transformers. Starters will have thermal overload relays in each ungrounded conductor, and each motor will be provided with a disconnecting means.

— Motor Control Centers

Motor Control Centers will be suitable for 480-volt, 3-phase, 60-cycle service and will consist of the required vertical sections, 90 inches high, joined together to form a rigid, free standing, completely dead front enclosed assembly of a NEMA Class I, Type B construction. Power will be distributed by means of a continuous horizontal bus connection to a vertical bus in each section. Busses will be braced to withstand a minimum of 25,000 amperes rms short circuit current.

The centers will be of a plug-in type construction. Circuit breaker will be the molded case type, with a minimum interrupting capacity of 25,000 rms amperes, at 480 volts.

Motor starters will be of the magnetic type, suitable for across the line starting, with thermal overload relays in each undergrounded conductor. Each starter will be supplied with a minimum of one normally open and one normally closed auxiliary contact, a 480/120-volt control transformer, a control door switch, and necessary controls.

Transformers

Transformers will be dry type with Class H insulation and full capacity NEMA standard taps on the high voltage winding. The neutral of the low voltage winding will be grounded.

Lighting

The lighting system will consist of all lighting fixtures, lamps, wiring devices, conduit, wire and components. All fluorescent fixtures will be rated for 277-volt a-c. All incandescent fixtures will be rated for 120-volt. A-C emergency lighting will be provided by battery operated units, complete with battery charger and transfer relays.

Uninterruptible Power Supply

— General

The uninterruptible power supply will consist of d-c rectifiers, batteries, noise free power supply motor-generating sets and critical power supply motor-generator.

— D-C Rectifiers

Rectifiers will have a rated output of 250 kw at a rated output voltage of 250 volts d-c. The supply voltage will be 480 volts, 3-phase, 60-cycle. The rectifier will maintain d-c voltage within plus or minus 1 percent of d-c volts, no load to full load, with plus or minus 10 percent a-c line voltage variation. It will automatically unite the current on overloads to a safe value. The rectifiers will be able to float or recharge batteries while running M-6 sets. Recharging rate will be 80 percent in 5 hours and 100 percent in 24 hours. The rectifier will be provided with the following: a-c voltage failure relay, a-c and d-c voltmeter, d-c circuit breaker and 0-24 hr timer.

— Batteries

Two 250-volt batteries of the lead acid sealed type will be provided. Batteries will be rack mounted. Each battery will have the capacity to run one M-G set from both the noise free power supply and the critical power supply at full load for a minimum of five minutes.

— Noise Free Uninterruptible Power Supply

The noise free uninterruptible power supply will be provided by two d-c motor-driven alternators powered from the d-c bus.

The drive-motor shall be d-c, constant speed, 240 volts, shunt wound drip proof, silicon insulated, Class B, 60 degrees C temperature rise, ball bearing, 1800 rpm, with horsepower as required. The alternator will be 120/208 volts, 3-phase, 4-wire, 0.8 power factor, 60 cycles per second, 1800 rpm, with a 10 kw output.

A high-inertia flywheel will be mounted between the motor and the alternator to limit a frequency transient to not more than 0.3 cycles per second for a loss of drive power of one second duration, when operated at rated load.

Automatic voltage regulation will be provided by a static type voltage regulator that will maintain the alternator output voltage within plus or minute 1 percent of rated from no load to full load, with a recovery time of 0.25 seconds for a step change of 25 percent of rated load.

Automatic frequency regulation will be provided by a static type frequency regulator that will maintain the alternator output frequency within plus or minus 0.5 percent from no load to full load. It will include continuous integral control to maintain overall frequency draft within plus or minus one minute over any 24-hour period.

The control switchboard will be mounted separately from the rotating equipment and will consist of motor starters, circuit breakers, controls, automatic voltage, and frequency regulators, meters synchronizing equipment, control, and protective relays.

Telephone influence factors, radio frequency noise and deviation factors, will comply with applicable NEMA standards for rotating machinery.

— Critical Uninterruptible Power Supply

The critical uninterruptible power supply will be provided by two d-c motor-driven alternators powered by the d-c bus. The motor-driven alternators will conform to the specifications for the noise free motor-driven alternators as stated above, with the following exceptions:

The flywheel will not be required.

The alternator output at 120/208-volt a-c shall be 60 kw.

Closed Circuit Television System

The closed circuit television system will be a complete system and will consist of, but not be limited to, the following equipment as manufactured by Cohu Electronics Inc. Kintel Division, or approved equal.

6 television cameras with 10:1 zoom lenses, Model 2001-005.

2 television cameras with 4:1 zoom lenses, Model 2001-001.

10 motor-driven pan tilt units, modified with switches to indicate "center of pan", Model ARC-14 HX.

1 pair of two eight-inch portable monitors mounted side by side, Model DRM-8c/2R. Portable monitors will be mounted in a suitable cabinet for carry and hoisting.

1 four-bay cabinet control console consisting of:

9 television monitors, Model FRM-14R; one monitor will be mounted in the rear, the other eight will be mounted in the front.

9 camera control units, Model 3911-211, mounted in the rear of the console.

1 video switching and distribution unit, consisting of 10 input channels and 12 output channels, Model 5100 series.

6 joy stick controls for pan tilt units.

Controls for disassembly area and test vault camera traverse equipment and remote connector.

Connectors in rear for accepting 10-input and video output in addition to power.

- 8 digital readout device, which will display number of the signal displayed on the adjacent monitor and will be located adjacent to the monitor.
- 1 power distribution panel.
- 1 console power key switch.
- 1 power pilot light.
- 1 running time meter.

Cables will be recommended by the manufacturer.

Connector Boxes

Connector boxes for television camera cables will be of three types; single, dual, and triple (1, 2 or 3 receptacles). Each connector box will be equipped with receptacles, guide fences, guide pin holes, and supports.

Connector boxes, guide fences, and support will be fabricated from 6061-T6 aluminum alloy plate .250 thick, commercial specifications. Box will have a top mounted aluminum screen cover. The connector box will be of a welded construction; guide fence and supports will be welded to box.

Receptacles will be of the self-aligning type as manufactured by Cole Electric Co., Culver City, California. Connectors will be screw mounted to box.

Aluminum conduit hubs as required shall be welded to the connector box.

Remote monitor cable and connectors.

Remote monitor cable will be No. AC-59 equipped with No. CA-8 connector set.

Intercommunication System

Two separate intercommunication systems will be provided, one between the control room and the process and work areas, and one between the control room and the closed circuit television camera station and remote

handling equipment. The intercom systems will be provided with paging to provide facilities for two-way voice communication between the master station and remote units or conferences between two or more units.

Master stations located in the control room will consist of a power supply unit, paging panel, speaker, and microphone. The remote station will consist of a speaker and a jack. A telephone headset will be provided for each master and remote station. The telephone headset will include 15 feet of cord and a connector to mate with remote station jack. Paging will transmit page messages over remote unit speakers by holding switch in page position and talking into microphone. Party replying to page will do so by plugging in headset to a remote unit, providing instant two-way voice contact.

The intercom system for the process and work area will consist of one master station complete, a remote station, and seven telephone headsets. Intercom system for the television camera stations and the remote handling equipment will comprise one master station complete, 11 remote stations, and 12 telephone headsets. Connections will be two-conductor No. 18 AWG shielded cable run in conduit. The system will be wired and installed in accordance with manufacturers specifications.

Fire Alarm System

The fire alarm system will be a complete system and shall include, but not limited to the following:

- Universal alarm transmitters, complete with coded wheels (code numbers to be provided by Atomics International). Potter Electric Signal and Manufacturing Co., Model UAT, Cat. No. 177.
- Supervisory transmitter with coded wheel (code numbers to be provided by Atomic International) Potter Electric Signal and Manufacturing Co., Model PJ-1-S, Cat. No. 233.
- Break glass fire alarm stations. Potter Electric Signal and Manufacturing Co., Model B6S, Cat. No. 200.
- Fire alarm bells.
- Fire alarm horn, resonating type.
- Fire detector, dual action rate of rise and fixed temperature type. Spot Fire Lowecator, Model 501.

- Fire detectors, fixed temperature type Spot Fire Lowecator, Model 504.
- Smoke and fire detector, using ionization chamber principle. PYR-A-LARM Detector. Assembly with ES5 Detector.
- Control relay
- Power supplies
- Conduit and wiring in accordance with manufacturers specifications and Atomics International Fire Department.

Connections to existing site general fire alarm system.

Warning Lights and Evacuation Alarm

The warning light and evacuation alarm system will be a complete system. Warning lights will be located inside and outside of building as required. Each warning light will consist of 3 rotating beam lights, with green, amber, and red lenses. The warning lights will be controlled from the facility control board to be located in the control room. The rotating beam lights shall be Rota-Beam, as manufactured by Pyle National Co. or approved equal.

Warning sirens will be located inside and outside of the building. The sirens will be operated by a break-glass station located at the exit of the control room. This break glass station will be suitably distinguished from the fire alarm break glass stations and clearly identified, and will have provision for transmitting a remote alarm signal when break glass station is operated.

Emergency Power System

— General

The emergency power system will be a complete standby system, consisting of three diesel engine-driven electric generator sets, and supporting equipment.

The diesel engine-driven generator sets will consist of a diesel engine, a 350 kw, .8 pf alternator, related control panels, and all necessary accessories to make it a complete and independent power source. This unit will be weatherproof and be skid mounted. The equipment will be a standard product of proven performance by manufacturers regularly engaged in the production of such equipment. All electrical work will conform to IEEE and NEMA specifications and meet the intent of the 1962 NEC standards of the NBFU.

— Electric Generator

Each generator will be rated as follows:

Output Rating Continuous	350 kw
Power Factor	0.8
Voltage	480Y/277
Phases	3
Frequency	60 cps
Speed	1800 rpm

Each generator will be a synchronous type with a brushless exciter and suitable for diesel mounting.

Each generator will have its own control panel mounted on the generator and will consist of a voltmeter, voltmeter switch, ammeter, ammeter switch, frequency meter, potential and current transformers, jacks or terminal for external metering equipment, and a four-position engine control switch for automatic, manual, test, and stop.

— Diesel Engines

Engine Rating and Characteristics — The engine will be of the outdoor, water cooled, direct injection, 4-cycle internal combustion, compression-ignition type, embodying removable wet type cylinder liners, and shall conform to the Standard Practices for low and medium speed Stationary Diesel Engines of the DEMA. The engine will have not less than 6 or more than 12 cylinders and may be of the in-line or V-type.

Engine speed will correspond to generator synchronous speed not to exceed 1800 rpm continuous.

Engine will have not less than 1700-cubic inch total piston displacement and not less than 610 hp net.

The engine will operate without over heating or suffering mechanical damage when driving generator at 10 percent above rated load of 350 kw for a period of 2 hours, when operating at an elevation of 2,000 feet and ambient temperature range from 30 degrees F to 105 degrees F.

Each engine will be water-cooled by means of radiator fan and pump. Each engine will be provided with a full pressure lubricating system. The exhaust system will consist of a water-cooled exhaust manifold, flexible seamless exhaust tube connection, a residential type muffler, and 10 feet of exhaust piping.

Each engine will have a load proportioning isosynchronous governor, adjustable within a range of ± 5 percent. Each governor will maintain a speed of ± 1 percent of the set point for any load from no load to full load. Governor response will stabilize engine speed within a maximum of 2 seconds after a step change of load from 0 percent to 100 percent. A servo-motor drive will permit frequency adjustment by pushbutton control from a remote station.

Starting will be done by means of air. Each unit will be equipped with a shaft-driven air compressor and air receiver. The air receiver will be equipped for a backup connection to facility air system and alarm to provide warning if a start has not been accomplished in a set period of time.

Each engine control panel will be on or near engine depending upon the manufacturer's recommendations. The engine control panel will comprise oil pressure gage, water temperature gage, elapsed running time hour meter, throttle control relay for remote automatic starting, and manual pushbutton starter switch.

A 15-gallon unit mounted day tank and fuel transfer pump mechanically driven from engine will be provided to transfer fuel from main fuel storage to the day tank. A warning system will be provided to indicate liquid level at a remote station and provide a warning when the storage tank level is below half-full.

— Main Generator Control Panel

Main generator control panel will be mounted separately from the generators, and will consist of three electrically-operated load circuit breaker with auxiliary contacts, one for each generator, synchronizing equipment, voltmeter, voltmeter switch, ammeter, ammeter switch, frequency meter, watt meter, automatic voltage regulating equipment, potential and current transformer, and governor control switch. Provisions will also be made for remote start indication of generator on condition and synchronization.

Each voltage regulator will be adjustable over a range of ± 5 percent voltage. Voltage regulator will hold the generator output to within 3 percent of rated voltage from no-load to full-load.

Synchronizing equipment will automatically synchronize all three generators on the line. The three diesel engine-driven generators will automatically start when normal power supply to test essential switch gear drops below 70 percent. One generator load circuit breaker will immediately close, and then as the second and then the third generator is synchronized with the first, their load circuit breakers shall close. The auxiliary contacts for load circuit breakers will be wired in series with close circuit for the transfer load circuit breaker for test essential switchgear. A manual override switch will be supplied for each auxiliary contact in this circuit.

INSTRUMENTATION

General

Instrument and final control element specifications will be written to utilize standard commercially available equipment as much as possible, to permit the widest range of competition. Specifications will be written so that one subcontractor may supply and install all of the instruments and controls required by the facility systems design. Pneumatic systems will be utilized except when electronic systems have a definite advantage or when a standard packaged unit comes equipped with electronic controls. Instruments and final control elements will withstand the erosive, corrosive, and nuclear radiation conditions of their environment. Soft seats will be utilized on all final control elements requiring tight shutoff.

Special Instruments

Area Radiation Monitoring

A 14-channel area radiation monitor system will be provided and be of the same manufacturer as now used by the facility operator. The gamma radiation levels at each detection station will be indicated continuously and recorded intermittently in the control room on a modular relay rack for trend information.

Radiation detectors located in the control room, hot change room, high bay area, cable spreading, and administration area electrical and mechanical equipment rooms will be of Geiger-Mueller type for gamma radiation, built-in isotope source for internal calibration, range of 0.01-100 mr per hour, local alarm for each detector with flashing light and buzzer (omit for control room detector), and provisions for fixed position local mounting.

The radiation detectors located in the transfer lock, disassembly area, vault electrical and mechanical equipment rooms, pump room, vacuum equipment room, vault access stairways, and radioactive liquid and gas hold-up vault, will have the same characteristics as above except the detectors may be either of the Geiger-Mueller or ionization chamber type with a range of 1 mr to 1000 r per hour.

The deviation (accuracy) of the indicator reading with respect to a standard known source of radiation at the detector will be within 15 percent of the dose rate (for gamma energy between 80 kev and 2.5 Mev) when checked

immediately after calibration, and within 25 percent of the dose rate when checked 30 days after calibration.

A check source will be provided to facilitate testing the accuracy of the system. This check source will be actuated from the control station in the control room by a pushbutton check point. Calibration markings will be shown on the meter readout (scale).

Stack Gas Radiation Monitor System

The stack gas radiation monitor (RE-40) will have a dual channel system measuring the stack effluent for both particulate and gaseous radioactivity. Detector sensitivity for the particulate detectors will be a minimum of 1×10^{-11} microcuries Na-24 per cc air. The gaseous detector sensitivity will be a minimum of 7×10^{-7} microcuries Xenon-133 per cc air.

Check sources in the remote detectors will check overall system accuracy. These will be capable of being actuated at the operator's discretion from the facility control board.

Annunciator contacts will indicate torn paper filter or loss of vacuum.

The system will be of the same manufacture as now used by the facility operator.

Room Exhaust Radiation Monitors

The room exhaust radiation monitors will be sensitive on gamma and beta radiation, with the detectors of Geiger-Mueller type mounted directly in the stream of effluent gas from the transfer lock, disassembly area, and test vaults. The sensitivity ranges are to be determined by the facility operator.

Each detector will contain a local preamplifier and a remote control panel in the control room. Log ratemeters will be used with ranges to match detectors, and with a high control point adjustable over full scale range by a knob on the ratemeter front and which actuates a contact for remote annunciation and control.

Mercury Vapor Analyzer

The mercury vapor analyzer system will consist of nine sniffer tubes to obtain gas samples from suspected areas, a detector system, a programming or sequencing system, an amplifier, a recorder, and an adjustable high alarm switch.

The mercury vapor detector will consist of ultra violet light for measuring and reference (2537 angstroms) phototubes, measuring sample cell and reference cell, accessories such as filters for light and sample, crystals, power supply regulator, a light intensity electronic regulator for measurement stability (if required), and amplifiers.

A means of automatic zero standardization will be provided to take the sample and divert it over a filter, which will remove the mercury vapor entrained within the stream. The resulting mercury free stream will then give a zero reading upon the recorder. This standardization will be done every twenty-four hours automatically.

Manual standardization of the span range will be provided, using the method of placing a glass filter in the light path for simulating mercury vapor in the line to give full scale reading.

Recording of each mercury vapor level will be on an intermittent basis. The recorder will be the potentiometer type, strip chart, with one alarm switch for all points.

Sensitivity of the mercury vapor analyzer will enable it to meet the requirements of the General Industrial Safety Orders for the State of California, Title 8, Appendix A (Section 432.171, Article 81, entitled Dust, Fumes, Mist, Vapors and Gases) to detect 0.1 milligram of mercury per cubic meter of gas.

Range of the analyzer will be chosen so that no trouble is encountered in obtaining the desired sensitivity of the instrument.

Accuracy of the analyzer will be 0.02 milligrams per cubic meter for a range of 0 to 0.2 milligrams per cubic meter and plus or minus 10 percent for a range greater than 0.2 milligrams per cubic meter.

Scanning speed of the overall system will be one minute per point.

Oxygen Analyzers

Each analyzer will be either of the paramagnetic type or of the catalytic combustion type. If the paramagnetic type detector equipment supplied will have a sensing system that includes a power supply, an amplifier, a heater for the analyzer cell, and a thermostat for case temperature control. If the catalytic combustion type, the detector will have a sensing system that includes an inductor system, if required, and a hydrogen assembly for combustion.

A dual range of 0 to 25 percent and 0 to 5 percent is required on each analyzer. Electrical switches mounted on the facility control board will change the range of the associated analyzers.

Automatic standardization of the overall system will be performed every twenty-four hours, with remote and local indication when it is being done. This automatic standardization will consist of checking the span and zero adjustments.

Accuracy of the analyzers will be within plus or minus one percent of the full scale reading for range of 0 to 5 percent and plus or minus two percent of the full scale reading for range of 0 to 25 percent.

Response time of the analyzer will be at least 90 percent within 50 seconds.

Sensitivity of the analyzer will be within 1/10 of one percent of the full scale reading.

Facility Control Board

The facility control board will be free standing. The steel front plate will be tack welded to a frame extending 24 inches back from the front of the board. The basic frame will be constructed of angle iron, with gussets provided in both the horizontal and vertical planes, as necessary, to provide a rigid structure. Welded construction will be used throughout in fabrication of the panel board, with all reinforcing angles and bars tack welded two inches in every six inches on both sides. The board height and paint will match that of the facility operator furnished relay racks, also located on the control room.

Graphic portion of the control board will be covered with laminated plastic sheets or sheet similar to formica. The plastic sheets will be attached to the steel panels with mechanical fasteners in sections so that individual pieces can be removed. No fasteners, screw heads, etc., will be visible from the front of the board. All symbols, vessels, lines, valves, arrows, etc., will be attached to the base sheet by an adhesive which can be loosened by a special solvent, in the event that a change in flow diagram is required. Tri-color lights will be used to show the operating condition of vessels, pumps, compressors, valves, etc., on the graphic portion of the panel.

Two annunciators will be mounted on the board, with each annunciator consisting of 15 back-lighted window units mounted in a sheet steel enclosure. The system will provide visual and audible warnings in the following sequence of operation:

1. Normal. Window nameplate will be dark and audible signal off.
2. Abnormal. Window nameplate will flash, accompanied by audible signal.
3. Acknowledge. Window nameplate will be illuminated steadily and audible signal silenced.
4. Return to Normal. Window nameplate will be darkened (automatic reset) and audible signal off.

The annunciator will lock-in on momentary alarms to enable the operator to determine which alarm point operated. A test button will be furnished and connected so that all components of the annunciator are tested when the button is depressed.

To insure delivery to the jobsite as scheduled, certain long lead items must be purchased in advance of the subcontracting of the packages. Materials and items of equipment requiring pre-purchasing have been listed with dates of jobsite delivery and date that a purchase order must be issued to meet the required delivery.

SNAP 8 FLIGHT PROTOTYPE TEST FACILITY
ENGINEERING & CONSTRUCTION SCHEDULE

8/4/64 Rev. 0

X P. O. PLACED
▲ REQ'D JOB SITE DELIVERY

VIII. COST ESTIMATES

The cost estimates have been separated from this report and forwarded under separate cover.

DRAWINGS

<u>No.</u>	<u>Title</u>
C-1	Plot Utility & Grading Plan
A-1	Floor Plan
A-2	Exterior Elevation Sheet No. 1
A-3	Exterior Elevation Sheet No. 2
A-4	Typical Cross-Section
A-5	Disassembly Area, Mechanical and Electrical Equipment — Floor Plans
A-6	Vault Area, Vacuum and Pump Room Equipment Floor Plans
A-7	Longitudinal Section — Sheet No. 1 Vault and Disassembly Areas
A-8	Longitudinal Section — Sheet No. 2 Vault and Equipment Room Areas
A-9	Typical Details
M-1	Piping & Instrumentation Diagram Utility Systems & Legend
M-2	Piping & Instrumentation Diagram Cooling Water Systems
M-3	Heating, Ventilation, & Air Conditioning, Administrative Area & Control Room
M-4	Heating, Ventilation, & Air Conditioning, High Bay and Test Vault Complex
E-1	Uninterruptible Power Single Line Diagram
E-2	Test Essential Power Single Line Diagram
E-3	Interruptible Power Single Line Diagram

VICINITY PLAN
SCALE - 1"=200'

LEGEND

- W --- WATER
- SS --- SAN. SEWER
- G --- GAS
- SL --- SECURITY LIGHTING
- 4160 V --- OVERHEAD LINE

GRAPHIC SCALE

1"=20 FT
0 10 20 30 40 50

BECHTEL CORPORATION					
LOS ANGELES	SAN FRANCISCO			NEW YORK	
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA, CALIFORNIA U. S. ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE					
BLDG 056					
PLOT, UTILITY & GRADING PLAN					
DRAWN	DATE	DESIGN	JOB NO.	REV.	CLIENT
UT					
CHECKED	3976-021				
SCALE 1/8"=1'					

C-1

FLOOR PLAN
SCALE 1/8" = 1'-0"

LEGEND

- FIRE PROTECTION EQUIPMENT**
- ☒ FIRE ALARM BOX
 - ⊖ CO₂ BOTTLE - 15"
 - △ ANSUL DRY CHEMICAL - 20"
 - MET L X BOTTLE - 30"
 - MET-L X (ON WHEELS) 150"
 - ⊗ EMERG BATTERY OPERATED LIGHTS

CONTROL ROOM EQUIPMENT

- ① AI - REACTOR CONTROL
- ② AI AGC - STATUS CONTROL
- ③ AI AGC - STATUS GRAPHIC PANEL VITAL INSTR
- ④ AI NUCLEAR INSTRUMENTATION
- ⑤ AI - PROCESS INSTRUMENTATION
- ⑥ AI - VEHICLE SIMULATION PROGRAM & SEQUENCE
- ⑦ AI NUCLEAR CRITICALITY INSTRUMENTATION
- ⑧ AI VACUUM SYSTEM CONTROL
- ⑨ AI DATA ACQUISITION

- ⑩ AGC PCS CONTROL
- ⑪ AGC INSTRUMENTATION
- ⑫ AGC - RECORDING EQUIPMENT
- ⑬ AGC - SIGNAL CONDITIONING
- ⑭ AGC - DIGITAL DATA ACQUISITION

- ⑮ FACILITY BOARD

ROOM FINISH SCHEDULE

ROOM	FLOOR	BASE	WALLS	CEILING
ELEC EQUIP RM	CONC	-	CB EDW	EC
MECH EQUIP RM	CONC	-	CB EDW	EC
HOT CHANGE RM	CEMENT	CEMENT	DW	EC
LOCKER ROOM	"	"	"	"
MENS TOILET	"	"	CB EDW	"
JANITOR	CONC	-	CB EDW	"
WOMENS TOILET	AT	RUBBER	CB EDW	"
INSTRU REPAIR	"	"	DW	"
HEALTH PHYSICS	"	"	CB EDW	"
CORRIDOR	"	"	DW	"
OFFICE AREAS	"	"	CB EDW	"
CONTROL ROOM	VINYL	VINYL	CB EDW	SAT
CONF ROOM	AT	RUBBER	CB EDW	EC
LOBBY	"	"	CB EDW	"

SCHEDULE ABBREVIATIONS

- CONC - CONCRETE
- CB - CONCRETE BLOCK
- DW - DRY WALL
- AT - ASPHALT TILE
- EC - EXPOSED CONSTRUCTION
- SAT - SUSPENDED ACOUSTIC TILE

NOTE 1 PROVIDE PREFINISHED WALLBOARD
WAINSCOT AT URINALS

BECHTEL CORPORATION

LOS ANGELES SAN FRANCISCO NEW YORK

SNAP 8 FLIGHT PROTOTYPE TEST FACILITY
SANTA SUSANA, CALIFORNIA
U S ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE

BLDG 056

FLOOR PLAN

DESIGNED	DATE	DRAWN	JOB NO.	REV	BY	CHKD
DRWN LJT						
CHECKED	3976-021					
SCALE 1/8" = 1'-0"						

A-1

SOUTH ELEVATION

$\frac{1}{8}'' = 1'-0''$

WEST ELEVATION

$\frac{1}{8}'' = 1'-0''$

BECHTEL CORPORATION						
LOS ANGELES		SAN FRANCISCO		NEW YORK		
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY						
SANTA SUSANA, CALIFORNIA						
U. S. ATOMIC ENERGY COMMISSION						
CHICAGO OPERATIONS OFFICE						
BLDG 056						
EXTERIOR ELEVATIONS SHEET No. 1						
DESIGNED	DATE	DRAWN	JOB	BY	CHKD	CLIENT
BY L. J. T.						
CHECKED						
BY						
3976-021						
SCALE						

A-2

NORTH ELEVATION
 $\frac{1}{8}'' = 1'-0''$

EAST ELEVATION
 $\frac{1}{8}'' = 1'-0''$

BECHTEL CORPORATION						
LOS ANGELES		SAN FRANCISCO		NEW YORK		
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA, CALIFORNIA U. S. ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE						
BLDG 056						
EXTERIOR ELEVATION SHEET No 2						
DESIGNED	DATE	DRAWN	JOB NO.	SECT	PROJ	CLIENT
DRAWN L. J. T.						
CHECKED						
SCALE $\frac{1}{8}'' = 1'-0''$	3976-021					

A-3

SECTION A-A

BECHTEL CORPORATION						
LOS ANGELES		SAN FRANCISCO			NEW YORK	
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA, CALIFORNIA U. S. ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE						
BLDG 056						
TYPICAL CROSS SECTION						
DES. GRED.	DATE	DRAWN'S SUP'RS	JOB ENGR'S	SECT SUP'RS	PROJ. ENGR	CLIENT
DRAWN: L. J. T.	JOB NO.			DRAWING NO.		REV.
CHECKED						
SCALE: 1/8" = 1'-0"	3976 021			A-4

PLAN - DISASSEMBLY AREA & MECH EQUIP ROOM
SCALE - $\frac{1}{8}$ 1" = 10'

PLAN - VAULT ELEC EQUIP AREA
SCALE - $\frac{1}{8}$ 1" = 10'

BECHTEL CORPORATION					
LOS ANGELES		SAN FRANCISCO		NEW YORK	
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA, CALIFORNIA U S ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE					
BLDG 056					
DISASSEMBLY AREA, MECHANICAL AND ELECTRICAL EQUIPMENT FLOOR PLANS					
DESIGNED	DATE	DRAWN BY	JOB NO.	REVISIONS	CLIENT
DRUM	1/7				
CHECKED					
SCALE	3976 021			A-5

PLAN - VAULT & VACUUM EQUIP ROOM
SCALE $\frac{1}{8} = 1' 0''$

PLAN - PUMP EQUIP ROOM
SCALE $\frac{1}{8} = 1' 0''$

BECHTEL CORPORATION					
LOS ANGELES		SAN FRANCISCO		NEW YORK	
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA, CALIFORNIA U. S. ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE					
BLDG 056					
VAULT AREA, VACUUM AND PUMP ROOM EQUIPMENT FLOOR PLANS					
DESIGNED	DATE	DRAWN	JOB NO.	BY	CLIENT
DRW: LJT				DRAWING NO.	REV.
CHECKED					
SCALE 1"=10'	3976-021			A-6

BECHTEL CORPORATION					
LOS ANGELES		SAN FRANCISCO		NEW YORK	
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA, CALIFORNIA U. S. ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE					
BLDG 056					
LONGITUDINAL SECTION SHT. No. 1 VAULT AND DISASSEMBLY AREAS					
DESIGNED	DATE	DRAFT'S REVISIONS	JOB CHIEF	REV'T REVISIONS	PROJ. ENGINEER
DRAWN	DATE	JOB NO.	DRAWING NO.		REV.
CHECKED	DATE	SCALE	3976-021		A-7

SECTION C
 $\frac{1}{8}'' = 1'-0''$ (A1)

BECHTEL CORPORATION						
LOS ANGELES		SAN FRANCISCO		NEW YORK		
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA, CALIFORNIA U S ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE						
BLDG 056						
LONGITUDINAL SECTION SHT. No. 2 VAULT AND EQUIPMENT ROOM AREAS						
REVISION	DATE	SNAP'S DATE	JOB SHEET	SECT SHEET	PRG SHEET	CLIENT
DESIGNED LJT		JOB NO.		REVISION NO.		REV.
CHECKED						
SCALE 1-10	3976-021			A-8

PNEUMATIC SEAL DETAIL
SCALE HALF SIZE

SECTION D
3'-10"

TYPICAL 3" PIPE PLUG

HALF SIZE

TYPICAL EQUIPMENT SLEEVE & PLUG

3'-10"

MANIPULATOR SLEEVE DETAIL

3'-10"

PERISCOPE PLUG DETAIL

3'-10"

BECHTEL CORPORATION						
LOS ANGELES	SAN FRANCISCO				NEW YORK	
SNAP & FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA CALIFORNIA U S ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE						
BLDG 056						
TYPICAL DETAILS						
DESIGNED	DATE	DRAWN'S SHEET	JOB SHEET	NOT SHEET	PROJ. SHEET	CLIENT
DRAWN L T	JOB NO.	DRAWING NO.			REV.	
CHECKED	3976-021	A-9				
SCALE

COMPRESSED AIR & GASEOUS NITROGEN SYSTEMS

POTENTIALLY CONTAMINATED LIQUID WASTE SYSTEM

DIESEL OIL SYSTEM

LEGEND

- LINES -

PRIMARY FLOW
SECONDARY FLOW
CONTROL AIR
INSTRUMENT PROCESS PIPING
INSTRUMENT ELECTRICAL LEADS

- VALVES -

Gate Globe Check Plug Open Normally Closed Butterfly
Self-Contained
Controlled (On Air Failure)
Relief
Damped

- OPERATORS -

Non Electric Damped with Power Operator Float Solenoid Diaphragm

- MISCELLANEOUS -

Basket Strainer Flow Meter Insulating Flange Manometer Bypassing Device Sample Nozzle
Screwed Welded Cap Funnel Hose Connection Reducer Filter
Air Relay Alarm Annunciation Controller Seal Switch Panel Light Remote Manual Control Remote Manual Electric Switch

INSTRUMENT IDENTIFICATION		SELF-CONTAINED VALVES	
PANEL NO.	BOARD SYMBOL	TYPE	ACTUATOR
(P) SERVICE	(P) SERVICE	PCV	PCV
INSTRUMENT NO.	REFERENCE INSTR.	TCV	TCV
LOCAL MOUNTED	REMOTE MOUNTED	FCV	FCV
SINGLE SERVICE		MULTIPLE SERVICE	
FUNCTION OF DEVICE	CONTROLLER TRANSMITTER	METER	MISCELLANEOUS
THIRD LETTER	THIRD LETTER	THIRD LETTER	THIRD LETTER
MEASURED VARIABLE	INDICATOR OR BLIND	RECORDER	RECORDER
PRESSURE	P	PC	PC
DIFFERENTIAL PRESSURE	DP	PC	PC
TEMPERATURE	T	TC	TC
FLOW	F	FC	FC
LEVEL	L	LC	LC
CONDUCTIVITY	C	CC	CC
HYDROGEN ION CONC.	H	HC	HC
COMBUSTIBLES	CB	CB	CB
POSITION	P	PC	PC
CHEMICAL ANALYSIS	CA	CA	CA
RADIATION	R	RC	RC
DEW POINT	D	DC	DC
MERCURY	M	MC	MC

BECHTEL CORPORATION
LOS ANGELES SAN FRANCISCO NEW YORK

SNAP 8 FLIGHT PROTOTYPE TEST FACILITY
SANTA SUSANA, CALIFORNIA
U. S. ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE

BLDG 056
PIPING & INSTRUMENTATION DIAGRAM
UTILITY SYSTEMS & LEGEND

REVISION	DATE	BY	CHKD	APP'D	CLERK
PAU					
NONE	3976-021				

M-1

BECHTEL CORPORATION						
LOS ANGELES		SAN FRANCISCO			NEW YORK	
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA, CALIFORNIA U S ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE BLDG 056						
HEATING, VENTILATION, AND AIR CONDITIONING ADMINISTRATIVE AREA AND CONTROL ROOM						
DESIGNED BY	DATE	DRAWN BY	JOB NO.	REVISION NO.	PROJ. NO.	CUSTOMER
SHAWKIN, P. J.		JOS. W.		REVISIONS: No.		NAVY
CHECKED BY						
3976-021				M-3		
NOTED

NOTE
1 FOR GASEOUS NITROGEN SYSTEM (GN₂) SEE
DWG M 2

BECHTEL CORPORATION					
LOS ANGELES		SAN FRANCISCO		NEW YORK	
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA, CALIFORNIA U S ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE					
BLDG 056					
HEATING, VENTILATION, AND AIR CONDITIONING HIGH BAY AND TEST VAULT COMPLEX					
DESIGNED	DATE	DRAWN'S BY	JOB NO.	REV. BY	CLIENT
DRAWN PAJ		JOB NO.		DRAWING NO.	REV.
CHECKED					
SCALE	3976-021			M-4

SYMBOLS	
	TRANSFORMER
	CIRCUIT BREAKER
	CIRCUIT BREAKER ELECTRICALLY OPERATED
	STARTER NUMBER INDICATES SIZE
	CONTACTOR NUMBER INDICATES SIZE
	SYNCHRONIZER
	INSTRUMENT TRANSFORMER
	AMMETER
	FREQUENCY METER
	VOLTMETER
	KILOWATT-HOUR METER
	MOTOR GENERATOR SET
	MOTOR NUMBER INDICATES HORSEPOWER
	REVERSE POWER RELAY
	DIFFUSION PUMP
	GROUND
	RECTIFIER
	GENERATOR
	BATTERY
	POWER RECEPTACLE
	WELDING RECEPTACLE
	MISCELLANEOUS LOADS AS INDICATED ON DRAWINGS

NOTES

1. SYNCHRONIZATION OF BOTH GENERATORS AND INTERRUPTIBLE POWER SUPPLY SHALL BE DONE MANUALLY WITH ELECTRICALLY OPERATED BREAKERS
2. CIRCUIT BREAKERS BEING FED FROM THE NOISE FREE AND CRITICAL BUSES SHALL BE PROVIDED WITH A SHUNT TRIP DEVICE THIS DEVICE SHALL BE ELECTRICALLY INTERLOCKED WITH THE BUS MAIN CIRCUIT BREAKER SO THAT WHEN MAIN BREAKER OPENS, BRANCH CIRCUITS BREAKERS WILL TRIP

BECHTEL CORPORATION					
LOS ANGELES	SAN FRANCISCO	NEW YORK			
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA, CALIFORNIA U. S. ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE					
BLDG 056					
UNINTERRUPTIBLE POWER SINGLE LINE DIAGRAM					
DESIGNED BY	DATE	DRAWN BY	CHECKED BY	APPROVED BY	CLIENT
DRAWN V.H.A.	8-10				
CHECKED BY					
SCALE NONE	3976-021		E-1

- NOTES**
- SEE DRAWING NO E-1 FOR SYMBOLS
 - GENERATOR LOAD BREAKER AUXILIARY CONTACTS ARE WIRED IN SERIES WITH TRANSFER BREAKER "CLOSE" CONTROL CIRCUIT
 - TEST ESSENTIAL SWITCHGEAR MAIN BREAKER AND TRANSFER BREAKER ARE ELECTRICALLY INTERLOCKED SO THAT ONLY ONE BREAKER CAN BE CLOSE AT ANY TIME

BECHTEL CORPORATION						
LOS ANGELES		SAN FRANCISCO		NEW YORK		
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA CALIFORNIA U S ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE						
BLDG 056						
TEST ESSENTIAL POWER SINGLE LINE DIAGRAM						
DESIGNED <i>ACB</i>	DATE	DRAFT C SUPP-R	JOB END-R <i>ACB</i>	SECT SUPP-R	PROJ END-R	CL ENT
DRAWN <i>VH A</i>		JOB NO		DRAW NO. NO		REV
CHECKED <i>MP</i>	3976-021			E-2		
SCALE NONE

NOTES
1 SEE DRAWING NO E-1 FOR SYMBOLS

BECHTEL CORPORATION					
LOS ANGELES		SAN FRANCISCO		NEW YORK	
SNAP 8 FLIGHT PROTOTYPE TEST FACILITY SANTA SUSANA, CALIFORNIA U. S. ATOMIC ENERGY COMMISSION CHICAGO OPERATIONS OFFICE					
BLDG 036					
INTERRUPTIBLE POWER SINGLE LINE DIAGRAM					
DESIGNED <i>WJS</i> DATE	DRAWN <i>WJS</i> BY	JOB <i>WJS</i> NO.	SHEET <i>WJS</i> 1 OF 1	PROJ. NO.	CLIENT
GRUNIN V H A	JOB NO.		GRUNIN NO.		FE
CHECKED <i>WJS</i>	3976-021		E-3		
SCALE NONE					

E-3

X. APPENDIX

Table of Contents

REVIEW OF SOILS INVESTIGATION

CORROSION CONTROL

METHODS OF CALCULATION (NUCLEAR)

EVALUATION OF CLEAN CONCRETE

REVIEW OF SOILS INVESTIGATION

The reports by Dames and Moore, Foundation Investigation, SNAP 8 Flight Configuration Test Facility No. 056, dated March 13, 1964 and Foundation Investigation Proposed SNAP 8 Systems Test Facility and A.E.C. Expanded Area Soils Survey, dated April 21, 1961 at Santa Susana, California were reviewed. In addition, a field trip was made to view the existing excavation and rock formation.

During Phase I, the excavation has been completed and a two-inch layer of concrete was placed on the bottom to serve as a working base and to provide a smooth surface for the exterior waterproofing membrane. When inspected, the excavation contained several feet of water which had accumulated during the rainy season. The water will be removed by Atomics International before start of the construction work under Phase II. As indicated in the basic reports, no ground water was previously encountered either during the test hole borings or the actual excavation.

The designated location of Building 056 is as shown on Bechtel Drawing C-1. Outline of the existing excavation is shown in dash lines, with the new building outline superimposed.

The existing excavation, circular in shape, will be fully utilized and will be expanded in an easterly direction and deepened to provide for the larger rectangular and deeper concrete test vault facility. The deep vault will be based on a mat type foundation, bearing on firm sandstone.

As indicated in the soils report, it will not be necessary to structurally separate the high bay area from the low bay area, since the differential settlement will be small. Footings will, in all cases, be placed at least 18 inches below finish grade. In the high bay area, all columns will fall within the vault area and be supported directly by the vault ceiling slab or walls.

Backfill in the sloping area around the vault excavation will be compacted to 95 percent of maximum density (modified AASHO method). All other areas will be compacted to at least 90 percent of maximum density.

All surface footings in natural ground or in fill will be placed at least 18 inches below original or adjacent final grade, with a recommended bearing value of 3000 psf for total of dead plus frequently applied live loads. This value may be increased by 300 psf for each additional foot of depth, up to a maximum of 4500 psf. The values may be increased by one-third for total of all loads, including live, dead, wind, and seismic.

In cut areas, the footings will also be placed at least 18 inches below the adjacent grade, with a recommended bearing value of 6000 psf for total dead load plus frequently applied live loads. This value may be increased by 500 psf for each additional foot of depth, up to a maximum of 8000 psf.

It is anticipated that the deep vault structure will be in hard and well confined shale and sandstone bedrock, with a bearing value of 20,000 psf at depths of 10 feet or more into the bedrock.

The deep vault pit will be excavated into bedrock and although no ground water was encountered in the borings, it is possible that in wet years, water seeping into the ground will be channeled towards the vault and deposited in the pit outside of the vault walls. There are no means of natural drainage in the bedrock.

The tributary area for this ground water channel is relatively small, on the order of four acres or less. The design criteria calls for a "once in ten-year storm". Rainfall intensity is based on one-inch per hour, or a maximum intensity of 2.7 inches per ten minutes, once in 10 years. Based on the foregoing, and a seepage of 10 percent, the total ground water for the drainage area is approximately 4000 cubic feet. Assuming 20 percent voids in the four-foot wide backfill strip around the concrete vault, the height of water, without pumping, would be approximately 11 feet.

In the future, most of the tributary area will be either constructed upon or paved, and very little, if any, of the rainfall will find its way into ground water.

CORROSION CONTROL

INTRODUCTION

This report is the conclusion of the Title I investigation of electrochemical corrosion in the SNAP 8, Flight Prototype Test Facility, Building 056, in accordance with paragraph 3.3.2.12.5 of Atomics International Specification NF 7568-90-001. The investigation included soil resistivity tests at the site.

DISCUSSION

Test Data Analysis and Results

To determine the corrosive nature of the soil, resistivity tests were conducted at three site locations on June 8, 1964. The Wenner¹ four pin method of ground resistivity measurement was used, which is an accepted test for relating resistivity and subsurface corrosion.

Location of the tests are as shown on Figure I. From the test readings, soil resistivity was calculated for each location.

Test data was statistically analyzed by arranging it in ascending values of resistivity (see Table 1) and plotting the data on logarithmic-probability paper. Graph 1 is a plot of the data for each depth or range of depths, and Graph 2 of all test points on a single graph. The soil is uniform when resistivity plotted in this manner defines a straight line.

The statistical mean (50 percent probability point on the graph) serves as the basis for classifying the corrosive properties of the soil. Mean resistivity readings of 7,000 ohm-cm at 2 1/2 ft depth, 6,400 ohm-cm at 5 ft depth, and 7,800 ohm-cm at 7 1/2 ft depth classify the earth as moderately corrosive, while the readings of 8,800 ohm-cm at 10 and 15 ft depth and 9,800 ohm-cm in the depth range of 30 to 100 feet classify the earth as mildly corrosive. The mean resistivity of 8,000 ohm-cm for all points classifies the overall site soil as borderline between moderately and mildly corrosive.

¹F. Wenner, Guide For Safety in Alternating Current Substation Grounding, Report No. 80, (New York: American Institute of Electrical Engineers), P. 132.

THIRD
APPROX. 30'

SECOND
(APPROX. 15')

FIRST
(APPROX. 100')

TEST LOCATIONS

FIGURE 1

GRAPH 1 SOIL RESISTIVITY PLOT

GRAPH 2 SOIL RESISTIVITY PLOT

Ground Water

Ground water dissolves salts, decreases soil resistivity and increases the rate of corrosion. However, accelerated corrosion should not occur because natural ground water was not encountered in any of the test borings made before start of the existing excavation. Unless precautions are taken, ground water flow may be altered by subsurface structures.

Subsurface Structures

The facility, as proposed, is a predominately subsurface structure consisting of steel reinforced concrete, steel storage tanks, pipes, conduits, copper ground system, aluminum liner, and aluminum cooling water pipes embedded in concrete. From a corrosion standpoint, items of primary concern are the diesel fuel tank, gas and water pipes, aluminum liner, and the embedded aluminum cooling water pipes. The concrete trench and vault for the potentially radioactive gas pipes, liquid pipes, and holdup tanks will prevent earth contact thereby minimizing corrosion.

Aluminum Structures

If the aluminum vault liner in contact with the concrete, or the aluminum cooling water piping embedded in the concrete, are connected to either the reinforcing steel or the facility ground system, the aluminum will be subject to severe galvanic corrosion. When interconnected with noble metals (steel or copper), aluminum will act as a sacrificial metal, and dissolve by galvanic action. The use of cathodic protection on aluminum requires careful control to prevent the formation of a damaging alkaline environment due to overprotection. Past experience has shown that obtaining satisfactory cathodic protection of aluminum embedded in reinforced concrete is a difficult application.

Protection Schemes

In general, cathodic protection of a structure is provided by impressed current or by galvanic current from sacrificial anodes. Either scheme will reverse ion migration and stop natural consumption of metals.

Protection of the proposed facility can be accomplished in two ways. The first would be to place the entire interconnected subsurface structure under protection. Estimated cost for this method is \$14,000 and would require an impressed current of 50 amperes.

The second method would be to electrically insulate subsurface pipes and tanks from other subsurface structures, including utility piping (water and gas) and provide cathodic protection for only subsurface piping and tanks. This method of protection would require 5 amperes of impressed current and the estimated cost is \$7,000. This cost includes pipe insulating flanges and flange inspection boxes.

The following will be incorporated in the facility design to minimize corrosion and the cost of corrosion protection:

- No aluminum conduit embedded in concrete.
- No additives (calcium chloride, etc.) in the concrete mix.
- Electrically isolate the aluminum liner and embedded aluminum cooling water pipes from the reinforcing steel and copper ground system.
- Provide area paving and drainage to collect runoff water.
- Protect the subsurface concrete from natural ground water with waterproofing.
- Install concrete trenches and a vault for the potentially radioactive gas piping, liquid piping, and holdup tanks.
- Electrically insulate all buried steel pipes and tanks from other subsurface structures.
- Provide cathodic protection for isolated steel buried pipes and tanks.

METHODS OF CALCULATION (NUCLEAR)

NEUTRON ATTENUATION

Calculation of the neutron distribution in the test vault walls was accomplished using the removal theory and modified age theory.

GAMMA RAY ATTENUATION

In the calculation of the primary gamma ray attenuation in the test vault walls, the test reactor (SNAP 8 reactor with a scatter shield) was considered as a point source located seven feet from the innerface of the wall. The gamma flux at any point in the wall at a distance x from the innerface is then, for each energy considered,

$$\phi_v = \frac{S_o}{4\pi d^2} B e^{-\mu x}$$

where d is the distance from the source to the point, B is a buildup factor, μ is the linear mass absorption coefficient for concrete and S_o is the point source strength, and the total flux is the sum over-all energies.

In calculating the gamma ray distribution in the disassembly area walls and transfer lock walls, the test reactor 30 days after shutdown from a 10,000 hour period of operation at full power was considered as a point source located 5 feet and 2 feet from the respective walls.

PENETRATIONS

Penetrations were treated using the methods presented in Reactor Shielding Design Manual by T. Rockwell. For neutrons, the flux emerging from the duct is related to the flux entering the duct by:

$$\phi/\phi_o = 10 (1/8)^n \prod_{i=1}^n \left(\frac{d}{L_i}\right)^2$$

where d is the diameter of the duct, L_i is the length of the i^{th} section of the duct, n is the total number of section, and $\prod_{i=1}^n$ denotes the product of terms from $i=1$ to $i=n$.

SOIL RESISTIVITY TEST DATA

TEST DATE 6-8-64

TABLE 1

<u>Depth in Feet</u>	<u>Test Location</u>	<u>Test Reading ohms</u>	<u>Calculated Resistivity ohm-cm</u>
5	2	5.5	5,500
2-1/2	1	12	6,000
5	1	6.5	6,500
2-1/2	2	13	6,500
7-1/2	2	4.5	6,750
15	3	2.5	7,500
15	2	2.6	7,800
7-1/2	3	5.3	8,000
7-1/2	1	5.3	8,000
10	3	4.0	8,000
10	2	4.2	8,400
90	1	.58	8,600
5	3	8.6	8,600
2-1/2	3	19	9,000
30	3	1.5	9,000
10	1	5.0	10,000
15	1	3.7	11,100
30	1	2.0	12,000

METHODS OF CALCULATION (NUCLEAR)

NEUTRON ATTENUATION

Calculation of the neutron distribution in the test vault walls was accomplished using the removal theory and modified age theory.

GAMMA RAY ATTENUATION

In the calculation of the primary gamma ray attenuation in the test vault walls, the test reactor (SNAP 8 reactor with a scatter shield) was considered as a point source located seven feet from the innerface of the wall. The gamma flux at any point in the wall at a distance x from the innerface is then, for each energy considered,

$$\phi_v = \frac{S_o}{4\pi d^2} B e^{-\mu x}$$

where d is the distance from the source to the point, B is a buildup factor, μ is the linear mass absorption coefficient for concrete and S_o is the point source strength, and the total flux is the sum over-all energies.

In calculating the gamma ray distribution in the disassembly area walls and transfer lock walls, the test reactor 30 days after shutdown from a 10,000 hour period of operation at full power was considered as a point source located 5 feet and 2 feet from the respective walls.

PENETRATIONS

Penetrations were treated using the methods presented in Reactor Shielding Design Manual by T. Rockwell. For neutrons, the flux emerging from the duct is related to the flux entering the duct by:

$$\phi/\phi_o = 10 (1/8)^n \frac{n}{\prod_{i=1}^n} \left(\frac{d}{L_i}\right)^2$$

where d is the diameter of the duct, L_i is the length of the i^{th} section of the duct, n is the total number of section, and $\frac{n}{\prod_{i=1}^n}$ denotes the product of terms from $i=1$ to $i=n$.

For gamma rays, the flux emerging from the duct is related to the flux entering the duct by:

$$\phi/\phi_0 = (1/8)^n \prod_{i=1}^n \left(\frac{d}{L_i}\right)^2$$

with the same nomenclature as above.

For all calculations involving penetrations, the radiation source where practical was a bare reactor considered as a point source, a minimum of five feet from the nearest surface.

SHIELD HEATING

In calculating the radiation heat generation in the test vault walls, two cases were considered. For fixed walls, the radiation source was a bare reactor considered as a point source located five feet from the wall. For removable walls, the radiation source was a shielded test reactor considered as a point source located seven feet from the wall.

The heat generated by thermal neutrons is given by:

$$Q_{th}(x) = \phi_{th} F(x)$$

where $F(x)$ is the heat generation per unit thermal neutron flux and is usually obtained from a graph of $F(x)$ vs. x . The contribution from fast neutrons is given by:

$$Q_n(x) = (E_n + E_1) \frac{N_n \Sigma r}{4\pi(a+x)^2} e^{-\Sigma r x}$$

Where E_n is the neutron energy, E_1 is the neutron binding energy, N_n is the fast neutron strength at the source, a is the distance from the source to the innerface of the wall, x is the distance the wall, and Σ is the microscopic removal cross-section. The contribution from gamma rays is given by:

$$Q_\gamma(x) = \mu_e E \phi_\gamma(x)$$

where μ_e is the energy absorption coefficient, E is the energy of the gamma photons, and $\phi_\gamma(x)$ the gamma ray flux at x calculated as described under gamma ray attenuation.

The total heat generation rate in the shield is then the sum of the individual heat generation rates for thermal neutrons, fast neutrons, and gamma rays.

ACTIVATION OF MATERIALS

The neutron induced gamma radiation was calculated for each element by:

$$\phi_r = \phi_n N_i \sigma_{act} (1 - e^{-\lambda t}) e^{-\lambda t_z} f(E)$$

where ϕ_n is the neutron flux which is greater than the threshold energy, N_i is the atom density per unit cross-sectional area, σ_{act} is the activation cross-section, λ is the decay constant, t is the length of the irradiation period, t_z is the length of the decay period, and $f(E)$ is the fraction of the gamma rays emitted which have energy E . The total induced activation is then the sum over all elements and all energies.

EVALUATION OF CLEAN CONCRETE

The Atomics International technical specifications require that a neutron absorbing layer of borated special concrete be used to line the floor, ceiling, and walls of the facility test vault to reduce neutron activation of the test vault walls due to operation of a reactor at full power for 10,000 hours.

Cost estimates indicate the price of the boron frit, which is used in the borated special concrete, to be approximately 26¢ per pound or \$125 per cubic yard of concrete. In addition, the AI specification states that the borated special concrete must have an iron content of less than 0.03 percent by weight. All commercial concretes consisting of standard aggregate and Type II portland cement have an iron content of approximately 2 percent by weight and are, therefore, unacceptable for use in construction of the test facility. The low iron content criteria dictates that a limestone aggregate or manufactured aggregate and Type I white cement be used for the borated special concrete.

Neutron activation calculations (see Nuclear portion of section IV) indicate that the special concrete without the boron addition will meet the test vault re-entry criteria; therefore, it is the purpose of this section to evaluate the use of borated versus special concrete.

BORATED SPECIAL CONCRETE

The use of borated concrete requires double forming, which adds an expense to the facility in addition to the extra cost of the boron frit. It does, however, permit the use of conventional concrete for the remainder (the borated concrete layer is 16 inches thick) of the 7 feet structural wall thickness.

SPECIAL CONCRETE

The use of special concrete would allow the test vault structure to be a monolithic pour. However, a premium cost over conventional concrete is incurred. Except for special handling techniques to keep the concrete clean, all other construction aspects are similar to conventional concrete.

The premium cost for using borated special concrete for the SNAP 8 test vault is approximately \$60,000 over the cost for special concrete.

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED

PLAN

GENERAL NOTES
 1. PRESSURE AT REACTOR CPES 3X10⁻⁶ TORR
 2. RADIATION LEVEL IN VACUUM EQUIPMENT ROOM APPROXIMATELY 1400 MR/HR

ELEVATION

END ELEVATION

NOTICE

THIS DRAWING INVOLVES CONFIDENTIAL PROPRIETARY DESIGN INFORMATION OF ATOMICS INTERNATIONAL, A DIVISION OF NORTH AMERICAN AVIATION, INC. AND ALL RIGHTS ARE EXPRESSLY RESERVED. IT IS SUBMITTED UNDER A TRUST RELATIONSHIP FOR A SPECIFIED PURPOSE. IT IS AGREED THAT IT WILL NOT BE USED FOR ANY OTHER PURPOSE, NOR ITS CONTENTS REVEALED TO ANYONE EXCEPT FOR THAT PURPOSE, NOR COPIED IN WHOLE OR IN PART, NOR ITS DESIGN FEATURES USED IN OTHER PROJECTS. IT WILL BE RETURNED TO ATOMICS INTERNATIONAL WHEN NO LONGER REQUIRED OR UPON REQUEST.

ATOMICS INTERNATIONAL
 A DIVISION OF NORTH AMERICAN AVIATION, INC.
 8900 DESOTO AVENUE, CANOGA PARK, CALIF.

PRELIMINARY LAYOUT FOR REVISED
 BLDG 056 VACUUM SHIELD SYSTEM

DRAWN: H.E. HINTON	DWG. SIZE: D	CONCEPT A
CHECKED:	SCALE: 1/4" = 1'-0"	SHEET NO. 1 OF 1
ENGINEER:		
APPROVED:		

AUG 7, 1968