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# Design Documentation: Krypton Encapsulation Preconceptual Design

**Ralph M. Parsons Company**
**D. A. Knecht (INEL Contact)**

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Lockheed Idaho Technologies Company

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# FOREWORD

This report represents work performed by The Ralph M. Parsons Company under Contract No. DE-AC07-81ID12176 (Task No. 81-3) with the U.S. Department of Energy (DOE), with technical guidance provided by Exxon Nuclear Idaho Company, Inc., (ENICO), Idaho National Engineering Laboratory, and by Battelle, Pacific Northwest Laboratories.

This report presents preconceptual designs, process evaluations, and life cycle costing data for comparison of two alternate candidate processes for encapsulation of Krypton-85 released during reprocessing of commercial irradiated nuclear fuels.

## SUMMARY

The following table presents various parameters as identified in this report for comparison of the two alternate candidate processes.

| PARAMETER | ION IMPLANTATION/ SPUTTERING | ZEOLITE ENCAPSULATION |
|---|---|---|
| 1. Process Conditions | $10^{-2}$ Torr Vacuum, 300°C | 14,700 psia, 700°C |
| 2. Process Units | 8 | 1 |
| 3. Product Form | Sealed container of metallic solid | Doubly contained pellets |
| 4. Product Size | 10.75 in. O.D. x 17 in. long | 8.625 in. O.D. x 20 in. long |
| 5. $Kr^{85}$ in Process as Gas | Negligible | 45,000 Ci |
| 6. Product Throughput | 305/yr. | 600/yr. |
| 7. Required Availability | 70% | 83% |
| 8. Remote Operations/ Product Batch | 9 | 10 |
| 9. Processing Time | 129 hrs. | 12 hrs. |
| 10. Hrs./Product Batch | 16 hrs. | 12 hrs. |
| 11. Building Floor Area | 7,138 SF | 4,368 SF |
| 12. Total Air Supply | 77,000 CFM | 6,700 CFM |
| 13. Demand Power | 539 KVA | 258 KVA |
| 14. Developments Needed | 1.8 scale-up, remote operation, power supplies, target/substrate assemblies. | Commercial scale of equipment, scale-up from tests, N-stamp equipment |
| 15. Licensing Concerns | 60 day lag storage, but may not be needed | 60 day lag storage, process vessel |
| 16. Capital Costs | | |
| a) Improv. to Land | $ 53,100 | $ 51,000 |
| b) Building | 6,684,400 | 5,560,400 |
| c) Equipment | 3,602,500 | 4,518,600 |
| Total | $10,340,000 | $10,130,000 |
| 17. Energy Consumption | | |
| a) Annual | 3,880,800 KW-hr | 1,857,600 KW-hr |
| b) Per Product Batch | 12,724 KW-hr | 3,096 KW-hr |
| c) Per Mole of Gas | 384 KW-hr | 179 KW-hr |
| 18. Life Cycle Costs (30 years) | | |
| a) Initial Investment | $ 9,306,000 | $ 9,117,000 |
| b) Energy Cost | 1,935,588 | 926,494 |
| c) Operating Manpower | 6,639,350 | 6,775,860 |
| d) Operating Materials | 7,648,283 | 4,094,059 |
| e) Maintenance Matls. | 690,568 | 884,353 |
| f) Insurance Costs | 105,327 | 103,117 |
| Total Life Cycle Costs | $26,430,684 | $21,900,883 |
| 19. Feasibility | Viable with 5 Yr. Development Program | Viable with 5 yr. Development Program |

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# SECTION 1

# INTRODUCTION

U.S. EPA regulations limit the release of Krypton-85 to the environment from commercial facilities after January 1, 1983. In order to comply with these regulations, Krypton-85, which would be released during reprocessing of commercial nuclear fuel, must be collected and stored. Technology currently exists for separation of krypton from other inert gases, and for its storage as a compressed gas in steel cylinders. The requirements, which would be imposed for 100-year storage of Krypton-85, have led to development of processes for encapsulation of krypton within a stable solid matrix. The objective of this effort was to provide preconceptual engineering designs, technical evaluations, and life cycle costing data for comparison of two alternate candidate processes for encapsulation of Krypton-85. This report has been prepared by The Ralph M. Parsons Company for the U.S. Department of Energy.

The general bases for this effort are contained within the Statement of Work for Preconceptual Design, Process Feasibility, and Economic Analysis for Krypton Encapsulation Facilities, December 3, 1980.

Preconceptual designs, process evaluations, and life cycle costing data are provided for facilities utilizing the following alternate processes:

(1) Ion Implantation/Sputtering Encapsulation

(2) Zeolite Encapsulation

Process throughput capacities for the encapsulation facilities considered in this report are based on 110% of an estimated 17 x $10^6$ curies/year of Krypton-85 released from a plant reprocessing 2000 MTHM/year of LWR fuels. The process gas feed stream is assumed to consist of 2% xenon, 8% argon, and 90% krypton by volume, with Krypton-85 making up 6% of the total krypton, based on the capabilities of existing technology for cryogenic noble gas separation. The facilities are required to operate 24 hours/day for 300 days/year, with a useful life of at least 30 years.

The process and equipment sizes selected for the alternate encapsulation processes are based only on a viable size basis for the required throughput. No attempt has been made to optimize, either on the basis of capital or life cycle costs. For either process there is a wide range of combinations of units, sizes, and substrate materials, all of which will satisfy the requirements. Therefore, this report should be used for comparing the two processes only. Optimization studies, as part of a conceptual or preliminary design effort, will better define the actual costs of implementing krypton encapsulation on a commercial scale.

# SECTION 2

# GENERAL CRITERIA

The following general criteria apply to the preconceptual design of the encapsulation facilities, and are the basis for the process evaluations and life cycle costing data.

1. The encapsulation facility will be a stand-alone facility located in the vicinity of a cryogenic noble gas separation facility as part of a commercial nuclear fuel reprocessing plant.

2. The commercial nuclear fuel reprocessing plant is assumed to be located at the Oak Ridge National Laboratory (ORNL) at Oak Ridge, Tennessee, for cost estimating purposes.

3. All utility services and power will be provided to the encapsulation facility through the reprocessing plant.

4. The design, installation, and operation of the encapsulation facility will conform to the applicable federal nuclear regulations and the applicable federal, state, and local industrial codes and standards. The encapsulation facility will be licensed by the Nuclear Regulatory Commission (NRC).

5. The encapsulation facility will be designed and operated to limit radiation exposure of personnel to "as low as reasonably achievable" (ALARA), in accordance with the requirements of the NRC.

6. The encapsulation facility will be designed, to the extent practical, for remote operation, and for contact maintenance after remote decontamination.

7. The encapsulation facility will include equipment and provisions for storage of up to 60 days operational supply of feed gas.

8. The encapsulation facility will include equipment and provisions to store the encapsulated Krypton-85 due to operation for up to one year.

9. Encapsulated product from the encapsulation facility will be compatible with the storage concepts reported in SAND 80-0122, "Krypton-85 Disposal Program Annual Report, October 1, 1978 to September 30, 1979", based on studies for a spent unreprocessed fuel (SURF) storage facility.

# SECTION 3

# PROCESSES AND EQUIPMENT

## 3.1 ION IMPLANTATION/SPUTTERING

### 3.1.1 PROCESS DESCRIPTION AND EQUIPMENT

Ion implantation is a process by which gases can be implanted into solids by bombarding the surface of the solid with energetic ions. For positively charged krypton ions, created by collisions between energetic electrons and krypton gas atoms, the depth of implantation amounts to only a few atom layers for ion energies in the keV range.

Sputter deposition is a film growth vapor deposition process in which a substrate is uniformly coated with a solid. The coating is initiated by accelerating positively charged ions to the surface of a target, resulting in sufficient momentum transfer to overcome the binding energy of the target atoms in their lattice.

In combining these processes, a dense thermionically supported plasma is created in the annulus between the target and the substrate. Positively charged krypton ions are accelerated to the target by applying a large negative voltage to the target, so that the krypton ions act as the sputtered ions. The krypton ions are also accelerated to the substrate to implant in the sputtering deposit by applying a lessor negative voltage to the substrate. Implanted krypton ions are entrapped by the growing sputtered deposit. The resulting deposited solid, based on analysis of laboratory scale process deposits, incorporates up to 12.9% krypton by weight.

The krypton encapsulation facility design (see Appendix D-7) is based on using eight process units. Each unit operates as a batch process, with a calculated processing time of 129 hours, and entraps 34.06 moles (763 liters at standard conditions) of krypton in each deposit. The equipment would operate 24 hours per day, 300 days per year, with a required availability of approximately 70% while the facility is in operation.

The substrate is a standard 10-inch stainless steel pipe and pipe cap, which, when seal welded after processing, provides containment of the encapsulation deposit. The target is a standard 6-inch steel pipe and pipe cap which is initially coated with 1.30 centimeters of 79% nickel and 21% lanthanum by weight, and will result in a 1.0 centimeter thick sputtering deposit. The plasma is initiated by electrons emitted from a tungsten filament in the annulus between the target and the substrate. Cooling water for heat removal during processing is provided to the interior of the target and to the exterior of the substrate. Electrical insulators are provided on all connections and to isolate the target, substrate, and filament from each other. These assemblies will be fabricated, factory tested, and shipped to the encapsulation facility as an assembled unit. A total of 305 assemblies per year are utilized to encapsulate 10,380 moles (232,500 liters at standard conditions) of feed gas per year.

The primary supporting equipment to the process are the power supplies and current limiters and controls for the target, substrate, and filament, vacuum pumps, and cooling systems. A list of major equipment for Ion Implanation/Sputtering is given in Appendix B-1.

3.1.2 LAG STORAGE EQUIPMENT

The facility is required to include the capability to store up to 60 days operational supply of feed gas (46,500 liters at standard conditions). The lag storage equipment is based on storage at 500 psig gas pressure. The equipment consists of a bank of pressure vessels, each constructed of 12-inch Schedule 80S pipe by 12'0" long. A total of eight vessels is required to provide the necessary capacity. The vessels are arranged horizontally in a two wide by four high array. Calculations (see Appendix D-3)show that natural convection will remove the heat generated by radioactive decay of Krypton-85, and will maintain the temperature of the stored gas at less than 250°F. Based on ENICO-1081, "Materials Screening Tests for the Krypton-85 Storage Development Program-Final Report", April, 1981, the storage vessels will be constructed of Type 316L stainless steel to provide corrosion resistance to rubidium, the decay product of Krypton-85, and compounds of rubidium, and to allow decontamination.

3.1.3 SUBSTRATE HANDLING AND SEALING

New target/substrate assemblies are received at the facility and stored in the substrate storage area. A total of 305 target/substrate assemblies are used each year. During processing, shielding is required for the encapsulation deposit, which contains a large quantity of radioactive krypton, to allow maintenance on other units within the cell. A lead lined shielding assembly is provided which also acts as a cooling jacket around the target/substrate assembly during processing.

New target/substrate assemblies can be installed in the cell either manually or remotely. A shielding assembly is placed on a mini-trailer robo-carrier with the overhead bridge crane which spans the cell. The robo-carrier is a remotely controlled cart and platform lift assembly, with pre-programmed positioning capability. A new target/substrate assembly is placed in the shielding assembly, manually or with the use of the bridge crane. The robo-carrier then moves to the appropriate station, and lifts the assembly upward, mating with electrical and piping connections, and locking in position.

After processing, the robo-carrier returns to the processing station, the assembly is remotely unlocked, and is lowered and moved away to the welding station. The bridge crane is used to lift the target/substrate assembly, which now includes encapsulated krypton, and position it for welding. A lid is welded to the target/substrate assembly with a fully remotely operated welder, assisted or maintained by two Model "F" type master-slave manipulators. A shielding viewing window is provided to allow operator supervision of welding.

After welding, the product canister is replaced on the robo-carrier with the bridge crane, and moved to the inspection station. The lid weld is visually inspected through a shielding viewing window. The product canister is purged and filled with helium, through a connection provided for this purpose, and the lid weld is helium leak tested. If required, the weld could also be dye penetrant inspected. The remote equipment is assisted or maintained by two Model "F" type master-slave manipulators. The product canister is now ready for storage.

These operations for substrate handling and sealing are not ideal from the standpoint of remote operations, but recognizing that they are performed on an average of only once every 16 hours, and that a more elaborate scheme would be less reliable and considerably more expensive, these operations are considered to be appropriate.

### 3.1.4 PRODUCT STORAGE AND HANDLING

Completed product canisters are stored for up to one year within the facility. The product canister is placed horizontally in a cradle on the robo-carrier. The robo-carrier is moved out of the process cell into the product load-in area, and is positioned and lifts the canister to a pre-selected storage location. A pneumatic piston is used to push the canister into the storage rack.

The storage rack holds product canisters in a horizontal array, to allow cooling by natural convection. Calculations (see Appendix D-5) show that natural convection will remove the heat generated by radioactive decay of Krypton-85, and will maintain the temperature of the stored product at less than 250$^{o}$F. The storage rack is 26 ft.-0 in. long, and stores canisters in a six by six array, for a total of 468 available storage positions. Product canisters are stored 15 inches on center in the array, with a maximum of 13 canisters in each position.

The storage positions consist of a pair of lines of rollers, one each at 45 degrees in each lower quadrant. The rollers are spaced with two together on 6 inch centers, for a total of 208 rollers at each storage position (36 positions). The rollers are constructed of Nitronic 60 material, for decontaminability and non-galling, and are each held in a bracket by a through bolt. The roller/bracket assemblies are mounted on 4 inch angles, (total of 72, two for each position) which are mounted in a frame of angle columns, (total of 35, in five rows of seven at about 5 ft.-0 in. center-to-center). The storage rack, except for rollers, is constructed of 304L SS.

Inserted product canisters push other canisters in the same position along the length of the storage rack. Canisters are inserted sequentially by storage position. When the storage rack is filled, the oldest 36 product canisters are exposed at the far end of the storage rack. A second mini-trailer robo-carrier, which is also a spare for the process robo-carrier, is used to retrieve the oldest product canisters for shipment to long-term storage.

## 3.2 ZEOLITE ENCAPSULATION

### 3.2.1 PROCESS DESCRIPTION AND EQUIPMENT

Gases can be entrapped by sintering in solids such as zeolite or vycor which have molecular defects in their structure. Krypton gas can be diffused into the solid, and encapsulated in a structural vacancy when the molecular lattice of the solid substrate is sintered at high temperatures. The encapsulation facility design is based on the use of zeolite 5A as the substrate, due to the relatively much higher cost of vycor (see Appendix D-9).

Encapsulation of krypton in zeolite requires high pressure and moderate temperature. The base case utilized for design of the encapsulation facility consists of a working volume of 8 liters loaded with 7,750 cubic centimeters of compacted zeolite 5A pellets. The process will operate in a batch sequence, with each batch encapsulating 17.3 moles (387.5 liters at standard conditions) of gas when held at a pressure of 1000 atmospheres (14,700 psia) and 700°C for 2 hours. Each batch, including loading, pressurization, heating, processing, cooling, depressurization, purging, and unloading is estimated to take 10 hours. A total of 600 batches per year are utilized to encapsulate 10,380 moles (232,500 liters at standard conditions) of feed gas (see Appendix D-7). Assuming a single unit, the process will operate 24 hours per day, 300 days per year, with a required availability of approximately 83% while the facility is in operation.

The process equipment is an application of commercial hot isostatic pressing equipment. The pressure vessel is a cooled shell with a capacity of 30 liters (approximately 12 in. dia. x 16 in. high), with a top plug. The pressure vessel is estimated to be 6 inches thick. A moveable yoke is used to restrain the plug during operation and to provide partial protection from vessel fragments in the event of a rupture. The interior of the vessel contains electrical heating for the substrate container.

The substrate container is a thin-walled cylinder, constructed of Type 316L stainless steel, with a volume of 8.8 liters (7 in. dia. x 14 in. high). The differential pressure across the container wall is maintained at 50 psig or less by pressurizing the annulus between the pressure vessel and the substrate container with helium.

The primary supporting equipment to the process are compressors and controls for pressurization of the system, vacuum pumps, and cooling systems. A list of major equipment for Zeolite Encapsulation is given in Appendix B-2.

### 3.2.2 LAG STORAGE EQUIPMENT

The facility is required to include the capability to store up to 60 days operational supply of feed gas (46,500 liters at standard conditions). The lag storage equipment is based on storage at 500 psig gas pressure. The equipment consists of a bank of pressure vessels, each constructed of 12-inch Schedule 80S pipe by 12'0" long. A total of eight vessels is required to provide the necessary capacity. The vessels are arranged horizontally in a two wide by four high array. Calculations (see Appendix D-3) show that natural convection will remove the heat generated by radioactive decay of Krypton-85, and will maintain the temperature of the stored gas at less than 250°F. Based on ENICO-1081, "Materials Screening Tests for the Krypton-85 Storage Development Program-Final Report", April, 1981, the storage vessels will be constructed of Type 316L stainless steel to provide corrosion resistance to rubidium, the decay product of Krypton-85, and compounds of rubidium, and to allow decontamination.

### 3.2.3 SUBSTRATE HANDLING AND SEALING

New substrate assemblies are received at the facility and stored in the substrate storage area. A total of 600 substrate assemblies are used each year. During processing, the heavy-wall pressure vessel provides adequate shielding for the encapsulated product, which contains a large quantity of radioactive krypton. However, personnel will not enter the cell due to the extremely high processing pressure, and danger in the unlikely event of equipment/piping failure.

New substrate assemblies can be installed in the cell either manually or remotely. The overhead bridge crane which services the cell places the assembly in one of two substrate activation furnaces, for drying and preheating. Activation is estimated to take 12 hours. When ready for processing, the vessel yoke is retracted, the vessel top plug is removed, and the bridge crane places the substrate assembly in the Hot Isostatic Press.

After processing, the vessel yoke and plug are again removed. The bridge crane is used to lift the substrate assembly, which now includes encapsulated krypton, and position it for welding. A lid is welded to the substrate assembly with a fully remotely operated welder, assisted or maintained by two Model "F" type master-slave manipulators. A shielding viewing window is provided to allow operator supervision of welding. The substrate assembly is placed in a carbon steel pipe overpack, and a lid is welded to the overpack to form the product canister.

After welding, the bridge crane moves the product canister to the inspection station. The lid weld is visually inspected through a shielding viewing window. The product canister is purged and filled with helium, through a connection provided for this purpose, and the lid weld is helium leak tested. If required, the weld could also be dye penetrant inspected. The remote equipment is assisted or maintained by two Model "F" type master-slave manipulators. The product canister is now ready for storage.

These operations for substrate handling and sealing are not ideal from the standpoint of remote operations, but recognizing that they are performed on an average of only once every 12 hours, and that a more elaborate scheme would be less reliable and considerably more expensive, these operations are considered to be appropriate.

### 3.2.4 PRODUCT STORAGE AND HANDLING

Completed product canisters are stored for up to one year within the facility. The bridge crane places the product canister horizontally in a cradle on a mini-trailer robo-carrier. The robo-carrier is a remotely controlled cart and platform lift assembly, with pre-programmed positioning capability. The robo-carrier is moved out of the process cell into the product load-in area, an is positioned and lifts the canister to a pre-selected storage location. A pneumatic piston is used to push the canister into the storage rack.

The storage rack holds product canisters in a horizontal array, to allow cooling by natural convection. Calculations (see Appendix D-8) show that natural convection will remove the heat generated by radioactive decay of Krypton-85, and will maintain the temperature of the stored product at less than 250°F. The storage rack is 26 ft.-0 in. long, and stores canisters in a seven by seven array, for a total of 637 available storage positions. Product canisters are stored 12 inches on center in the array, with a maximum of 13 canisters in each position.

The storage positions consist of a pair of lines of rollers, one each at 45 degrees in each lower quadrant. The rollers are spaced with two together on 6 inch centers, for a total of 208 rollers at each position (49 positions). The rollers are constructed of Nitronic 60 material for decontaminability and non-galling, and are each held in a bracket by a through bolt. The roller/bracket assemblies are mounted on 4 inch angles (total of 98, two for each position), which are mounted in a frame of angle columns (total of 40, in five rows of 8 at about 5 ft.-0 in. center-to-center). The storage rack, except for rollers, is constructed of 304L SS.

Inserted product canisters push other canisters in the same position along the length of the storage rack. Canisters are inserted sequentially by storage position. When the storage rack is filled, the oldest 49 product canisters are exposed at the far end of the storage rack. A second mini-trailer robo-carrier, which is also a spare for the in-cell robo-carrier, is used to retrieve the oldest product canisters for shipment to long term storage.

# SECTION 4

# BUILDINGS AND BUILDING SERVICES

## 4.1 ION IMPLANTATION/SPUTTERING

### 4.1.1 BUILDING DESCRIPTION

The Ion Implantation/Sputtering Facility is a rectangular building with overall dimensions of 89 ft.-0 in. by 50 ft.- 6 in. The building is constructed of reinforced concrete for all areas required to survive design basis natural phenomena. Other areas of the building are constructed of reinforced masonry concrete block walls with roofing over metal decking supported by structural steel beams, and are required to survive operating basis natural phenomena. Areas required to survive design basis natural phenomena are those areas of the building necessary for containment of Krypton-85. Preconceptual drawings of the Ion Implanation/Sputtering Facility are contained in Appendix A. Outline specifications of the facility materials and equipment are contained in Appendix C-1.

The facility is on two levels, with power supplies to the process and heating and ventilating equipment located on the second level, which is 89 ft.-0 in. by 29 ft.-6 in. The total floor area of the facility is 7,138 square feet.

All exterior walls of the building are covered with insulated metal siding. The building roof is an "inverted" type, consisting of asphalt felt layers, insulation, and roofing aggregate.

#### 4.1.1.1 Process Cell

The Process Cell is 34 ft.-0 in. long by 13 ft.-6 in. wide by 12 ft.-0 in. high constructed of 12 in. thick reinforced concrete walls and ceiling, and a 6 in. thick concrete floor supported by compacted backfill and concrete footings. The cell is designed to provide shielding from radiation exposure to personnel. Shielding viewing windows are provided for remote operations, substrate inspection, and substrate sealing. An overhead bridge crane services the Process Cell for loading, unloading, and transporting substrate containers.

#### 4.1.1.2 Gas Storage Area

The Gas Storage Area is 16 ft.-6 in. long by 13 ft.-6 in. wide by 12 ft.-0 in. high constructed of 12 in. thick reinforced concrete walls and ceiling and a 6 in. thick concrete floor supported by compacted backfill and concrete footings. The Gas Storage Area is designed to provide shielding for the Lag Storage Equipment, which may contain 60 days operational supply of feed gas, and to provide protection from the accidental rupture of the storage vessels.

4.1.1.3 Interim Product Storage Area

The Interim Product Storage Area is 26 ft.-0 in. long by 13 ft.-0 in. wide by 12 ft.-0 in. high constructed of reinforced concrete walls and ceiling and a 6 in. thick concrete floor supported by compacted backfill and concrete footings. The Interim Product Storage Area is designed to provide shielding for encapsulated product due to operation for one year. Shielding hatches are provided for access for maintenance.

4.1.1.4 Support Areas

Other Support Areas included in the building design are as follows:

(1) Substrate and Container Storage. 19 ft.-6 in. long by 15 ft.-0 in. wide by 9 ft.-0 in. high, constructed of masonry concrete block exterior walls, metal studs and gypsum board interior walls, and suspended plaster ceiling.

(2) Health Office. 13 ft.-0 in. long by 8 ft.-6 in. wide by 9 ft.-0 in. high, constructed of masonry concrete block exterior walls, metal studs and gypsum board interior walls, and suspended acoustical ceiling.

(3) Decontamination Area. 13 ft.-0 in. long by 6 ft.-0 in. wide by 9 ft.-0 in. high, constructed of metal studs and Type "X" gypsum board walls and suspended plaster ceiling, with an enclosed shower with ceramic tile floor and walls.

(4) Operating Gallery. 20 ft.-6 in. long by 20 ft.-6 in. wide by 9 ft.-0 in. high, constructed of masonry concrete block exterior walls, metal studs and gypsum board interior walls, and suspended acoustical ceiling.

(5) Supervisor's Office. 12 ft.-0 in. long by 10 ft.-0 in. wide by 9 ft.-0 in. high, constructed of masonry concrete block exterior walls, metal studs and gypsum board interior walls, and suspended acoustical ceiling. Includes an 11 ft.-0 in. long by 4 ft.-0 in. high glass window to the Operating Gallery.

(6) Electrical and HVAC Area. 87 ft.-0 in. long by 27 ft.-6 in. wide by 12 ft.-0 in. high, (second level), constructed of reinforced concrete floor, walls, and ceiling.

(7) Electrical and Equipment Area. 28 ft.-6 in. long by 27 ft.-6 in. wide by 12 ft.-0 in. high, (first level), constructed of reinforced concrete floor, walls, and ceiling.

(8) Product Storage Load-In Area. 13 ft.-0 in. long by 8 ft.-0 in. wide by 12 ft.-0 in. high, constructed of reinforced concrete floor, walls, and ceiling.

(9) Product Load-Out Area. 15 ft.-6 in. long by 13 ft.-0 in. wide by 12 ft.-0 in. high, constructed of reinforced concrete floor, walls, and ceiling.

(10) Restroom and Locker Area. 18 ft.-6 in. long by 15 ft.-0 in. wide by 9 ft.-0 in. high, constructed of masonry concrete block exterior walls, metal studs and Type "X" gypsum board interior walls, and suspended plaster ceiling.

4.1.2 HEATING AND VENTILATING

Three Heating and Ventilating Systems are provided for the Ion Implantation/Sputtering Facility. One system services the HVAC and Electrical Equipment Areas. A second system services the non-contaminated operating areas, consisting of the offices, the Operating Gallery, and the Restroom and Locker Area. A third system services the potentially contaminated areas, consisting of the Process Cell, Gas Storage Area, Interim Storage Area, Substrate and Container Storage, Product Storage Load-In Area, and Product Load-Out Area. As shown on Drawing V-1, the Heating and Ventilating Systems for the non-contaminated operating areas and for the potentially contaminated areas utilize common supply and exhaust air systems.

The Heating and Ventilating System for the HVAC and Electrical Equipment Areas provides a maximum of 72,000 cfm (summer) and a minimum of 9,000 cfm (winter) through four 25%, 15 hp vent fans. Air is exhausted through four 18,000 cfm maximum capacity roof ventilators. Steam unit heaters are provided, with 50,000 Btu/hr. capacity, for space heating.

The Heating and Ventilating Systems for the non-contaminated operating areas and for the potentially contaminated areas are once through air flow systems, designed to maintain confinement zones based on differential air pressure to ensure air flow from less contaminated to more contaminated areas. Ventilation and temperature control will provide a suitable working environment in areas occupied by personnel. Air filtration is employed to reduce potential radioactive contaminants in the effluent to "as low as reasonably achievable" (ALARA) prior to discharge to the environment.

The supply air system, which provides approximately 5,000 cfm to the non-contaminated and potentially contaminated systems, consists of two 100% (one standby) supply fans. Each supply air plenum includes a tornado shut-off valve, a steam preheat coil, 30% efficiency roughing and 80% efficiency pre-filters, backdraft damper, air flow monitor, and flow control damper. 100% outside air is supplied to the non-contaminated system and the potentially contaminated system.

Approximately 1200 cfm is supplied to the non-contaminated operating areas through a steam heating coil and a refrigerant cooling coil. Approximately 200 cfm is directed to the vestibule, and by infiltration to the Restroom and Locker Area, and is exhausted by exfiltration and by a powered roof ventilator. 1000 cfm is directed to the offices and the Operating Gallery, and is exhausted through the exhaust air system. The offices are maintained at -0.10 in. water gauge air pressure. The Operating Gallery is maintained at -0.20 in. water gauge air pressure.

Approximately 3800 cfm is supplied to the potentially contaminated areas. Approximately 3200 cfm is supplied directly to the Process Cell through heating/cooling coils. 600 cfm is supplied to the Load-Out Area, the Gas Storage Area, and the Substrate and Container Storage Area, which are maintained at -0.10 in. water gauge air pressure, and then to the Interim Storage Area, which is maintained at -0.25 in. water gauge air pressure, to the Load-In Area, which is maintained at 0.40 in. water gauge air pressure, and to the Process Cell, which is maintained at 0.60 in. water gauge air pressure.

The exhaust air system, which exhausts approximately 5000 cfm from the non-contaminated and the potentially contaminated systems, consists of two 100% (one standby) exhaust fans. Each exhaust air plenum includes a flow control damper, a water spray cooling chamber, two stages of high efficiency particulate air (HEPA) filters, a backflow damper, an air flow monitor, a flow control damper, and a constant air radiation monitor. Exhaust air is directed through an exhaust air stack on the facility roof.

### 4.1.3 ELECTRICAL

#### 4.1.3.1 Power Distribution

The Site power for non-critical loads in the Ion Implantation/Sputtering Facility will be distributed at 13.8 kV to the unit substation (US1). The two #4/0, 15 kV, 3 phase, primary feeders will be provided by Others. The unit substation steps down the voltage to the 277/480V motor control center, MCC1 and the split bus motor control center MCC2. Small loads are supplied power at 120/208V, 3 phase through stepdown transformers.

#### 4.1.3.2 Standby Power

Standby power for critical loads will be distributed at 277/480 volts from the automatic transfer switch in the standby section of motor control center MCC2. The standby section and transfer switch of MCC2 will be seismically qualified.

The critical equipment that requires standby power to ensure availability in the event of a power failure will be connected to the standby section of the motor control center MCC2. The critical process equipment includes an emergency panelboard, ventilation exhaust fans, and certain control functions. The small critical loads will be supplied power through a stepdown transformer. The system voltages will be 277/480V, 3 phase and 120/280V, 3 phase. A power outage occurring ahead of the standby section of MCC2 will momentarily shut down all equipment connected to it.

The automatic transfer from normal power to standby power, and the subsequent manual return to normal power, causes an interruption of services to all loads connected to this system. The fans will be arranged to restart automatically. Lighting and alarm circuit breakers will remain closed through an interruption of service and require no operator action to reset.

4.1.3.3 Lighting

The lighting levels will be designed for 50 foot candles at work stations, 30 fc in work areas and 10 fc in aisles or corridors in accordance with ERDA 6301. Fluorescent lighting luminaires with energy-saving ballasts and lamps will be utilized in the office and rooms with low ceilings. High pressure sodium fixtures (HPS) with prismatic glass reflectors will be utilized in other locations for energy conservation. Special lighting designed for remote servicing and constructed to permit decontamination will be provided in the cell. The building exterior doorways will be illuminated with wall-mounted HPS fixtures.

Emergency lighting will be provided by fully automatic battery units, wall mounted near doors and stairways. Certain building lighting fixtures will be connected to the emergency lighting panelboard.

4.1.3.4 Lightning Protection

Lightning protection with a UL Master Label will be provided.

4.1.3.5 Grounding

A No. 4/0 AWG soft drawn bare copper ground loop, with 3/4 inch by 10 foot copper-clad steel ground rods, will be provided. The grounding counterpoise around the building will be connected to the Site duct bank ground.

4.1.3.6 Telephone

The telephone system will be installed in conduit within the building and a 3 inch conduit only will be extended and capped 5 ft outside this building. Telephone cabinets will be provided, as required. The telephone system wiring will be by Others.

4.1.3.7 Public Address and Intercom

No intercom or public address is required in the building. A cell monitoring system will be provided.

4.1.3.8 Fire Alarm and Evacuation Alarm

The building fire alarm and evacuation alarm will be compatible with and connected to the Site system.

## 4.2 ZEOLITE ENCAPSULATION

### 4.2.1 BUILDING DESCRIPTION

The Zeolite Encapsulation Facility is a rectangular building with overall dimensions of 84 ft.-0 in. by 52 ft.-0 in. The building is constructed of reinforced concrete for all areas required to survive design basis natural phenomena. Other areas of the building are constructed of reinforced masonry concrete block walls with roofing over metal decking supported by structural steel beams, and are required to survive operating basis natural phenomena. Areas required to survive design basis natural phenomena are those areas of the building necessary for containment of Krypton-85. Preconceptual drawings of the Zeolite Encapsulation Facility are contained in Appendix A. Outline specifications of the facility materials and equipment are contained in Appendix C-2.

The facility is on one level, with a total floor area of 4,368 square feet.

All exterior walls of the building are covered with insulated metal siding. The building roof is an "inverted" type, consisting of asphalt felt layers, insulation, and roofing aggregate.

#### 4.2.1.1 Process Cell

The Process Cell is 24 ft.-0 in. long by 14 ft.-0 in. wide by 12 ft.-0 in. high constructed of 18 in. thick reinforced concrete walls and ceiling, with a two-level basement area for location of the Hot Isostatic Press and the Sump Catch Tank, and for use as a pipe chase. The floor of the lower level of the basement area is 9 ft.-0 in. below the cell operating level floor. The pipe chase is 2 ft.-6 in. wide, with the floor 4 ft.-0 in. below the operating level floor. The basement floor is an 18 in. thick reinforced concrete mat foundation. The operating floor is 12 in. thick reinforced concrete. The Process Cell is designed to provide shielding and to withstand 1PSI overpressure as a result of accidental rupture of the Hot Isostatic Press, and includes metal clad blast-proof doors and blast-proof shielding windows. The estimated maximum overpressure as a result of release of the high pressure gas in the Hot Isostatic Press is 0.80 PSI. Viewing windows are provided for remote operations, substrate inspection, and substrate sealing. An overhead bridge crane services the Process Cell for loading, unloading, and transporting substrate containers.

#### 4.2.1.2 Gas Storage Area

The Gas Storage Area is 16 ft.-6 in. long by 15 ft.-0 in. wide by 12 ft.-0 in. high constructed of 12 in. thick reinforced concrete walls and ceiling and a 6 in. thick concrete floor supported by compacted backfill and concrete footings. The Gas Storage Area is designed to provide shielding for the Lag Storage Equipment, which may contain 60 days operational supply of feed gas, and to provide protection from the accidental rupture of the storage vessels.

### 4.2.1.3 Interim Product Storage Area

The Interim Product Storage Area is 26 ft.-0 in. long by 13 ft.-0 in. wide by 12 ft.-0 in. high constructed of 12 in. thick reinforced concrete walls and ceiling and a 6 in. thick concrete floor supported by compacted backfill and concrete footings. The Interim Product Storage Area is designed to provide shielding for encapsulated product due to operation for one year. Shielding hatches are provided for access for maintenance.

### 4.2.1.4 Support Areas

Other Support Areas included in the building design are as follows:

(1) Substrate and Container Storage. 19 ft.-6 in. long by 14 ft.-6 in. wide by 9 ft.-0 in. high, constructed of masonry concrete block exterior walls, metal studs and gypsum board interior walls, and suspended ceiling.

(2) Health Office. 13 ft.-0 in. long by 8 ft.-0 in. wide by 9 ft.-0 in. high, constructed of masonry concrete block exterior walls, metal studs and gypsum board interior walls, and suspended acoustical ceiling.

(3) Decontamination Area. 13 ft.-0 in. long by 6 ft.-0 in. wide by 9 ft.-0 in. high, constructed of metal studs and Type "X" gypsum board walls and suspended plaster ceiling, with an enclosed shower with ceramic tile floor and walls.

(4) Operating Gallery. 20 ft.-6 in. long by 15 ft.-0 in. wide by 9 ft.-0 in. high, constructed of masonry concrete block exterior walls, metal studs and gypsum board interior walls, and suspended acoustical ceiling.

(5) Supervisor's Office. 12 ft.-0 in. long by 10 ft.-0 in. wide by 9 ft.-0 in. high, constructed of masonry concrete block exterior walls, metal studs and gypsum board interior walls, and suspended acoustical ceiling. Includes an 11 ft.-0 in. long by 4 ft.-0 in. high glass window to the Operating Gallery.

(6) HVAC and Electrical Area. 34 ft.-0 in. long by 29 ft.-0 in. wide by 12 ft.-0 in. high, constructed of reinforced concrete floor, walls, and ceiling.

(7) Product Storage Load-In Area. 13 ft.-0 in. long by 8 ft.-0 in. wide by 12 ft.-0 in. high, constructed of reinforced concrete floor, walls, and ceiling.

(8) Gas Cooling Area. 15 ft.-0 in. long by 8 ft.-0 in. wide by 12 ft.-0 in. high, constructed of reinforced concrete floor, walls, and ceiling.

(9) Product Load-Out Area. 13 ft.-0 in. long by 11 ft.-6 in. wide by 12 ft.-0 in. high, constructed of reinforced concrete floor, walls, and ceiling.

(10) Restroom and Locker Area. 19 ft.-0 in. long by 15 ft.-0 in. wide by 9 ft.-0 in. high, constructed of masonry concrete block exterior walls, metal studs and Type "X" gypsum board interior walls, and suspended plaster ceiling.

4.2.2 HEATING AND VENTILATING

Three Heating and Ventilating Systems are provided for the Zeolite Encapsulation Facility. One system services the HVAC and Electrical Equipment Areas. A second system services the non-contaminated operating areas, consisting of the offices, Operating Gallery, and the Restroom and Locker Area. A third system services the potentially contaminated areas, consisting of the Process Cell, Gas Storage Area, Interim Storage Area, Substrate and Container Storage, Product Storage Load-In Area, and Product Load-Out Area. As shown on Drawing V-2, the Heating and Ventilating Systems for the non-contaminated operating areas and for the potentially contaminated areas utilize common supply and exhaust air systems.

The Heating and Ventilating System for the HVAC and Electrical Equipment Area provides a maximum of 4000 cfm through a 1 hp vent fan. Air is exhausted through a 4000 cfm maximum capacity roof ventilator. Steam unit heaters, with 50,000 BTU/hr. capacity, are provided for space heating.

The Heating and Ventilating Systems for the non-contaminated operating areas and for the potentially contaminated areas are once through air flow systems, designed to maintain confinement zones based on differential air pressure to ensure air flow from less contaminated to more contaminated areas. Ventilation and temperature control will provide a suitable working environment in areas occupied by personnel. Air filtration is employed to reduce potential radioactive contaminants in the effluent to "as low as reasonably achievable" (ALARA) prior to discharge to the environment.

The supply air system, which provides approximately 2700 cfm to the non-contaminated and potentially contaminated systems, consists of two 100% (one standby) supply fans. Each supply air plenum consists of a tornado shut-off valve, a steam preheat coil, 30% efficiency roughing and 80% efficiency pre-filters, backdraft damper, air flow monitor, and flow control damper. 100% outside air is supplied to the non-contaminated system and the potentially contaminated system.

Approximately 900 cfm is supplied to the non-contaminated operating areas through a steam heating coil and a refrigerant cooling coil. Approximately 120 cfm is directed to the vestibule, and by infiltration to the Restroom and Locker Area, and is exhausted by exfiltration and by a powered roof ventilator. 800 cfm is directed to the offices and the Operating Gallery, and is exhausted through the exhaust air system. The offices are maintained at -0.10 in. water gauge air pressure. The Operating Gallery is maintained at -0.20 in. water gauge air pressure.

Approximately 1800 cfm is supplied to the potentially contaminted areas. Approximately 1200 cfm is supplied directly to the Process Cell through heating/cooling coils. Approximately 600 cfm is supplied to the Load-Out Area, the Gas Storage Area, and the Substrate and Container Storage Area, which are maintained at -0.10 in. water gauge air pressure, and then to the Interim Storage Area, which is maintained at -2.0 in. water gauge air pressure, to the Load-In Area, which is maintained at -2.20 in. water gauge air pressure, and to the Process Cell, which is maintained at -2.40 in. water gauge air pressure.

The exhaust air sytem, which exhausts approximately 2800 cfm from the non-contaminated and potentially contaminated systems, consists of two 100% (one standby) exhaust fans. Each exhaust air plenum includes a flow control damper, a water spray cooling chamber, two stages of high efficiency particulate air (HEPA) filters, a backflow damper, an air flow monitor, a flow control damper, and a constant air radiation monitor. Exhaust air is directed through an exhaust air stack on the facility roof.

### 4.2.3 ELECTRICAL DESIGN DESCRIPTION

#### 4.2.3.1 Power Distribution

The Site power for non-critical loads in the Zeolite Encapsulation Facility will be distributed at 13.8 kV to the unit substation (US1). The two #4/0, 15 kV, 3 phase, primary feeders will be provided by Others. The unit substation steps down the voltage to the 277/480V split bus motor control center, MCC1. Small loads are supplied power at 120/208V, 3 phase through stepdown transformers.

#### 4.2.3.2 Standby Power

Standby power for critical loads will be distributed at 277/480 volts from the automatic transfer switch in the standby section of motor control center MCC1. The standby section and transfer switch of MCC1 will be seismically qualified.

The critical equipment that requires standby power to ensure availability in the event of a power failure will be connected to the standby section of the motor control center. The critical process equipment includes an emergency panelboard, ventilation exhaust fans, and certain control functions. The small critical loads will be supplied power through a stepdown transformer. The system voltages will be 277/480V, 3 phase and 120/280V, 3 phase. A power outage occurring ahead of the standby section of MCC1 will momentarily shut down all equipment connected to it.

The automatic transfer from normal power to standby power, and the subsequent manual return to normal power, causes an interruption of services to all loads connected to this system. The fans will be arranged to restart automatically. Lighting and alarm circuit breakers will remain closed through an interruption of service and require no operator action to reset.

4.2.3.3 Lighting

The lighting levels will be designed for 50 foot candles at work stations, 30 fc in work areas and 10 fc in aisles or corridors in accordance with ERDA 6301. Fluorescent lighting luminaires with energy-saving ballasts and lamps will be utilized in the office and rooms with low ceilings. High pressure sodium fixtures (HPS) with prismatic glass reflectors will be utilized in other locations for energy conservation. Special lighting designed for remote servicing and constructed to permit decontamination will be provided in the cell. The building exterior doorways will be illuminated with wall-mounted HPS fixtures.

Emergency lighting will be provided by fully automatic battery units, wall mounted near doors and stairways. Certain building lighting fixtures will be connected to the emergency lighting panelboard.

4.2.3.4 Lightning Protection

Lightning protection with a UL Master Label will be provided.

4.2.3.5 Grounding

A No. 4/0 AWG soft drawn bare copper ground loop, with 3/4 inch by 10 foot copper-clad steel ground rods, will be provided. The grounding counterpoise around the building will be connected to the Site duct bank ground.

4.2.3.6 Telephone

The telephone system will be installed in conduit within the building and a 3 inch conduit only will be extended and capped 5 ft outside the building. Telephone cabinets will be provided, as required. The telephone system wiring will be by Others.

4.2.3.7 Public Address and Intercom

No intercom or public address is required in the building. A cell monitoring system will be provided.

4.2.3.8 Fire Alarm and Evacuation Alarm

The building fire alarm and evacuation alarm will be compatible with and connected to the Site system.

# SECTION 5

# FEASIBILITY EVALUATIONS

## 5.1 GENERAL

The purpose of this Section is to discuss and compare the feasibility of developing a viable commercial production scale process for Ion Implantation/Sputtering and for Zeolite Encapsulation within the next five years. The basis for this evaluation is a discussion of advancements which may be required beyond commercially available state-of-the-art equipment and process components.

## 5.2 ION IMPLANTATION/SPUTTERING

The Ion Implantation/Sputtering process has been developed by Battelle, Pacific Northwest Laboratories, for a wide spectrum of applications and for the specific application of krypton encapsulation. Process equipment has been designed, constructed, and operated by Battelle at laboratory and bench scales. The Encapsulation Facility would use equipment scaled up by only 1.8 over existing operating equipment. The commercial equipment would be somewhat different from laboratory equipment, in that all connections will be at the top of the target/substrate assembly, and that connections will seal automatically/remotely, but these differences are not considered to be serious technical concerns. There is a concern that some of the process equipment, particularly the target/sputtering assemblies, the in-cell sputtering heads, and the current limiters for the power supplies, are not commercially available equipment, nor are they anticipated to be commercially available within five years. These components will require additional development to allow design as special fabrications for a commercial facility.

The estimated cost of target/substrate assemblies is based on development of a source for these special fabrications, which does not presently exist economically or in sufficient production capacity. It is reasonable to assume, however, that a source for target/substrate assemblies could be developed within a five year period.

## 5.3 ZEOLITE ENCAPSULATION

The Zeolite Encapsulation process for encapsulation of krypton has been developed by Exxon Nuclear Idaho Company, Inc., Idaho National Engineering Laboratory. The process equipment is, with minor modifications, an application of currently available hot isostatic pressing equipment. Laboratory testing has been performed at a small scale, although equipment for the Encapsulation Facility is a commercially available equipment size. Some process components are not now commercially available, such as solenoid operated high pressure valves and control valves. It is reasonable to assume, however, that such components would be available due to normal technological development by the time the Encapsulation Facility is constructed, or suitable alternates, such as air operated high pressure valves which are presently commercially available, would be used.

The preconceptual design is based on the use of zeolite rather than vycor, although vycor has an apparently higher encapsulation efficiency for krypton, due to the much higher relative cost of vycor. It is conceivable that the production cost of vycor relative to zeolite may decrease, resulting in lower operating cost of the facility.

The estimated equipment costs are based on the application of industrial high pressure codes and standards, as existing commercial equipment is not available in accordance with nuclear codes (e.g. ASME Section III). It is also not anticipated that hot isostatic pressing equipment will be produced to nuclear codes in the future. It is reasonable to assume, however, that if application of nuclear codes and standards is required (see also Section 6 of this report), a source for such equipment could be developed within a five year period.

## 5.4 CONCLUSIONS

Based on these discussions, either alternate could result in a viable commercial production scale process within five years. No attempt has been made to assess the relative cost of development of the processes. Each process has its own associated risks and concerns. None of the concerns seem to be insurmountable, and the risks associated with each process appear to be of the same relative magnitude.

# SECTION 6

# LICENSIBILITY

The Krypton Encapsulation Facility will be licensed by the U.S. Nuclear Regulatory Commission (NRC), and will comply with the applicable federal regulations and NRC Regulatory guides. Federal regulations 10 CFR Part 50, "Licensing of Production and Utilization Facilities", and 10 CFR Part 100, "Reactor Siting Criteria", will provide the general design criteria for the commercial nuclear fuel reprocessing plant and for the encapsulation facility. Facilities utilizing either of the alternate encapsulation processes should not have difficulty in complying with existing criteria, however, NRC Regulatory Guides for handling and processing waste gases are still in preparation.

A fundamental criterion for the application of more stringent requirements is the consequence of a postulated accident at the site boundary. Since each facility could have as much as $3.74 \times 10^6$ Curies of radioactive Krypton-85 in storage (60 days lag storage) the requirements for this portion of the facility may be very stringent, although gas storage pressures are only moderate (500 PSIG). The actual requirements will depend on wind dispersion calculations and other factors for determining site boundary consequences, and since the requirements are identical for the two alternate facilities, these requirements have no impact on a comparative evaluation. Feed gas storage would be required so that a failure of process equipment in the encapsulation facility would not impact continued operation of the balance of the reprocessing plant. Since the Ion Implanation/Sputtering Facility would utilize multiple trains of process equipment, failure of one train would not effect encapsulation production, and equipment for feed gas storage may not be required.

The Ion Implantation/Sputtering Facility should have very few other safety-related components. During processing, the radioactive gas is maintained at a high vacuum, such that very little gas could be released during a postulated accident. Processing radioactive gases in this manner would be preferred from a safety standpoint.

The Zeolite Encapsulation Facility will have as much as 45,000 Curies of radioactive gas at very high pressure (14,700 PSIA) contained within the process equipment at a given time. It is likely that the process equipment, particularily the Hot Isostatic Press, would be required to meet high nuclear quality standards as safety-related equipment. Currently available commercial equipment, although adequate from an industrial safety standpoint, would require considerable modification to meet nuclear safety requirements. These additional requirements may have an impact on the cost of the Zeolite Encapsulation Facility.

No attempt has been made to assess the relative cost of licensing of the encapsulation facilities. The consequences of a postulated accident at the site boundary, and the resulting requirements which would be imposed are unknown at this time. The Zeolite Encapsulation Facility, however, would seem to require a higher risk due to the impact of nuclear safety requirements on the ultimate cost of the facility.

# SECTION 7

# LIFE CYCLE COSTING ANALYSIS

## 7.1 BASIS AND APPROACH

The Ion Implantation/Sputtering Facility and the Zeolite Encapsulation Facility were evaluated and compared on a life cycle cost basis, following the procedures of the "Life-Cycle Cost Manual for the Federal Energy Management Program," NBS Handbook 135, ("hereinafter referred to as the "Handbook"). In following the Handbook procedures, the total present value of the facility is determined, using a 7 percent per year discount rate for annual costs. For this analysis, a useful life of 30 years with no remaining salvage value was used.

The following cost categories were included in the analysis:

1) Initial Capital Investment

2) Annual Energy Cost

3) Annual Recurring (non-fuel) Costs

   a) Operating Manpower Cost

   b) Operating Materials Cost

4) Annual Non-Recurring Costs

   a) Replacement/Maintenance Materials Cost

   b) Insurance Cost

### 7.1.1 INITIAL CAPITAL INVESTMENT

In accordance with the Handbook, all initial capital investment is assumed to take place at the start of the base year, which is the year in which the analysis takes place. Furthermore, in determining the present value of the initial capital investment, the estimated actual investment is reduced by 10 percent. Therefore, the initial capital investment is 90 percent of the estimated Total Job Cost for the facilities, as shown in Appendix E.

### 7.1.2 ANNUAL ENERGY COST

The initial annual cost for energy is determined by the product of the estimated annual energy consumption, and the current regional energy cost. Table C-2 of the Handbook gives $0.037/KW-hr. as the current energy cost for the region of Oak Ridge, Tennessee (Region 4). The Handbook estimates the inflation of energy relative to other costs, and computes the present value for each annual expenditure using a 7 percent per year discount rate. The sum of present values of annual energy expenditures is the adjusted Uniform Present Worth Factor (UPW*). The Handbook, however, uses a maximum life of 25 years. Following the procedures of the Handbook for 30 years, the UPW*, adjusted for increases in energy costs, is estimated to be 13.48. The present value of the annual energy cost for the life of the facility is then the initial annual cost multiplied by the UPW*. The total life cycle energy cost is shown in Table 7-1.

### 7.1.3 ANNUAL RECURRING COSTS

The present value of annual recurring (non-fuel) costs is determined by multiplying the annual cost in current dollars by the unadjusted UPW. The UPW for a plant life of 30 years, using a 7 percent per year discount rate, is calculated to be 12.41.

#### 7.1.3.1 Operating Manpower Cost

The determination of life cycle costs for operating manpower is shown in Table 7-2. Operating manpower was estimated in terms of manhours per operating year. The current manpower cost is based on an assumed current rate of $25/manhour.

#### 7.1.3.2 Operating Materials Cost

The determination of life cycle costs for operating materials is shown in Table 7-3. Attachment 7A provides the details used in determining the current annual cost for operating materials.

### 7.1.4 ANNUAL NON-RECURRING COSTS

Annual non-recurring costs are those costs which vary year-to-year. The present value of a given expenditure during a given year is the expenditure in current dollars, multiplied by the Single Payment Present Worth Factor (SPW). The SPW for each year can be calculated using a 7 percent discount rate. The life cycle cost is then the sum of the present values of the annual expenditures.

#### 7.1.4.1 Replacement/Maintenance Materials Costs

The annual cost for replacement/maintenance materials was estimated as a varying percentage of the initial direct equipment costs. The determination of life cycle costs for replacement/maintenance materials is shown in Table 7-4.

#### 7.1.4.2 Insurance Costs

The annual cost for replacement insurance of the facility was estimated at 0.3 percent of the replacement value. Replacement value was determined based on the estimated Total Job Cost, shown in Appendix E, and using sum-of-the-years depreciation for the life of the facility. Insurance costs for liability and damage to the external environment, if any, are assumed to be the same for each facility, and are not included in this analysis. The determination of life cycle costs for replacement insurance is shown in Table 7-5.

### 7.1.5 SALVAGE

The Handbook calls for subtracting the present worth of the salvage value of the facility to determine the total life cycle cost. For this analysis, the salvage value is zero.

## 7.2 ION IMPLANTATION/SPUTTERING

Life cycle costs for the Ion Implantation/Sputtering Facility are summarized in Table 7-6. The total present value of all included life cycle costs is $26,430,684.

## 7.3 ZEOLITE ENCAPSULATION

Life cycle costs for the Zeolite Encapsulation Facility are summarized in Table 7-7. The total present value of all included life cycle costs is $21,900,883.

## 7.4 CONCLUSIONS

On a 30 year basis, the total life cycle cost for the Zeolite Encapsulation Facility is $4,529,801 less than for the Ion Implantation/Sputtering Facility, or a total savings of 16.5%. Additional investment for initial capital and replacement/maintenance materials (items 1 and 5 in Tables 7-6 and 7-7) is $4,785 for the Zeolite Encapsulation Facility. Life cycle savings for energy and all other operating and maintenance costs (items 2, 3, 4, and 6 in Tables 7-6 and 7-7) is $4,525,016. The life cycle savings-to-investment ratio is 946 in favor of Zeolite Encapsulation over Ion Implantation/Sputtering.

TABLE 7-1

LIFE CYCLE ENERGY COSTS

| | Ion Implantation/Sputtering | Zeolite Encapsulation |
|---|---|---|
| Estimated Demand Power Load, KVA | 539 | 258 |
| Load Factor | 85% | 85% |
| Hours/Year | 7,200 | 7,200 |
| Energy Consumption, KW-Hr./Yr. | 3,880,800 | 1,857,600 |
| Current (1981) Energy Cost, $/KW-hr | 0.037 | 0.037 |
| Current (1981) Annual Energy Cost | $ 143,590 | $ 68,731 |
| Adjusted UPW* | 13.48 | 13.48 |
| Total Present Value of Life Cycle Energy Costs | $1,935,588 | $ 926,494 |

TABLE 7-2

LIFE CYCLE OPERATING MANPOWER COSTS

| | Ion Implantation/Sputtering | Zeolite Encapsulation |
|---|---|---|
| **Personnel/Basis** | | |
| Operators<br>2 x 8 hr/day x 300 days/yr x 3 shifts | 14,400 MH | 14,400 MH |
| Supervisor<br>1 x 8 hr/day x 300 days/yr. | 2,400 MH | 2,400 MH |
| Welding & Inspection<br>1.5 hr./weld | 460 MH | 900 MH |
| Janitorial<br>2.5 hr./day x 360 | 900 MH | 900 MH |
| Maintenance | | |
| Scheduled<br>2 x 8 x 60 | 960 MH | 960 MH |
| Unscheduled<br>0.2 x 8 x 300 | 480 MH | 480 MH |
| HP/Fire/Hygiene<br>0.75 x 8 x 300 | 1,800 MH | 1,800 MH |
| Total Operating Manpower | 21,400 MH/Yr. | 21,840 MH/Yr. |
| Current (1981) Annual Manpower Cost ($25/MH) | $535,000 | $546,000 |
| UPW | 12.41 | 12.41 |
| Total Present Value of Life Cycle Manpower Costs | $6,639,350 | $6,775,860 |

TABLE 7-3

LIFE CYCLE OPERATING MATERIALS COSTS

| | Ion Implantation/Sputtering | Zeolite Encapsulation |
|---|---|---|
| Current (1981) Annual Costs of operating Materials | | |
| Substrate/Containers | $ 585,000 | $ 301,700 |
| Helium | 9,800 | 7,200 |
| Welding Supplies | 1,500 | 1,000 |
| Decon Chemicals | 5,000 | 5,000 |
| Other | 15,000 | 15,000 |
| Total Current (1981) Annual Cost of Operating Materials | $ 616,300 | $ 329,900 |
| UPW | 12.41 | 12.41 |
| Total Present Value of Life Cycle Operating Materials Costs | $7,648,283 | $4,094,059 |

TABLE 7-4

LIFE CYCLE REPLACEMENT/MAINTENANCE MATERIALS COST

| Yr. | % of Initial Direct Equip. | Estimated Annual Costs (1981) | | SPW | Present Value of Annual Costs | |
|---|---|---|---|---|---|---|
| | | Ion Implant./ Sputtering | Zeolite Encapsulation | | Ion Implant./ Sputtering | Zeolite Encapsulation |
| 1 | 2 | $ 29,600 | $ 37,900 | 0.93 | $27,528 | $35,247 |
| 2 | 2 | 29,600 | 37,900 | 0.87 | 25,752 | 32,973 |
| 3 | 2 | 29,600 | 37,900 | 0.82 | 24,272 | 31,078 |
| 4 | 2 | 29,600 | 37,900 | 0.76 | 22,496 | 28,804 |
| 5 | 2 | 29,600 | 37,900 | 0.71 | 21,016 | 26,909 |
| 6 | 3 | 44,400 | 56,900 | 0.67 | 29,748 | 38,123 |
| 7 | 3 | 44,400 | 56,900 | 0.62 | 27,528 | 35,278 |
| 8 | 3 | 44,400 | 56,900 | 0.58 | 25,752 | 33,002 |
| 9 | 3 | 44,400 | 56,900 | 0.54 | 23,976 | 30,726 |
| 10 | 3 | 44,400 | 56,900 | 0.51 | 22,644 | 29,019 |
| 11 | 4 | 59,200 | 75,800 | 0.48 | 28,416 | 36,384 |
| 12 | 4 | 59,200 | 75,800 | 0.44 | 26,048 | 33,352 |
| 13 | 4 | 59,200 | 75,800 | 0.42 | 24,864 | 31,836 |
| 14 | 4 | 59,200 | 75,800 | 0.39 | 23,088 | 29,562 |
| 15 | 4 | 59,200 | 75,800 | 0.36 | 21,312 | 27,288 |
| 16 | 6 | 88,800 | 113,700 | 0.34 | 30,192 | 38,658 |
| 17 | 6 | 88,800 | 113,700 | 0.32 | 28,416 | 36,384 |
| 18 | 6 | 88,800 | 113,700 | 0.30 | 26,640 | 34,110 |
| 19 | 6 | 88,800 | 113,700 | 0.28 | 24,864 | 31,836 |
| 20 | 6 | 88,800 | 113,700 | 0.26 | 23,088 | 29,562 |
| 21 | 6 | 88,800 | 113,700 | 0.24 | 21,312 | 27,288 |
| 22 | 6 | 88,800 | 113,700 | 0.23 | 20,424 | 26,151 |
| 23 | 6 | 88,800 | 113,700 | 0.21 | 18,648 | 23,877 |
| 24 | 6 | 88,800 | 113,700 | 0.20 | 17,760 | 22,740 |
| 25 | 6 | 88,800 | 113,700 | 0.18 | 15,984 | 20,466 |
| 26 | 8 | 118,400 | 151,600 | 0.17 | 20,128 | 25,772 |
| 27 | 8 | 118,400 | 151,600 | 0.16 | 18,944 | 24,256 |
| 28 | 8 | 118,400 | 151,600 | 0.15 | 17,760 | 22,740 |
| 29 | 8 | 118,400 | 151,600 | 0.14 | 16,576 | 21,224 |
| 30 | 8 | 118,400 | 151,600 | 0.13 | 15,392 | 19,708 |
| Total Present Value of Life Cycle Replacement/ Maintenance Costs | | | | | $690,568 | $884,353 |

TABLE 7-5

LIFE CYCLE REPLACEMENT INSURANCE COSTS

| Yr. | % of Initial Value Remaining (sum of years depreciation) | Estimated Annual Costs (1981) ($0.003/$) Ion Implant./ Sputtering | Estimated Annual Costs (1981) ($0.003/$) Zeolite Encapsulation | SPW | Present Value of Annual Costs Ion Implant./ Sputtering | Present Value of Annual Costs Zeolite Encapsulation |
|---|---|---|---|---|---|---|
| 1 | 100.0 | $16,060 | $15,720 | 0.93 | $14,936 | $14,620 |
| 2 | 93.5 | 15,010 | 14,700 | 0.87 | 13,059 | 12,789 |
| 3 | 87.3 | 14,020 | 13,720 | 0.82 | 11,496 | 11,250 |
| 4 | 81.3 | 13,050 | 12,780 | 0.76 | 9,918 | 9,713 |
| 5 | 75.5 | 12,120 | 11,870 | 0.71 | 8,605 | 8,428 |
| 6 | 69.9 | 11,220 | 10,990 | 0.67 | 7,517 | 7,363 |
| 7 | 64.5 | 10,360 | 10,140 | 0.62 | 6,423 | 6,287 |
| 8 | 59.4 | 9,540 | 9,340 | 0.58 | 5,533 | 5,417 |
| 9 | 54.4 | 8,730 | 8,550 | 0.54 | 4,714 | 4,617 |
| 10 | 49.7 | 7,980 | 7,810 | 0.51 | 4,070 | 3,983 |
| 11 | 45.2 | 7,260 | 7,110 | 0.48 | 3,485 | 3,413 |
| 12 | 40.9 | 6,570 | 6,430 | 0.44 | 2,891 | 2,829 |
| 13 | 36.8 | 5,910 | 5,780 | 0.42 | 2,482 | 2,428 |
| 14 | 32.9 | 5,280 | 5,170 | 0.39 | 2,059 | 2,016 |
| 15 | 29.2 | 4,690 | 4,590 | 0.36 | 1,688 | 1,652 |
| 16 | 25.8 | 4,140 | 4,060 | 0.34 | 1,408 | 1,380 |
| 17 | 22.6 | 3,630 | 3,550 | 0.32 | 1,162 | 1,136 |
| 18 | 19.6 | 3,150 | 3,080 | 0.30 | 945 | 924 |
| 19 | 16.8 | 2,700 | 2,640 | 0.28 | 756 | 739 |
| 20 | 14.2 | 2,280 | 2,230 | 0.26 | 593 | 580 |
| 21 | 11.8 | 1,890 | 1,850 | 0.24 | 454 | 444 |
| 22 | 9.7 | 1,556 | 1,520 | 0.23 | 358 | 350 |
| 23 | 7.7 | 1,240 | 1,210 | 0.21 | 260 | 254 |
| 24 | 6.0 | 960 | 940 | 0.20 | 192 | 188 |
| 25 | 4.5 | 720 | 710 | 0.18 | 130 | 128 |
| 26 | 3.2 | 510 | 500 | 0.17 | 87 | 85 |
| 27 | 2.2 | 350 | 350 | 0.16 | 56 | 56 |
| 28 | 1.3 | 210 | 200 | 0.15 | 32 | 30 |
| 29 | 0.6 | 100 | 100 | 0.14 | 14 | 14 |
| 30 | 0.2 | 30 | 30 | 0.13 | 4 | 4 |
| | | | | | $105,327 | $103,117 |

TABLE 7-6

ION IMPLANTATION/SPUTTERING LIFE CYCLE COSTS

| | | |
|---|---|---|
| 1. | Present Value of Initial Capital Investment (90% of Total Estimated Job Cost) | $ 9,306,000 |
| 2. | Present Value of Life Cycle Energy Costs (Table 7-1) | 1,935,588 |
| 3. | Present Value of Life Cycle Operating Manpower Costs (Table 7-2) | 6,639,350 |
| 4. | Present Value of Life Cycle Operating Materials Costs (Table 7-3) | 7,648,283 |
| 5. | Present Value of Life Cycle Replacement/Maintenance Materials Costs (Table 7-4) | 690,568 |
| 6. | Present Value of Life Cycle Replacement Insurance Costs (Table 7-5) | 105,327 |
| | Total Present Value of All Included Life Cycle Costs | $26,430,684 |

TABLE 7-7

ZEOLITE ENCAPSULATION LIFE CYCLE COSTS

| | | |
|---|---|---|
| 1. | Present Value of Initial Capital Investment (90% of Total Estimated Job Cost) | $ 9,117,000 |
| 2. | Present Value of Life Cycle Energy Costs (Table 7-1) | 926,494 |
| 3. | Present Value of Life Cycle Operating Manpower Costs (Table 7-2) | 6,775,860 |
| 4. | Present Value of Life Cycle Operating Materials Costs (Table 7-3) | 4,094,059 |
| 5. | Present Value of Life Cycle Replacement/Maintenance Materials Costs (Table 7-4) | 884,353 |
| 6. | Present Value of Life Cycle Replacement Insurance Costs (Table 7-5) | 103,117 |
| | Total Present Value of All Included Life Cycle Costs | $21,900,883 |

# ATTACHMENT 7A

## ANNUAL COST OF OPERATING MATERIALS

TITLE KRYPTON ENCAPSULATION SHEET NO. 1 OF 4
JOB NO. 6154-3 DEPARTMENT AUTHOR R. WILKINSON DATE 6/13/81

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

OPERATING MATERIALS (1981 $/YEAR)

SUMMARY

| | ZEOLITE ENCAP. | ION IMPL./SPUT. |
|---|---|---|
| SUBSTRATE/CONTAINERS | $ 301,700 | $ 585,000 |
| HELIUM | 7,200 | 9,800 |
| WELDING SUPPLIES | 1,000 | 1,500 |
| DECON CHEMICALS | 5,000 | 5,000 |
| OTHER | 15,000 | 15,000 |
| TOTAL | $ 329,900 | $ 616,300 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TITLE | KRYPTON ENCAPSULATION | | | | | SHEET NO. | 2 OF 4 | |
| JOB NO. | 6154-3 | DEPARTMENT | | AUTHOR | R. WILKINSON | | DATE | 6/13/81 |
| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
| | | | | | | | | |

OPERATING MATERIALS

1. ZEOLITE ENCAPSULATION

a. SUBSTRATE & CONTAINERS (600/YR.)

1). ZEOLITE ($ 3.35/LB)

600 × 7750 g/BATCH $\left(\frac{1}{454}\right)$ = 10,240 LB/YR.

= $ 34,300

2). CONTAINER, 7 IN. φ × 14 IN., T-316L S.S. × $\frac{3}{16}$" WALL

EST. $ 135/EA. × 600 = $ 81,000

3). ENDCAPS 2 @ 7 IN. O.D. × $\frac{1}{4}$"

EST $ 40/EA × 2 × 600 = $ 48,000

4). OVERPACK 8" C.S. PIPE × 16" LONG W/ PIPE CAPS

EST $ 45/EA × 600 = $ 27,000

5). ASSEMBLY, 4 MH. × $30/MH. × 600 = $ 72,000

6). QA, QC, SHIPPING, ETC. @ 15% $ 39,400

TOTAL $ 301,700

(~ $ 500 EA.)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TITLE | KRYPTON ENCAPSULATION | | | | | SHEET NO. 3 OF 4 | | |
| JOB NO. | 6154-3 | DEPARTMENT | | | AUTHOR | R. WILKINSON | DATE | 6/13/81 |
| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
| | | | | | | | | |

b. HELIUM (PURGE & TEST) EST. 3 CF/UNIT
EST. #4 /CF × 600 × 3 — $ 7,200

c. WELDING SUPPLIES (EST.) — $ 1,000

d. DECON CHEMICALS (EST.) — $ 5,000

e. OTHER (EST.) — $ 15,000

2. ION IMPLANTATION / SPUTTERING

a) SUBSTRATE & CONTAINERS (305/YR.)

1). NICKEL (15509 g/EA @ $3.25/LB)

$\frac{15509}{454} \times 3.25 \times 305$ = $ 33,860

2). LANTHANUM (4123 g/EA @ $27.30/LB)

$\frac{4123}{454} \times 27.30 \times 305$ = $ 75,620

3). TARGET (6" STD. WT. C.S. PIPE × 12" LONG W/ CAP)

305 (8.75 + 24.20) = $ 10,050

4). SUBSTRATE (10" SCH. 40S, T-316L SS × 12" LONG W/ CAPS

305 (110 + 280) = $ 118,950

5). FILAMENT & ANODES (EST) — $ 9,150

6). INSULATORS (EST) — $ 12,200

7). TUBING & CONNECTORS (EST) — $ 18,300

8). FABRICATION & ASSEMBLY (EST)
25.2 MH. × $30/MH. × 305 — $ 230,580

9). QA, QC, SHIPPING, ETC @ 15% — $ 76,290

TOTAL $ 585,000
($1920 EA)

**RMP** THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON ENCAPSULATION SHEET NO. 4 OF 4

JOB NO. 6154-3 DEPARTMENT AUTHOR R. WILKINSON DATE 6/13/81

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

| | |
|---|---|
| b. HELIUM (PURGE & TEST) EST 8CF / UNIT = 2440 @ $4/CF | $ 9,800/YR |
| c. WELDING SUPPLIES (EST) | 1,500/YR |
| d. DECON CHEMICALS (EST) | 5,000/YR |
| e. OTHER (EST) | 15,000/YR |

RMP-307 (2/78)

PAGE NUMBER

# APPENDICES

A. Drawing List and Drawings

B. Major Equipment List

C. Outline Specifications

D. Calculations

E. Cost Estimates

# APPENDIX A

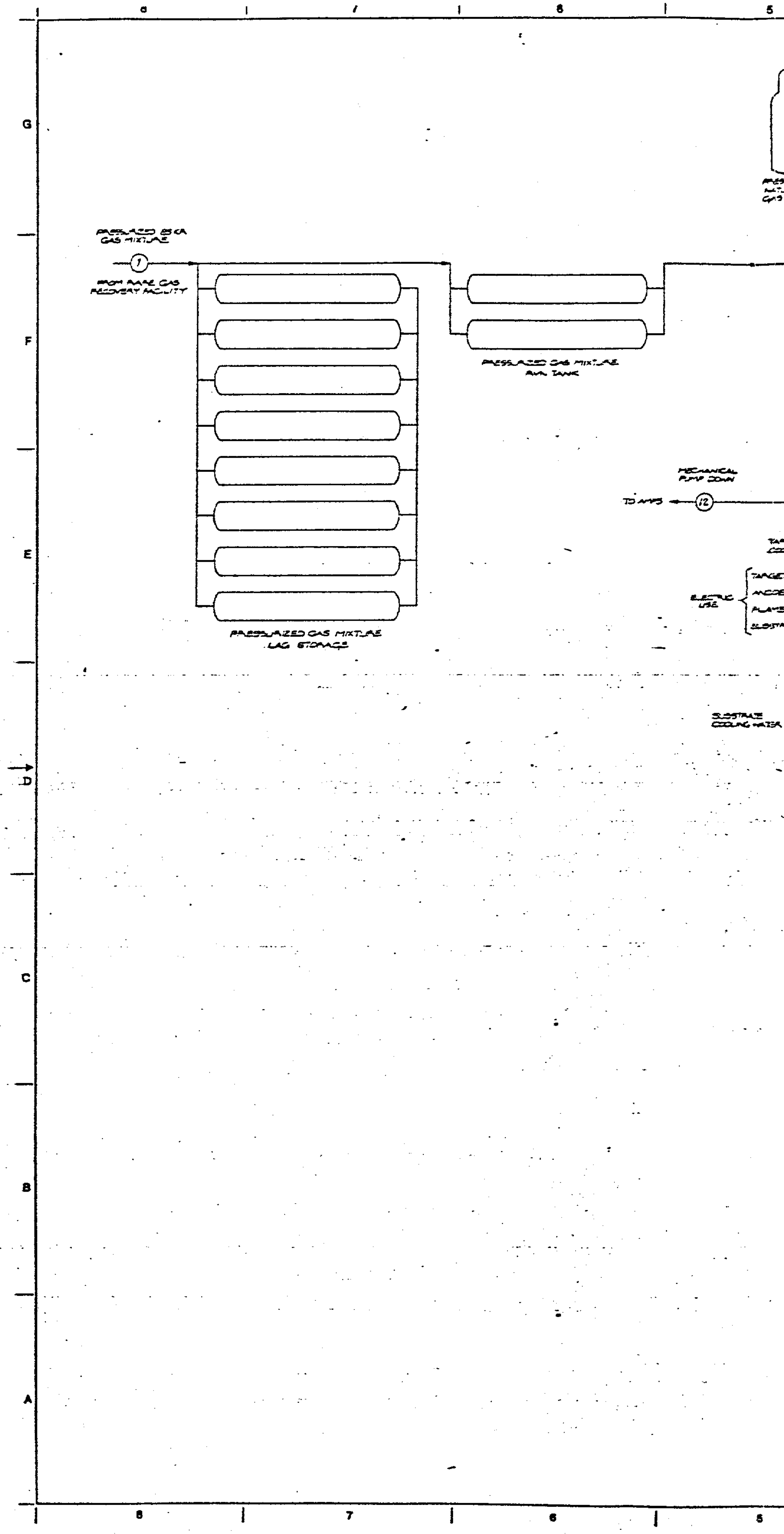
## DRAWING LIST AND DRAWINGS

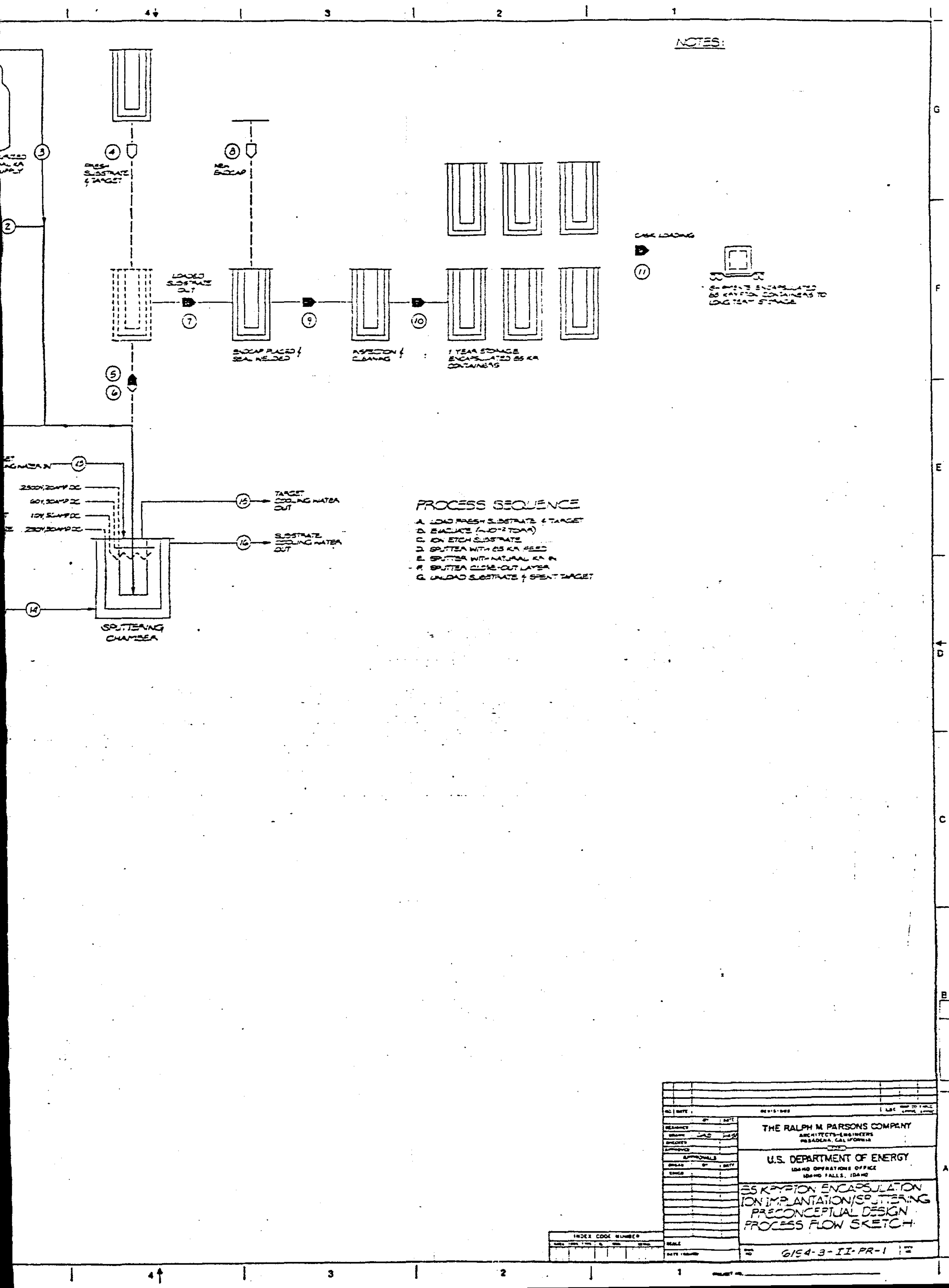
Ion Implantation/Sputtering Facility

| | |
|---|---|
| Dwg. No. 6154-3-II-PR-1 | Process Flow Diagram |
| M-1 | Piping and Instrumentation Diagram |
| A-1 | Ground Floor Plan |
| A-2 | Second Floor Plan |
| A-3 | Building Sections |
| V-1 | HVAC Flow Diagram |
| E-1 | Electrical Single Line Diagram |
| P-1 | Piping Plan |
| P-2 | Piping Isometric |
| P-3 | Drainage Plan |

Zeolite Encapsulation Facility

| | |
|---|---|
| Dwg. No. 6154-3-HP-PR-2 | Process Flow Diagram |
| M-2 | Piping and Instrumentation Diagram |
| A-4 | Ground Floor Plan |
| A-5 | Building Sections |
| V-2 | HVAC Flow Diagram |
| E-2 | Electrical Single Line Diagram |
| P-4 | Piping Plan |
| P-5 | Piping Isometric |
| P-6 | Drainage Plan |
| P-7 | Lag Storage Tanks |


PRESSURIZED GAS MIXTURE
AUX TANK
PRESSURIZED GAS MIXTURE
LAG STORAGE
MECHANICAL
PUMP DOWN
TO AMPS
12
1
SUBSTRATE
COOLING WATER


NOTES:
FRESH SUBSTRATE & TARGET
NEW ENDCAP
LOADED SUBSTRATE OUT
ENDCAP PLACED & SEAL WELDED
INSPECTION & CLEANING
1 YEAR STORAGE ENCAPSULATED 85 KR CONTAINERS
CASK LOADING
SHIPMENT ENCAPSULATED 85 KRYPTON CONTAINERS TO LONG TERM STORAGE
TARGET COOLING WATER OUT
SUBSTRATE COOLING WATER OUT
SPUTTERING CHAMBER
PROCESS SEQUENCE
A. LOAD FRESH SUBSTRATE & TARGET
B. EVACUATE
C. ION ETCH SUBSTRATE
D. SPUTTER WITH 85 KR FEED
E. SPUTTER WITH NATURAL KR IN
F. SPUTTER CLOSE-OUT LAYER
G. UNLOAD SUBSTRATE & SPENT TARGET
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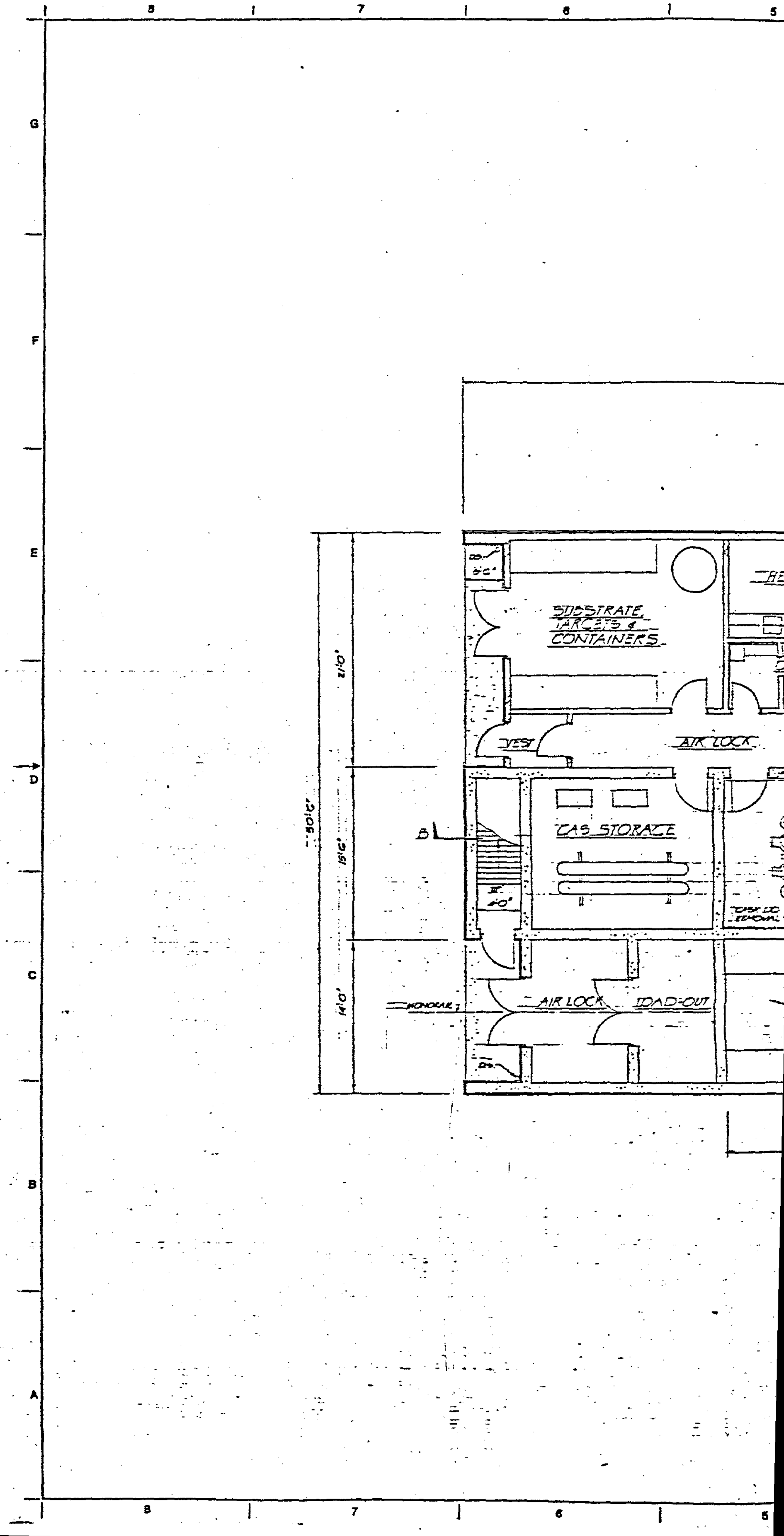
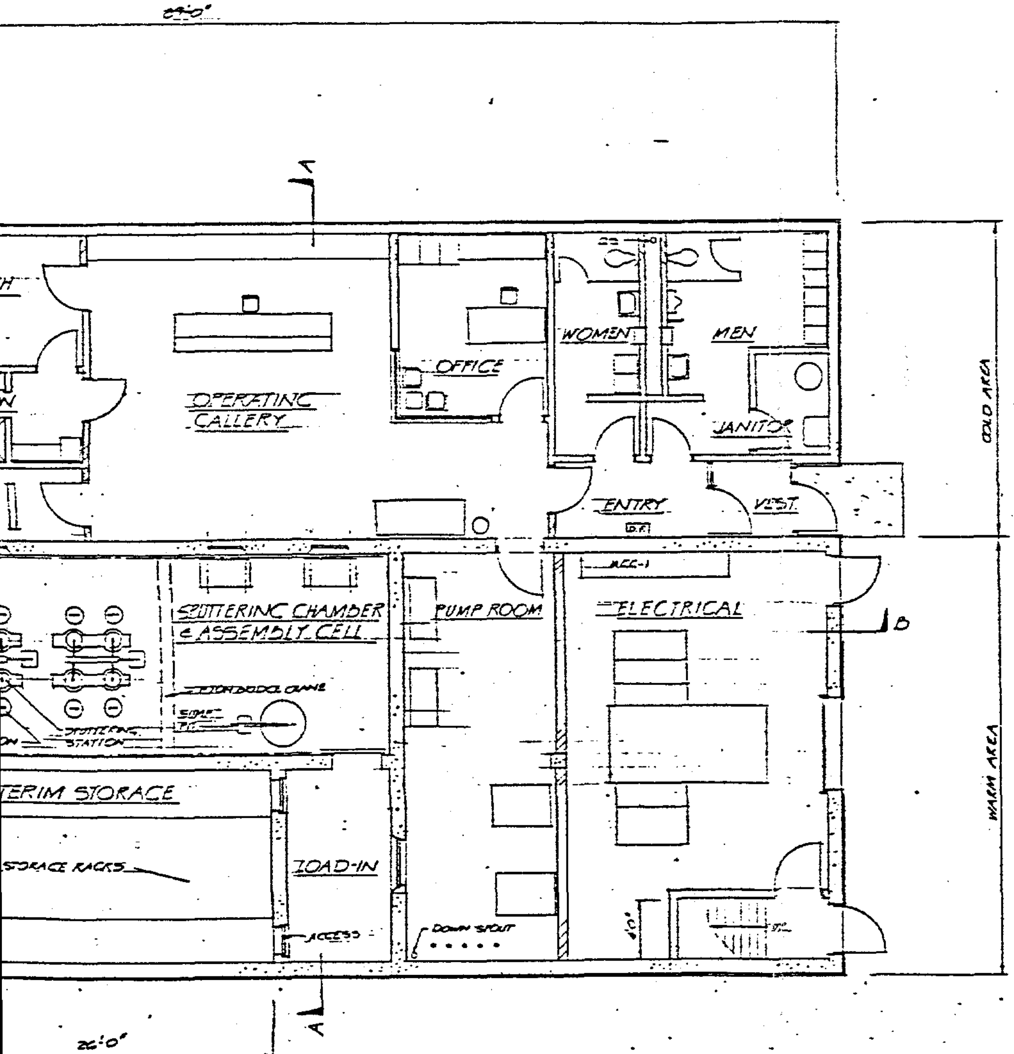
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO
85 KRYPTON ENCAPSULATION
ION IMPLANTATION/SPUTTERING
PRECONCEPTUAL DESIGN
PROCESS FLOW SKETCH
6154-3-II-PR-1


SUBSTRATE, TARGETS & CONTAINERS
VEST
AIR LOCK
GAS STORAGE
AIR LOCK
LOAD-OUT
21'0"
15'0"
14'0"
50'0"
B
G
F
E
D
C
B
A
8
7
6
5

47




WALL LEGEND

- REINFORCED CONCRETE
- CONCRETE BLOCK
- METAL STUDS WITH GYPSUM BOARD

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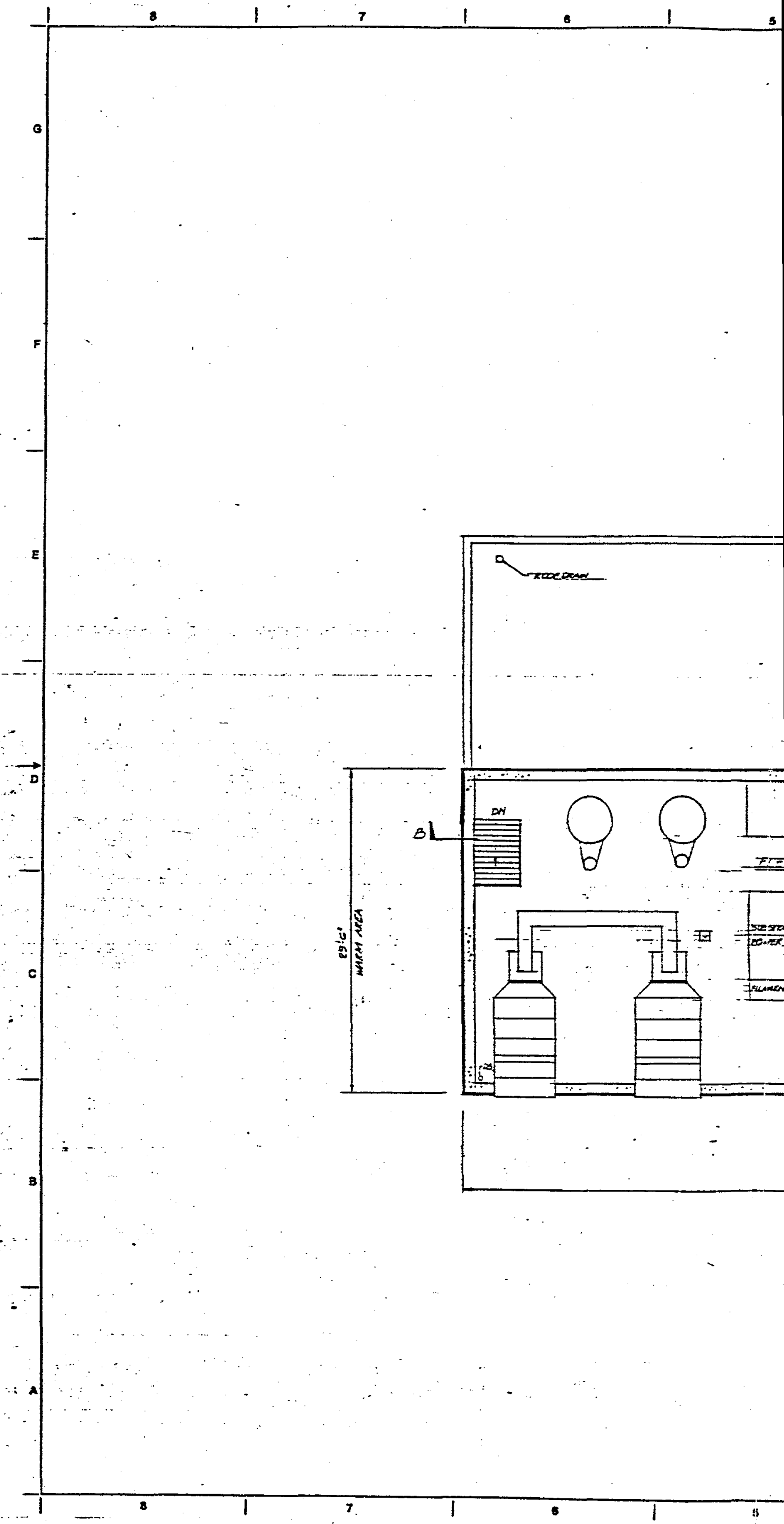
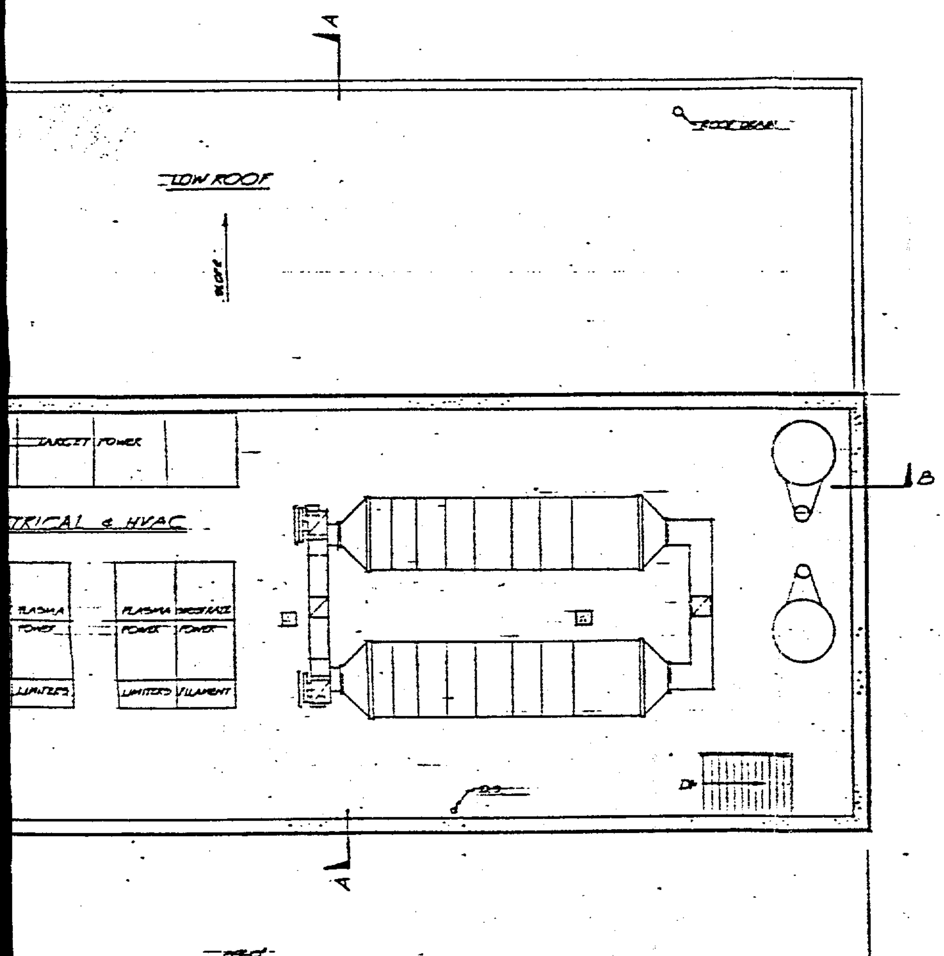
KRYPTON ENCAPSULATION
PRECONCEPTUAL DESIGN
ION IMPLANTATION/SPUTTERING

GROUND FLOOR PLAN

G-54-3-11-A-1




48

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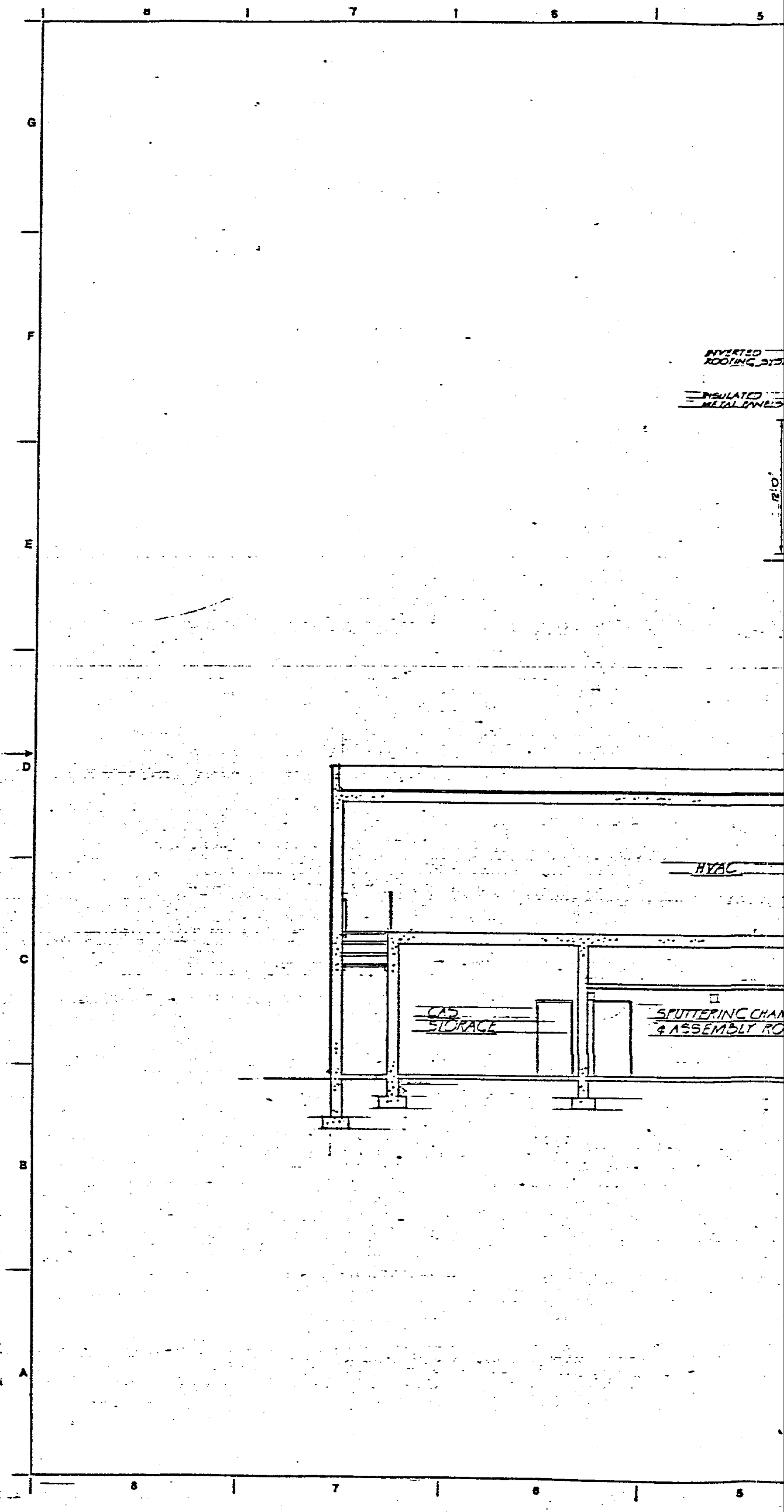
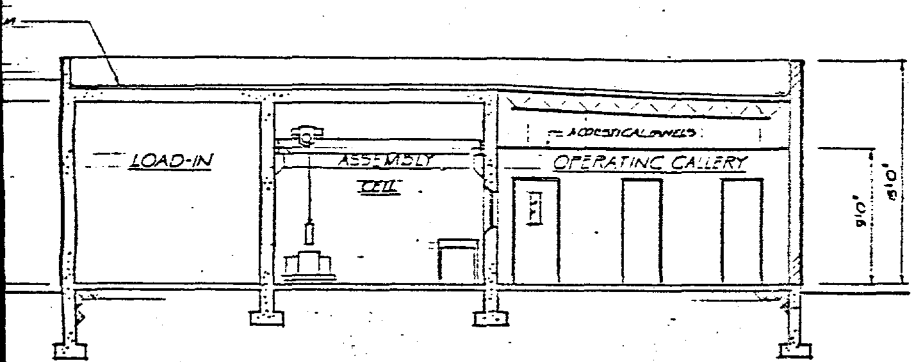
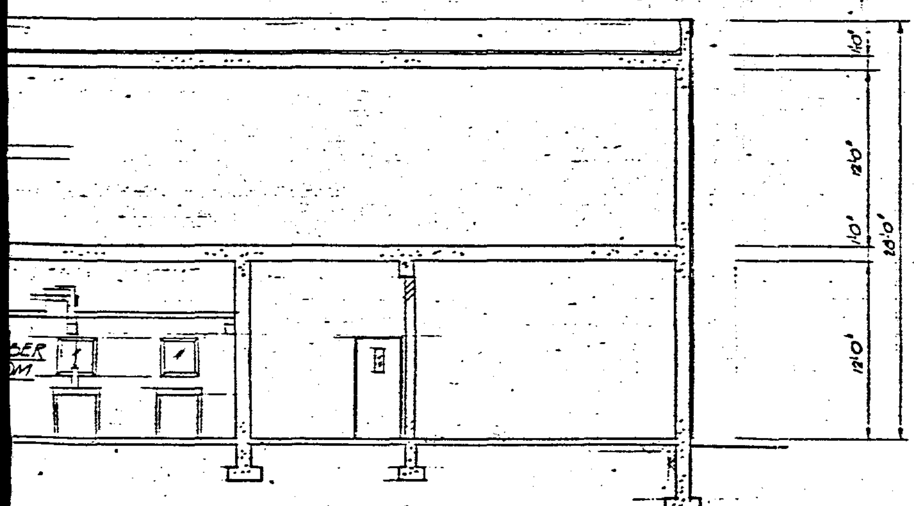
KRYPTON ENCAPSULATION
PRECONCEPTUAL DESIGN
ION IMPLANTATION/SPUTTERING
SECOND FLOOR PLAN

G154-3-11-A-2


HVAC
GAS STORAGE




SECTION A-A




SECTION B-B

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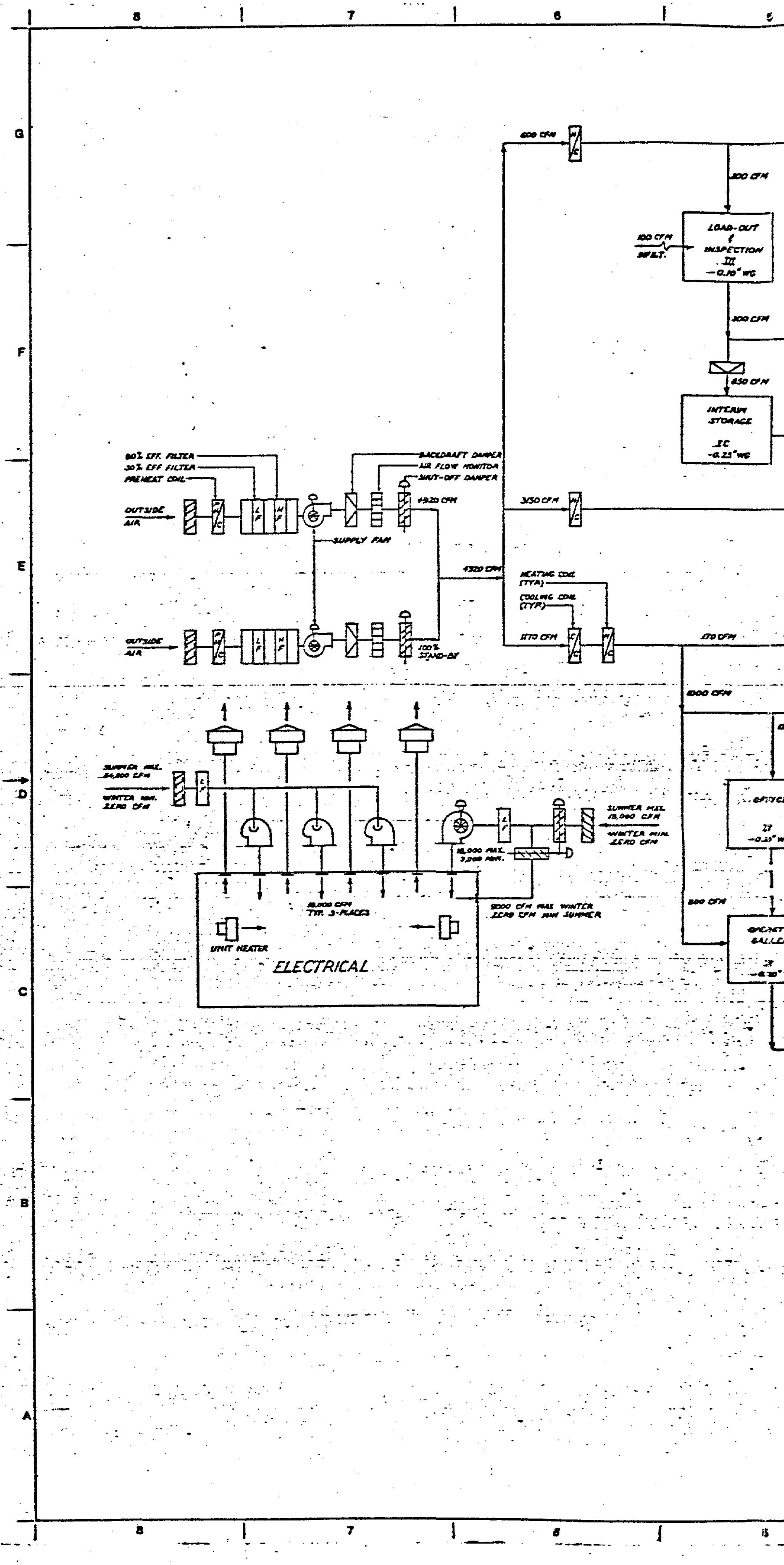
KRYPTON ENCAPSULATION
PRECONCEPTUAL DESIGN

ION IMPLANTATION / SPUTTERING

BUILDING SECTIONS

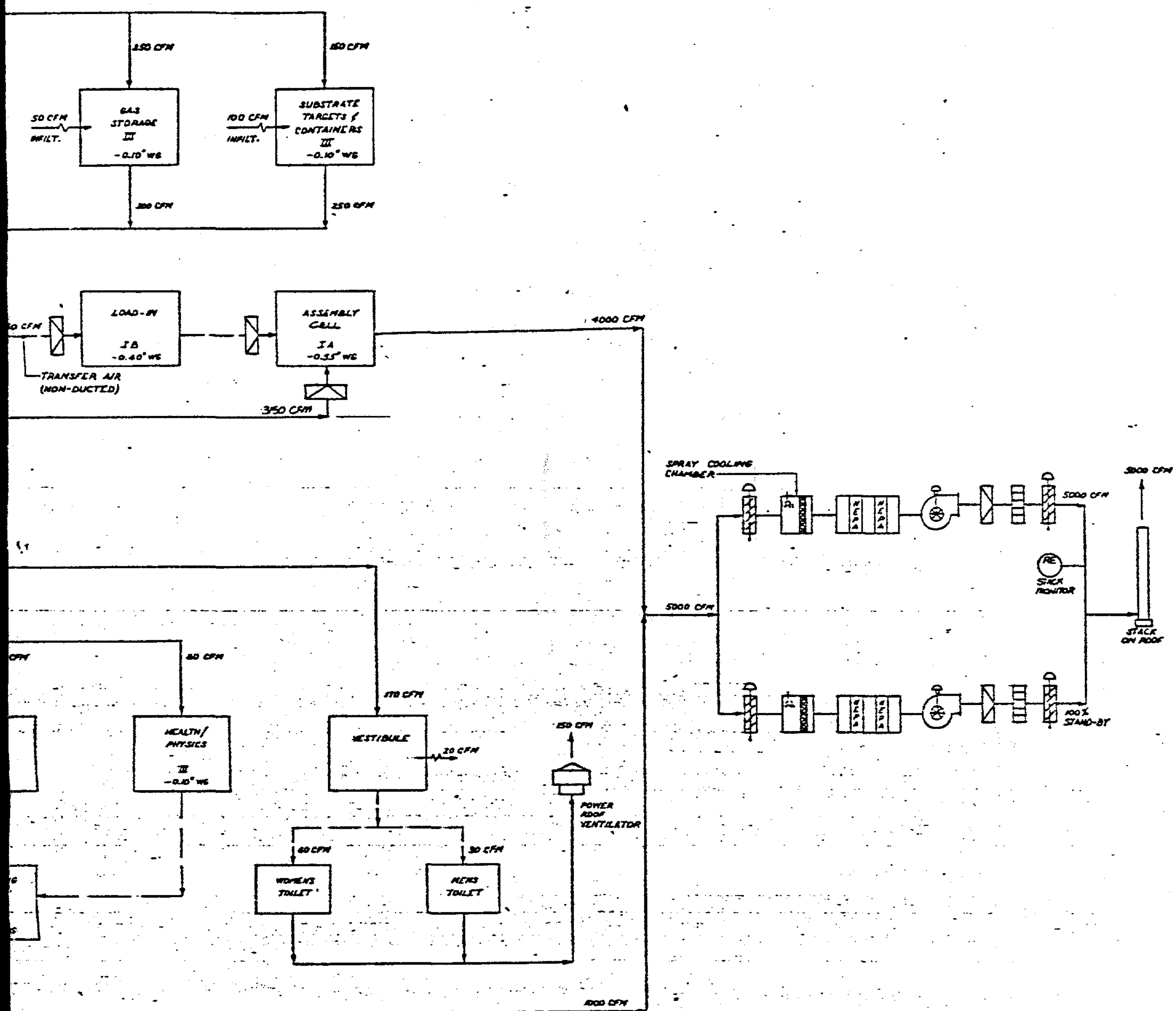
C154-3-11-A-3

9



LOAD-OUT & INSPECTION
INTERIM STORAGE
80% EFF. FILTER
30% EFF FILTER
PREHEAT COIL
BACKDRAFT DAMPER
AIR FLOW MONITOR
SHUT-OFF DAMPER
OUTSIDE AIR
SUPPLY FAN
HEATING COIL (TYP.)
COOLING COIL (TYP.)
OUTSIDE AIR
100% STAND-BY
WINTER MIN. ZERO CFM
WINTER MIN. ZERO CFM
TYP. 3-PLACES
UNIT HEATER
ELECTRICAL


50




AIR FLOW DIAGRAM

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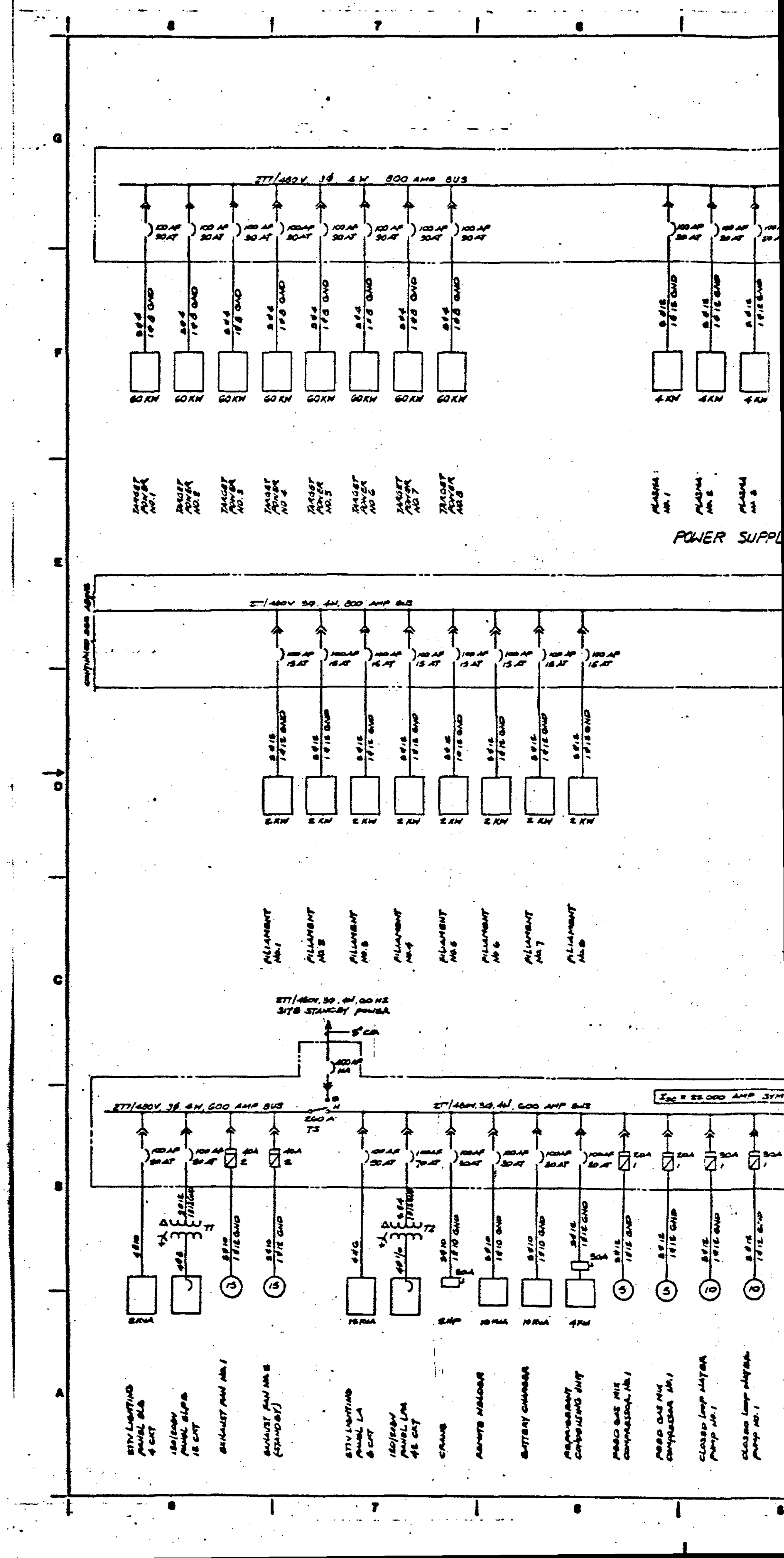
KRYPTON ENCAPSULATION
PRECONCEPTUAL DESIGN

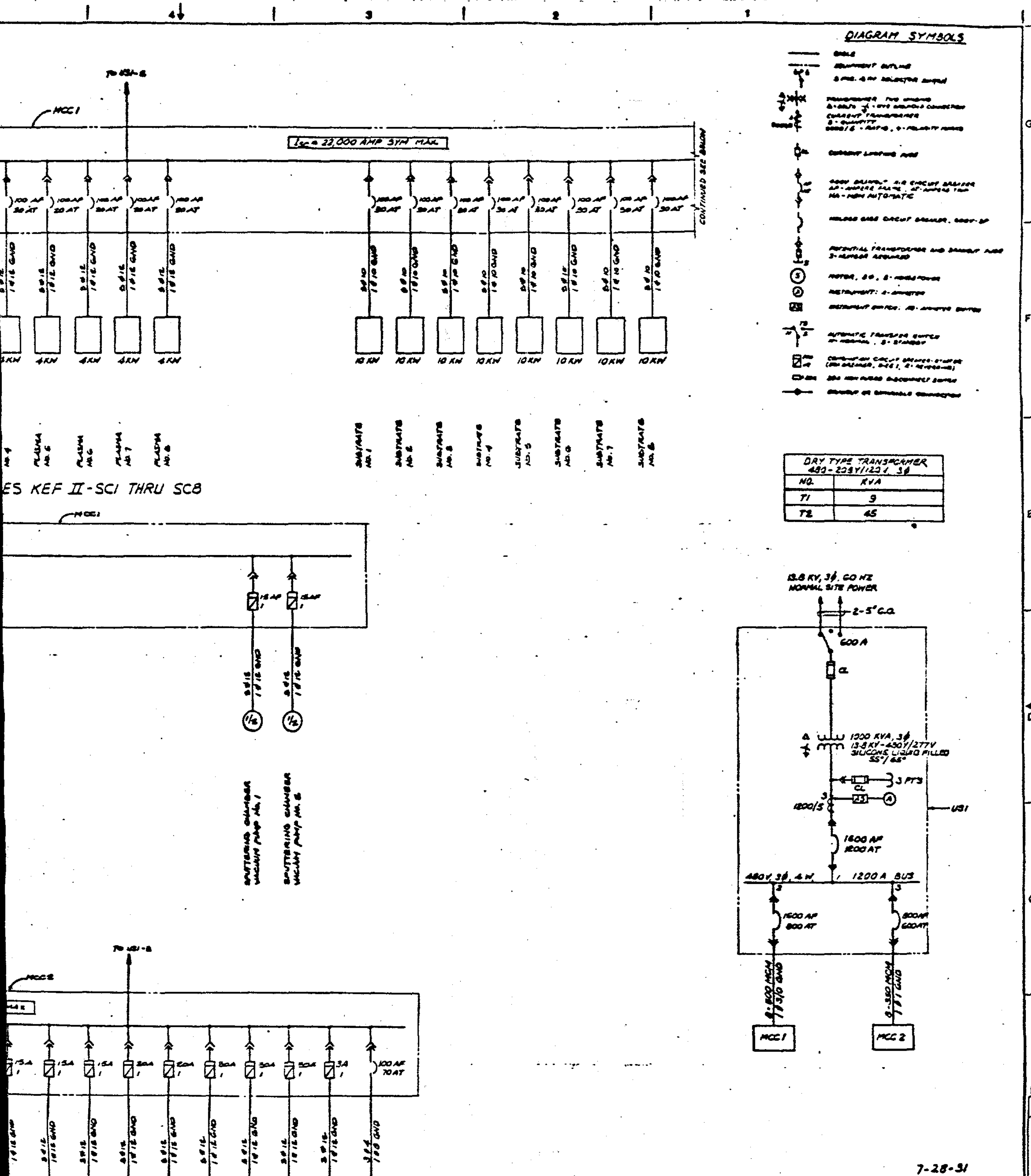
ION IMPLANTATION / SPUTTERING
HVAC FLOW DIAGRAM

SCALE NONE

G154-3-II-V-1



277/480V 3Ø 4W 800 AMP BUS
60 KW
TARGET POWER NO.1
TARGET POWER NO.2
TARGET POWER NO.3
TARGET POWER NO.4
TARGET POWER NO.5
TARGET POWER NO.6
TARGET POWER NO.7
TARGET POWER NO.8
4 KW
PLASMA NO.1
PLASMA NO.2
PLASMA NO.3
POWER SUPPL
2 KW
FILAMENT NO.1
FILAMENT NO.2
FILAMENT NO.3
FILAMENT NO.4
FILAMENT NO.5
FILAMENT NO.6
FILAMENT NO.7
FILAMENT NO.8
SITE STANDBY POWER
277/480V 3Ø 4W 600 AMP BUS
CRANE
BATTERY CHARGER




7-28-81

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KRYPTON ENCAPSULATION PRECONCEPTUAL DESIGN

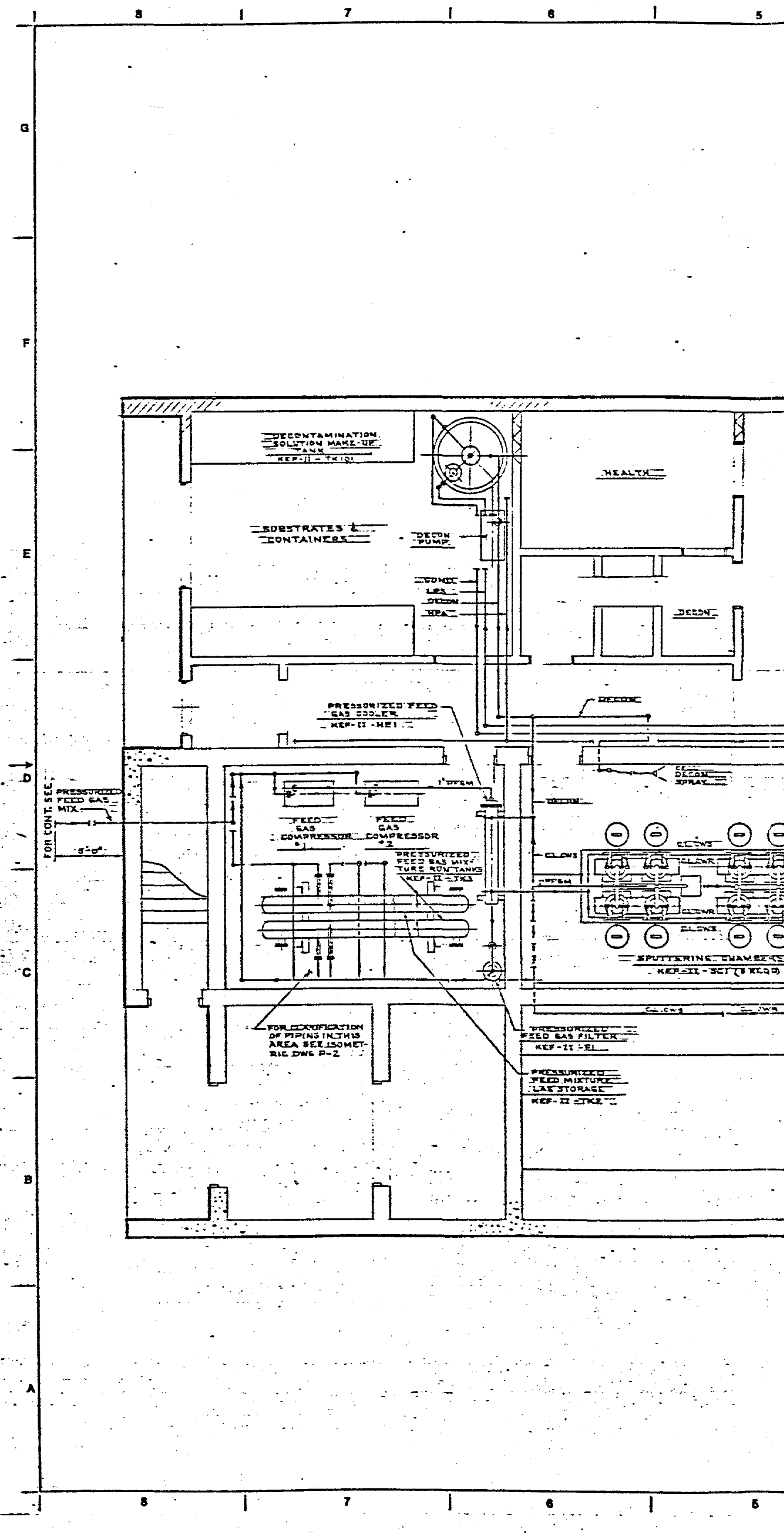
ION IMPLANTATION/SPUTTERING

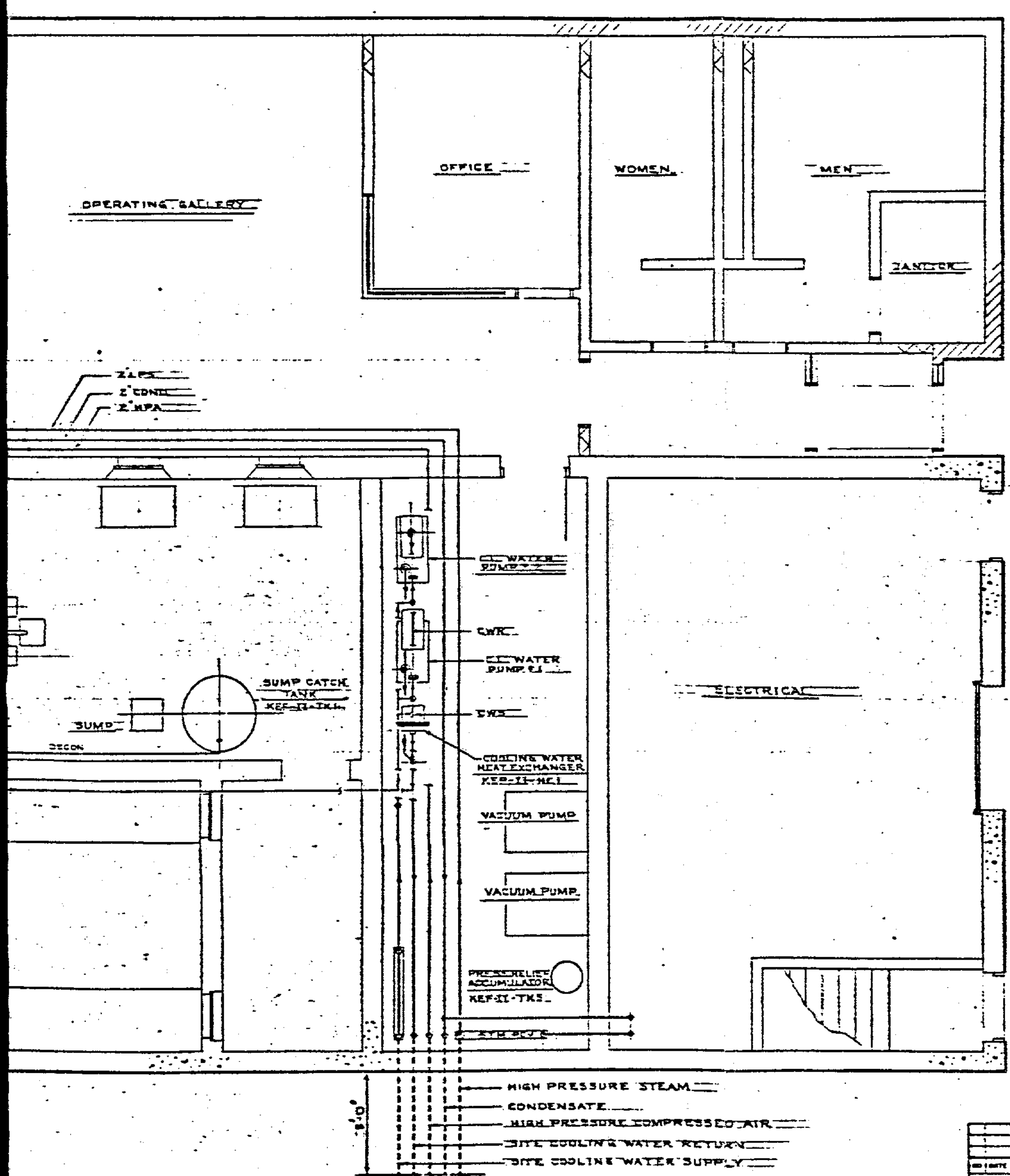
SINGLE LINE DIAGRAM

SCALE NONE

6154-3-II-E-1

PROJECT NO. 6154-3


DECONTAMINATION SOLUTION MAKE-UP TANK
KEF-II - TK101
HEALTH
SUBSTRATES & CONTAINERS
DECON PUMP
DECON
PRESSURIZED FEED GAS COOLER
KEF-II -HE1
DECON SPRAY
PRESSURIZED FEED GAS MIX
FOR CONT. SEE
5'-0"
FEED GAS COMPRESSOR #1
FEED GAS COMPRESSOR #2
PRESSURIZED FEED GAS MIXTURE RUN TANKS
KEF-II -TK3
CLCWS
CLCWR
SPUTTERING CHAMBERS
FOR CLARIFICATION OF PIPING IN THIS AREA SEE ISOMETRIC DWG P-2
PRESSURIZED FEED GAS FILTER
PRESSURIZED FEED MIXTURE GAS STORAGE
KEF-II -TK2




NOTE:
FOR ABBREVIATIONS SEE DRAWING NO. P-1

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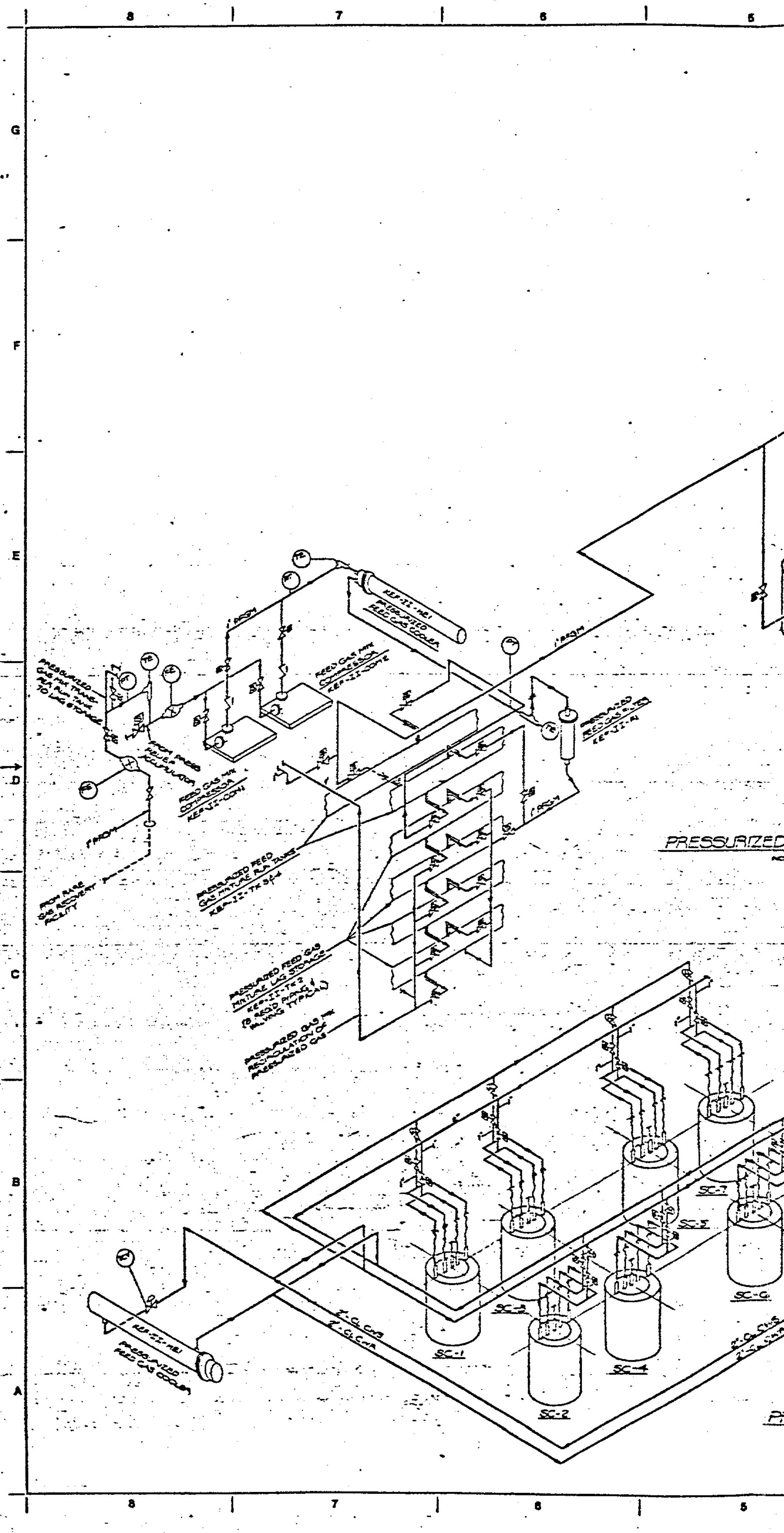
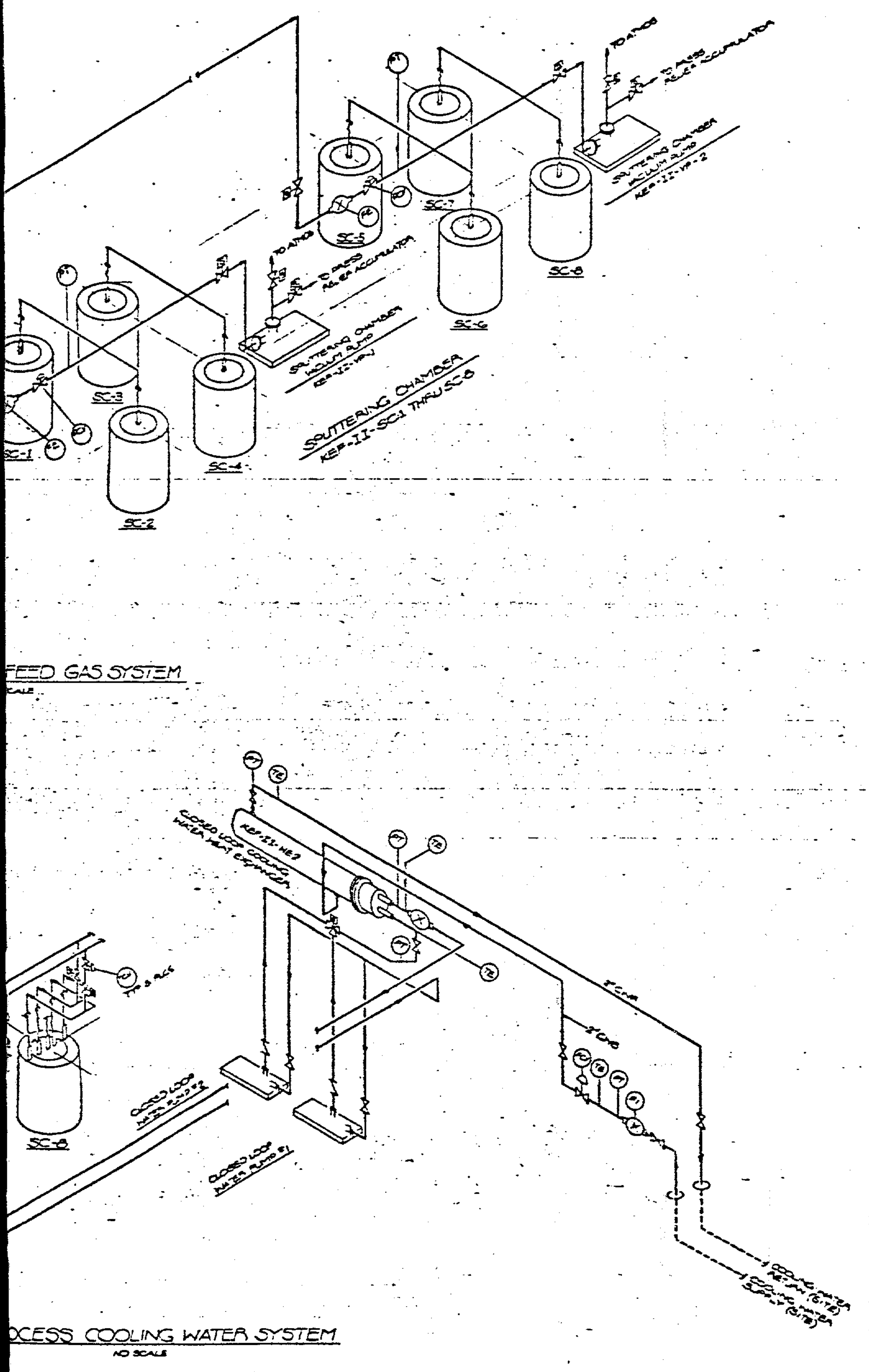
KRYPTON ENCAPSULATION
PRECONCEPTUAL DESIGN
IONIMPLANTATION/SPUTTERING
PIPING PLAN

6154-3-II-P31


PRESSURIZED
SC-1
SC-2
SC-3
SC-4
SC-5
SC-6
SC-7

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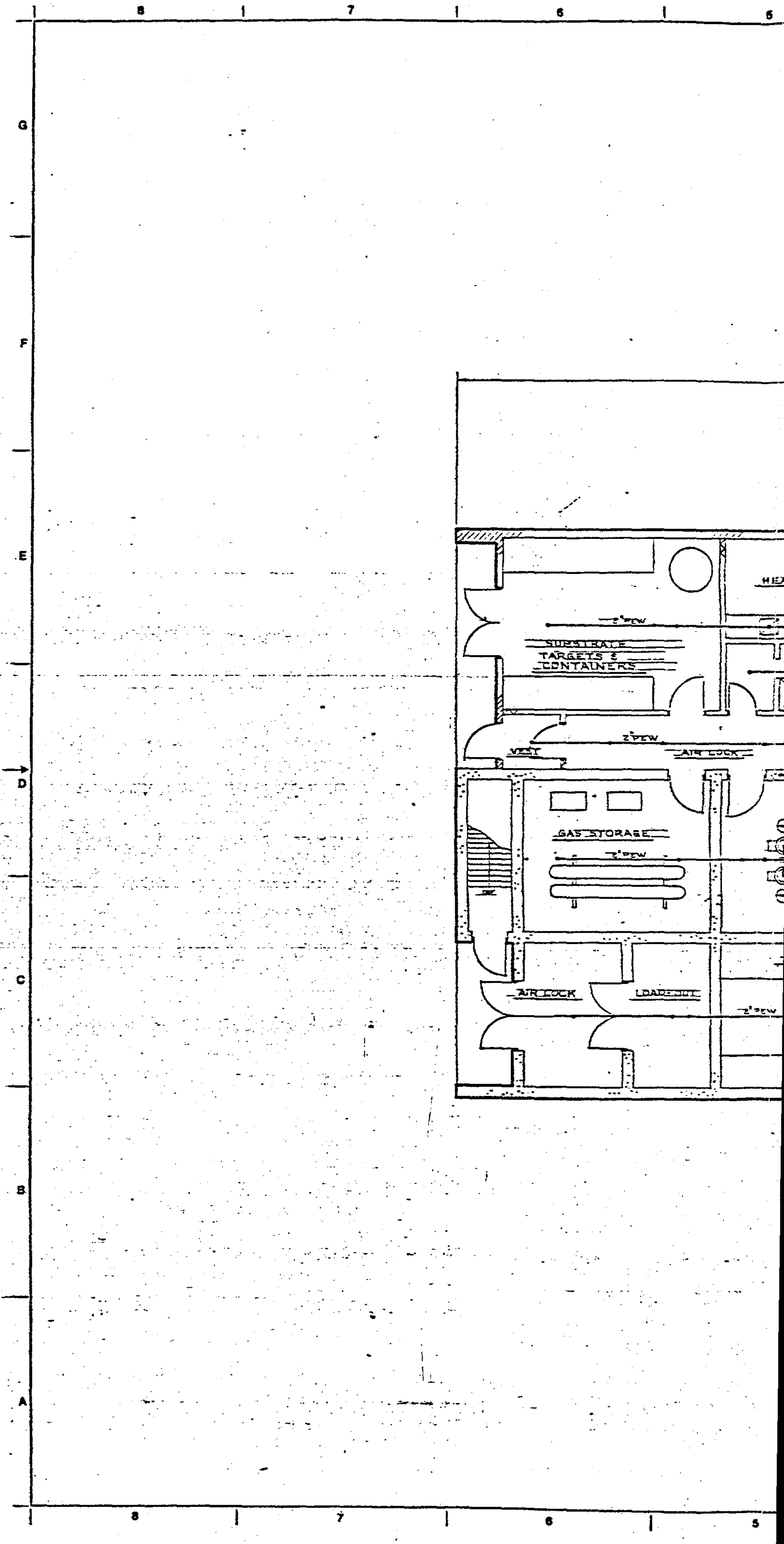
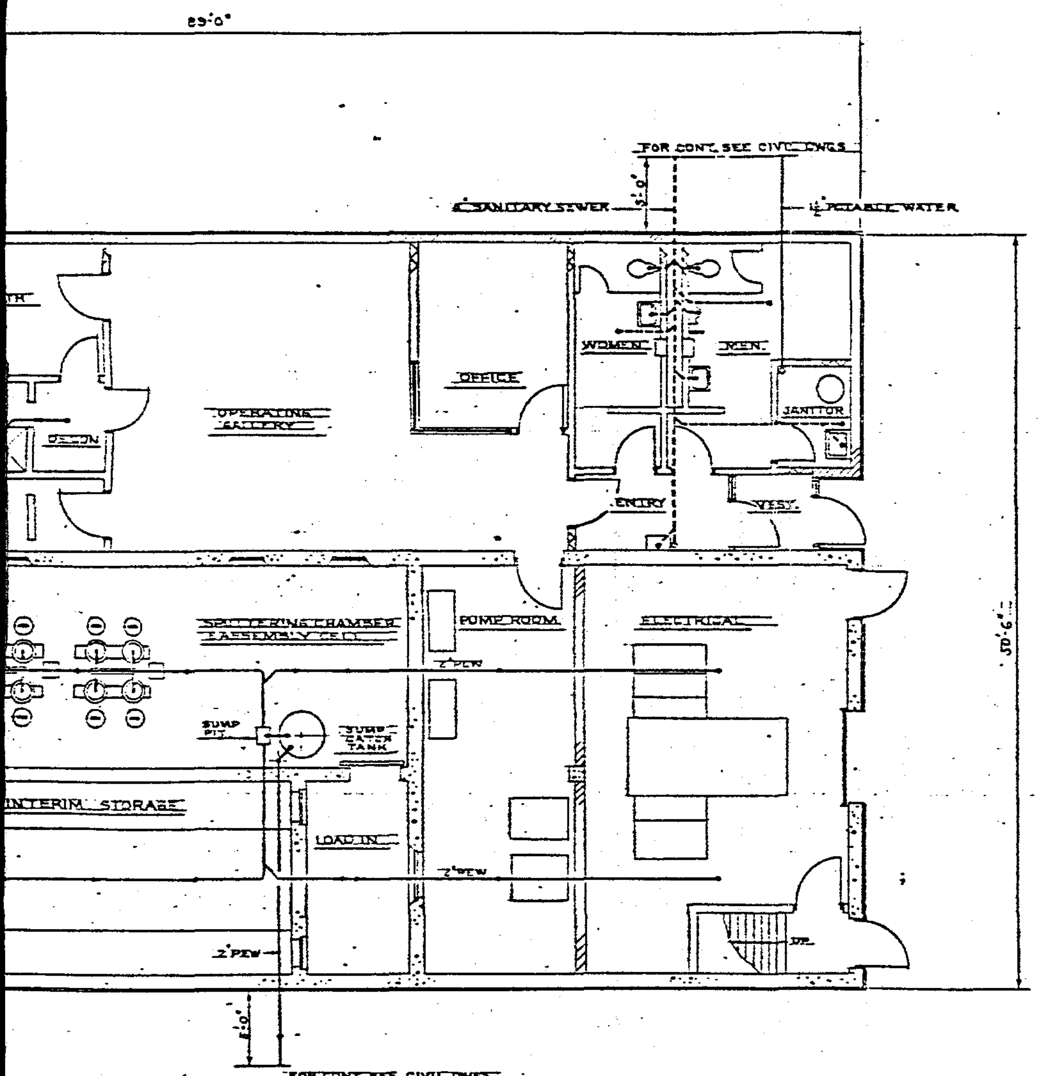
KRYPTON ENCAPSULATION
PRECONCEPTUAL DESIGN
ION IMPLANTATION/SPUTTERING
ISOMETRICS

SCALE NONE

6154-3-II-P-2



8
7
6
5
G
F
E
D
C
B
A
SUBSTRATE
TARGETS &
CONTAINERS
2" PEW
VEST
AIR LOCK
GAS STORAGE
LOAD-OUT

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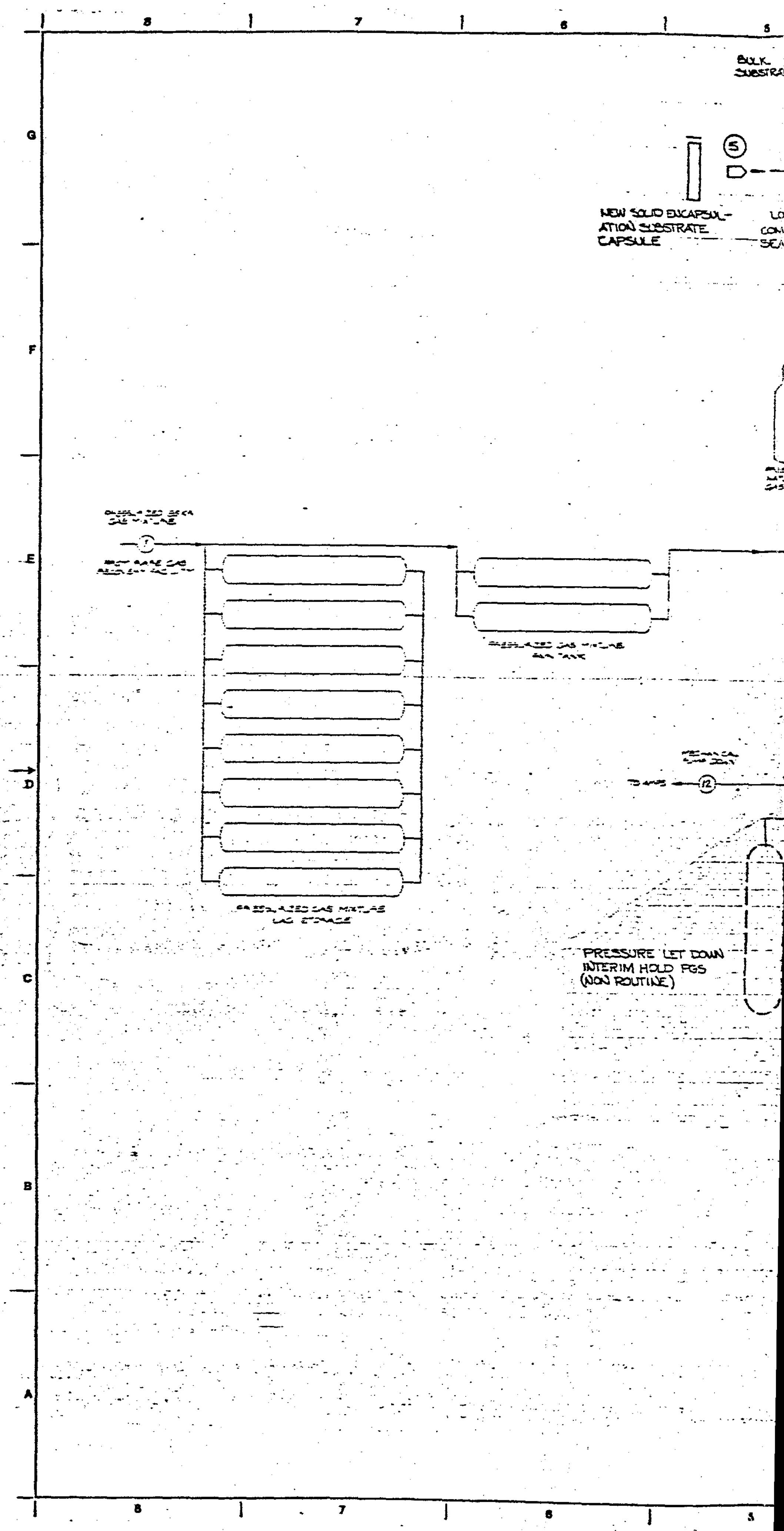
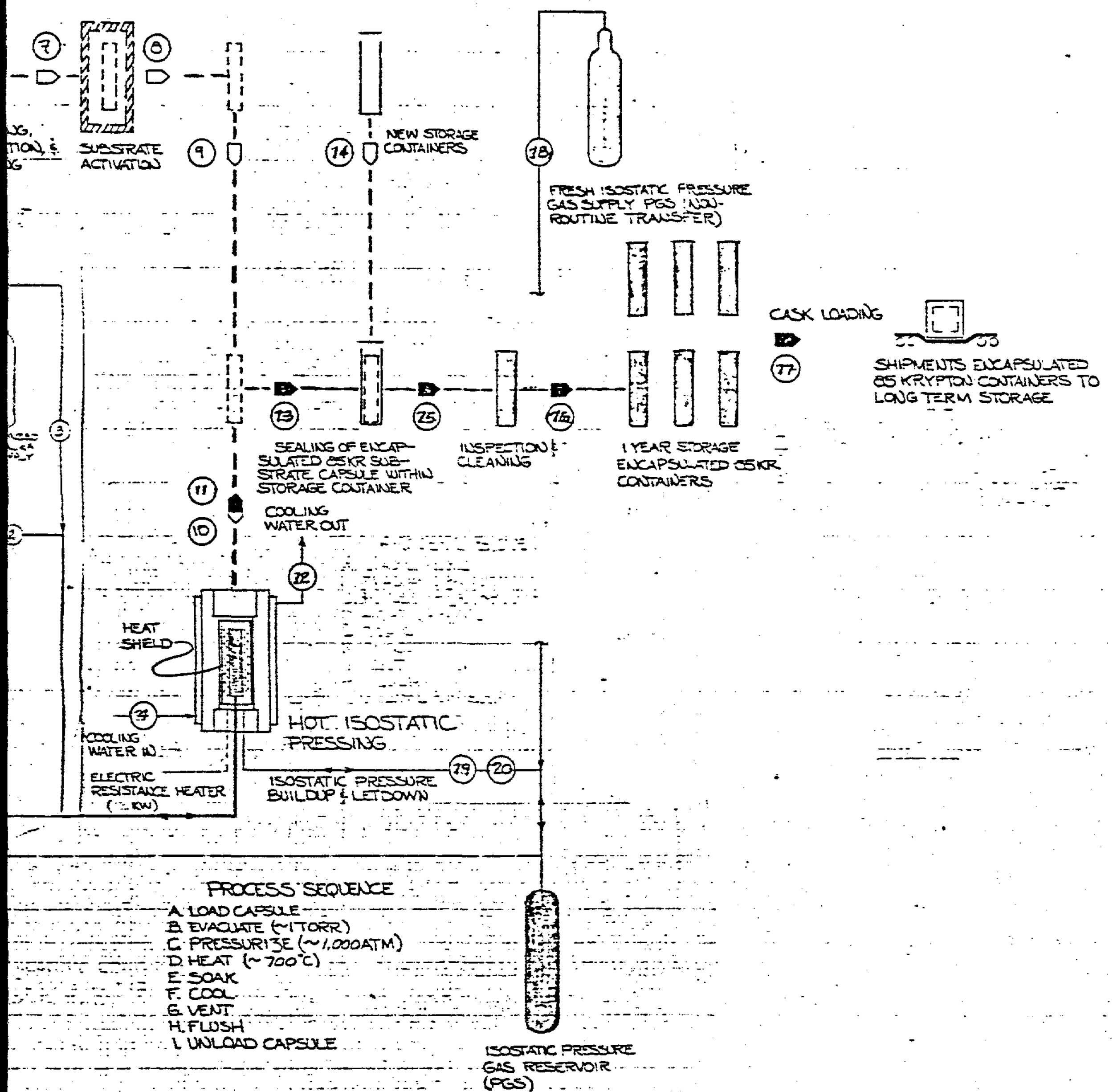
KRYPTON ENCAPSULATION
PRECONCEPTUAL DESIGN
ION IMPLANTATION/SPUTTERING
SANITARY & PROCESS DRAIN SYSTEM

6154-3-II-P-3


8
7
6
5
G
F
E
D
C
B
A
NEW SOLID ENCAPSUL-
ATION SUBSTRATE
CAPSULE
PRESSURE LET DOWN
INTERIM HOLD PGS
(NON ROUTINE)

55

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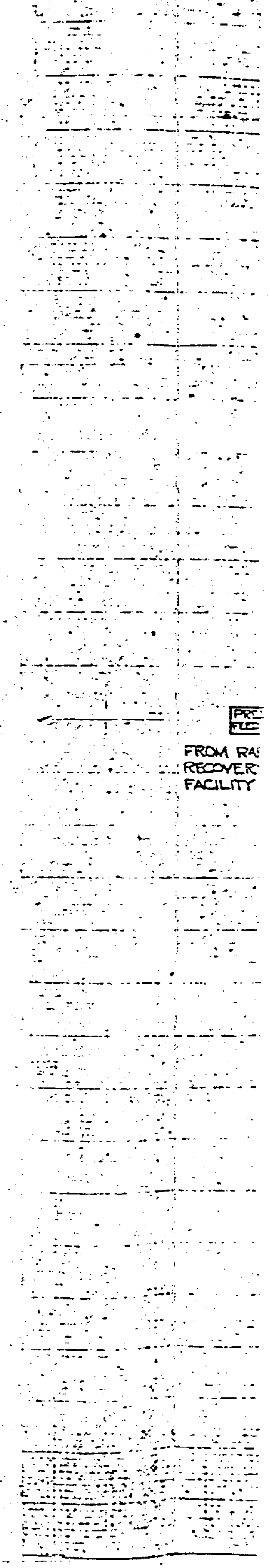
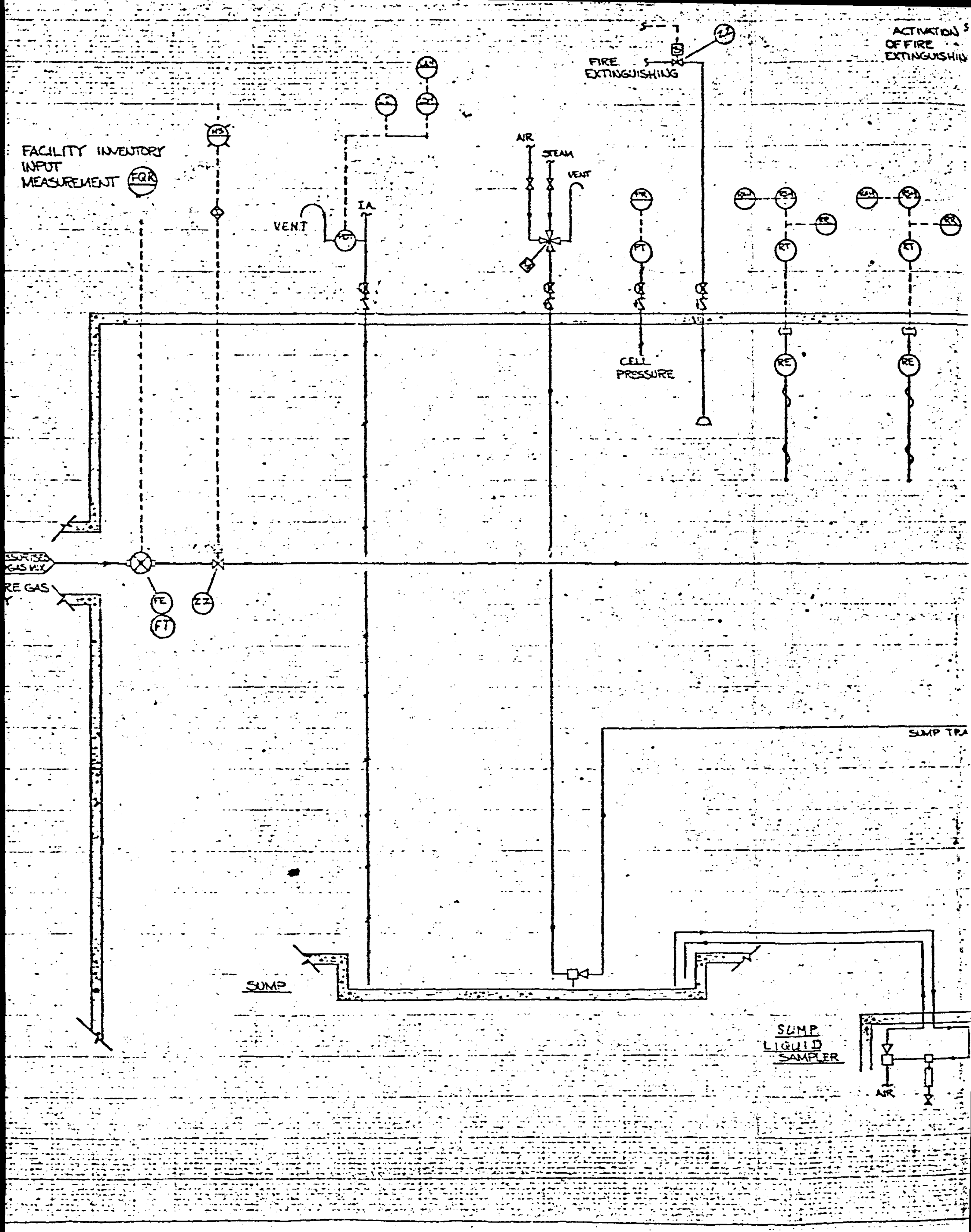
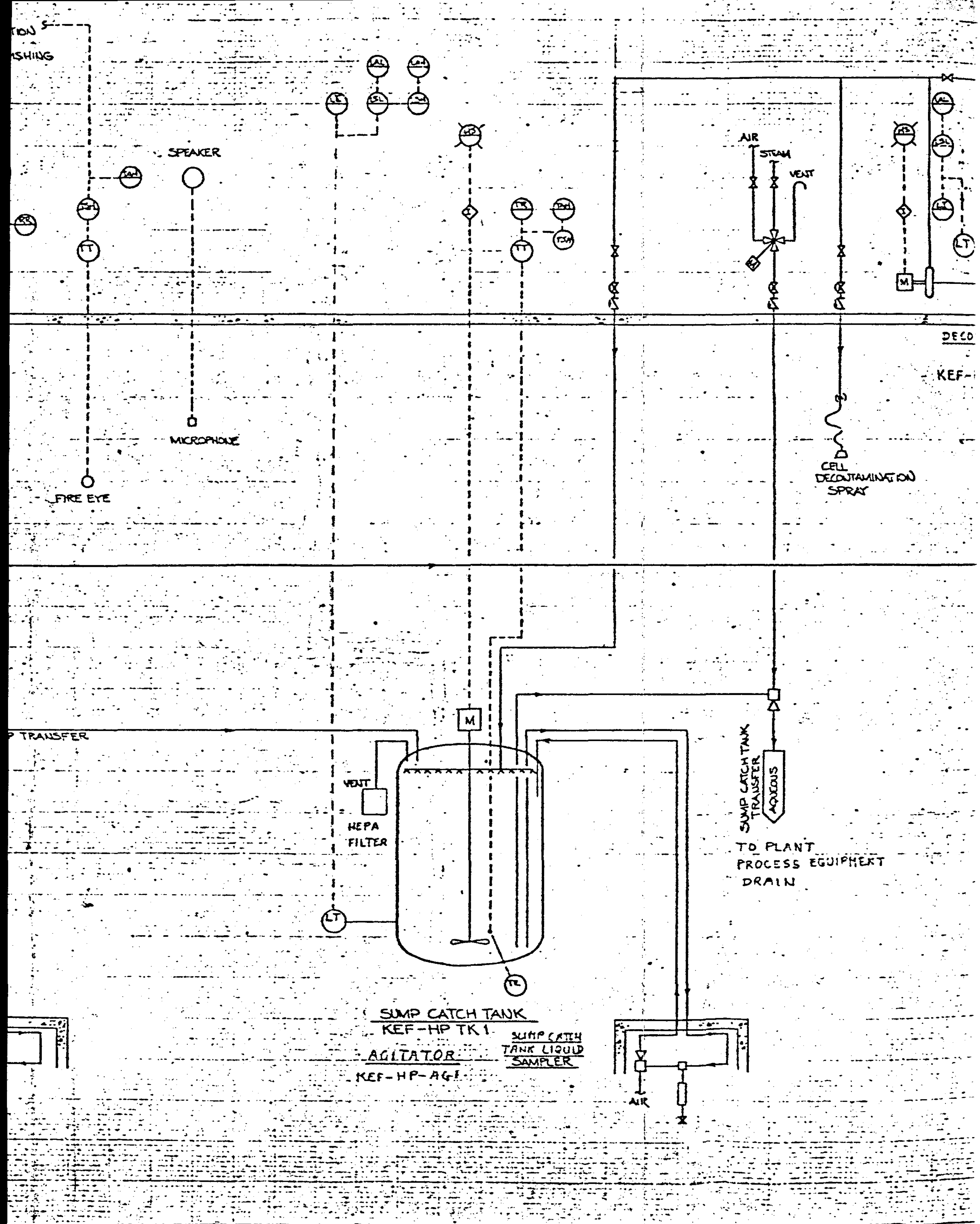
KRYPTON ENCAPSULATION
PRECONCEPTUAL DESIGN
ZEOLITE ENCAPSULATION
PROCESS FLOW DIAGRAM

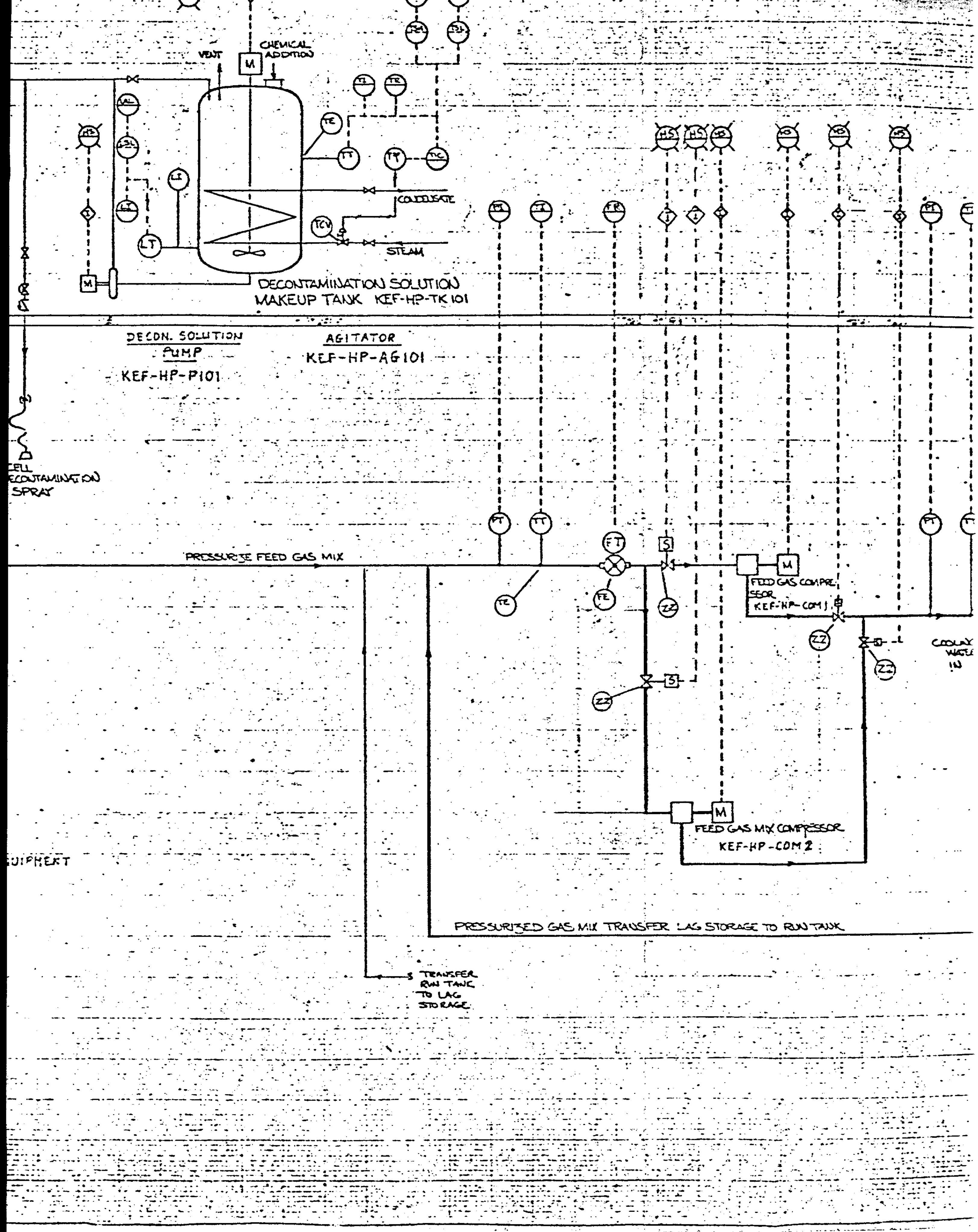
G154-3-HP-PR-2

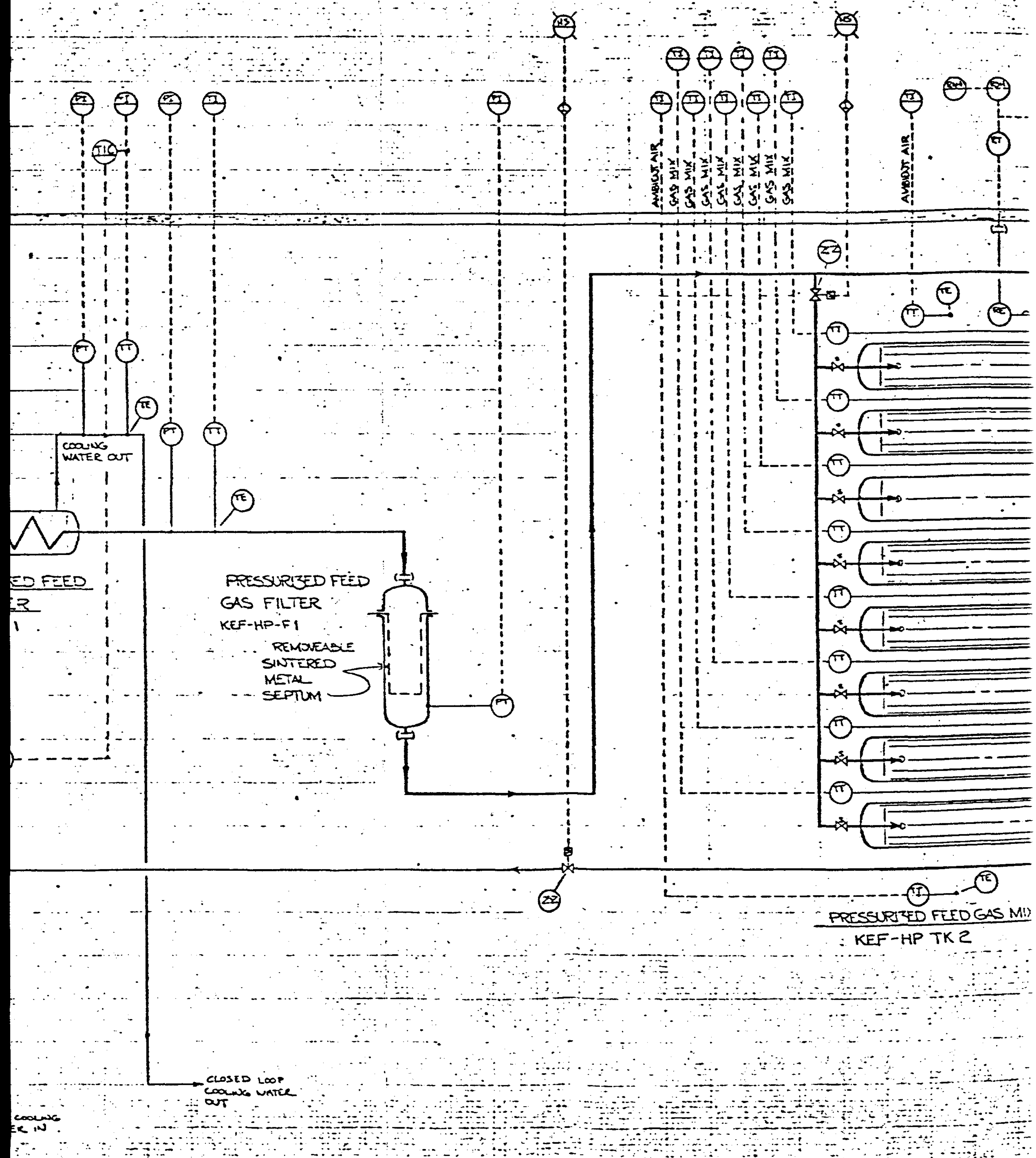

FROM RA
RECOVER
FACILITY



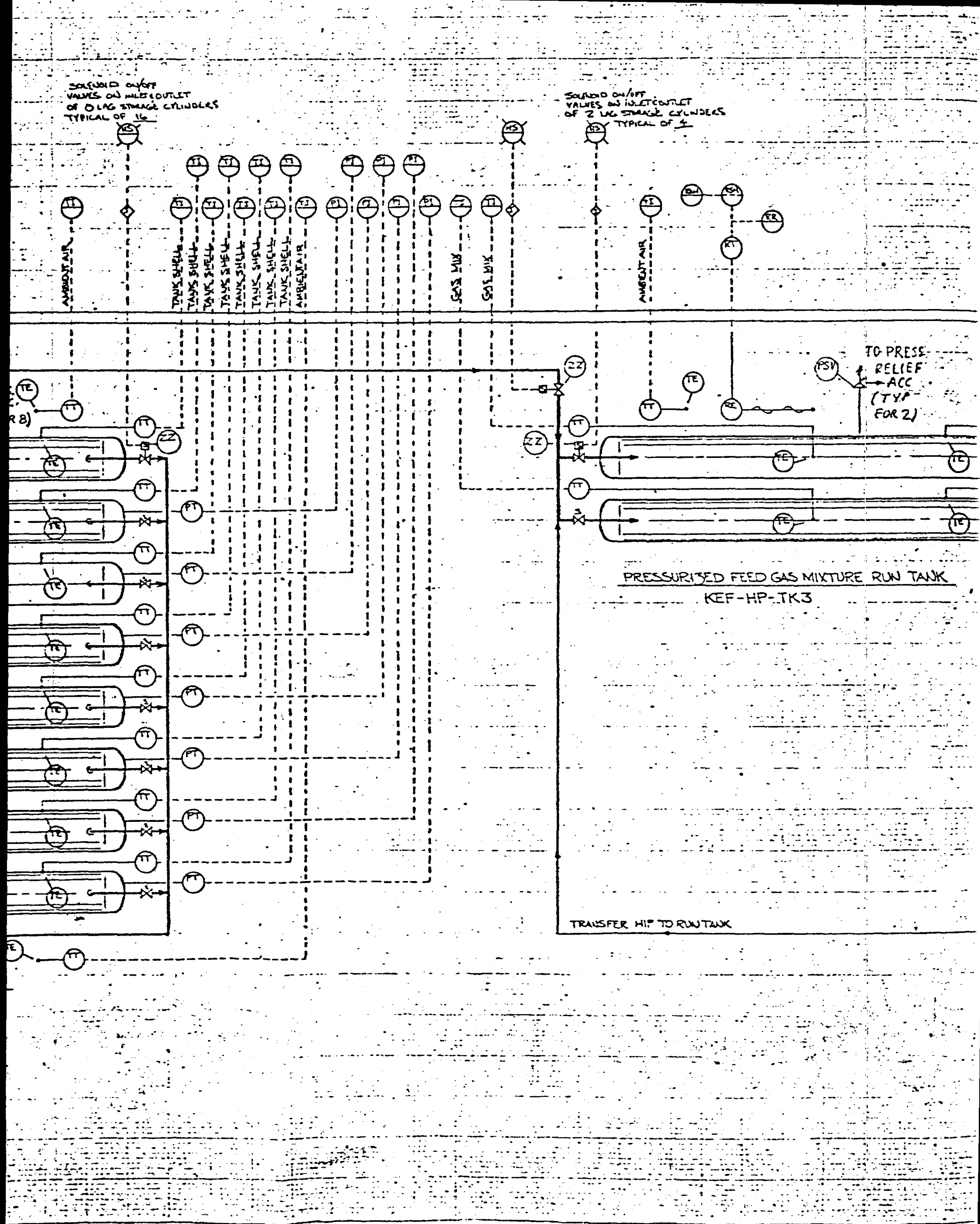
ACTIVATION
OF FIRE
FIRE EXTINGUISHING
FACILITY INVENTORY INPUT MEASUREMENT
FQR
AIR
STEAM
VENT
VENT
I.A.
FR
PT
CELL PRESSURE
RT
RE
FE
FT
ZZ
SUMP
SUMP LIQUID SAMPLER
AIR

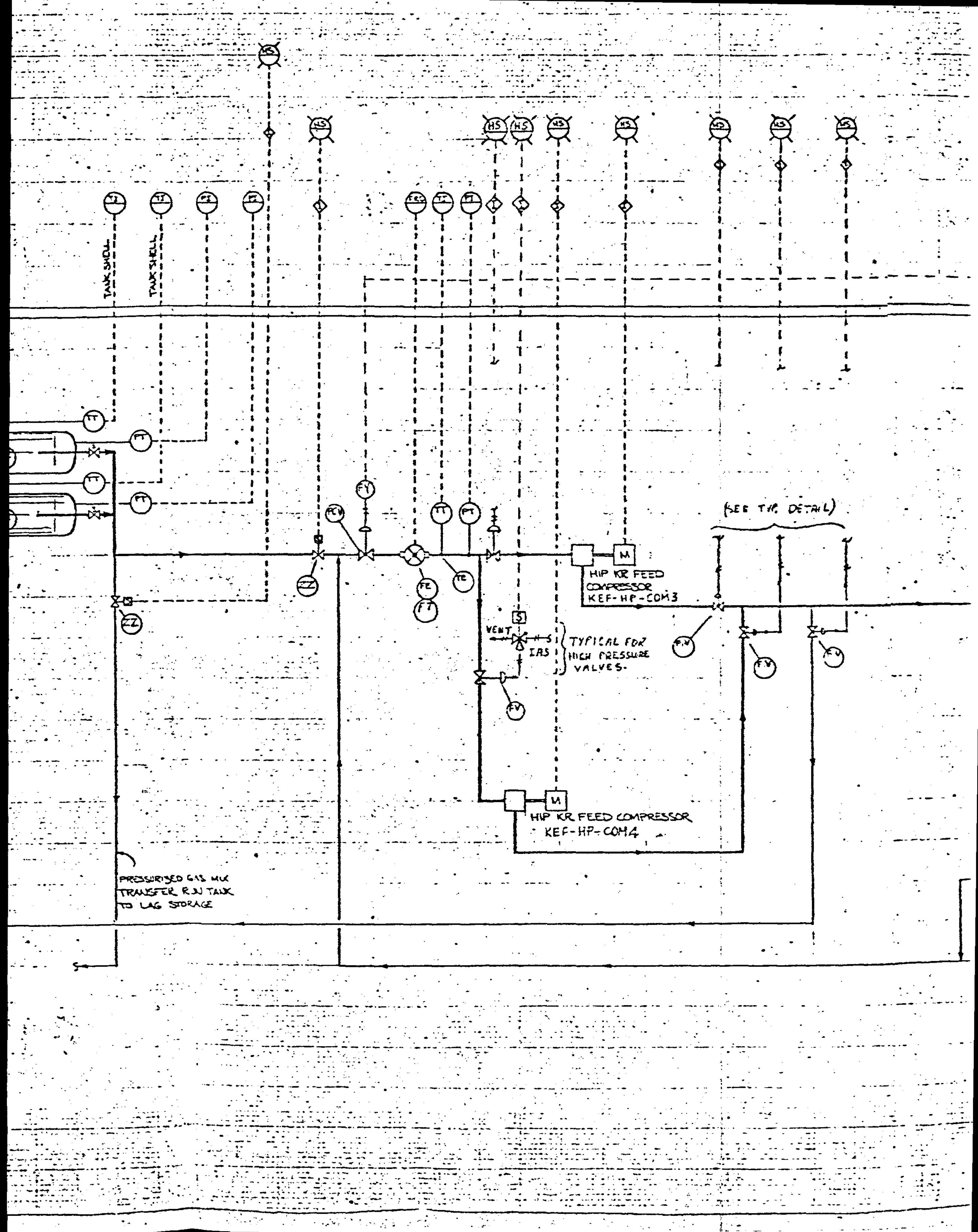

SPEAKER
MICROPHONE
FIRE EYE
AIR
STEAM
VENT
CELL
DECONTAMINATION
SPRAY
KEF-
TRANSFER
M
VENT
HEPA
FILTER
LT
SUMP CATCH TANK
TRANSFER
AQUEOUS
TO PLANT
PROCESS EQUIPHENT
DRAIN
SUMP CATCH TANK
KEF-HP TK 1
AGITATOR
KEF-HP-AG1
SUMP CATCH
TANK LIQUID
SAMPLER
AIR


VENT
CHEMICAL ADDITION
CONDENSATE
STEAM
DECONTAMINATION SOLUTION
MAKEUP TANK KEF-HP-TK101
DECON. SOLUTION
PUMP
KEF-HP-P101
AGITATOR
KEF-HP-AG101
CELL
SPRAY
PRESSURIZE FEED GAS MIX
FEED GAS COMPRESSOR
KEF-HP-COM1
FEED GAS MIX COMPRESSOR
KEF-HP-COM2
PRESSURIZED GAS MIX TRANSFER LAG STORAGE TO RUN TANK
TRANSFER
RUN TANK
TO LAG
STORAGE

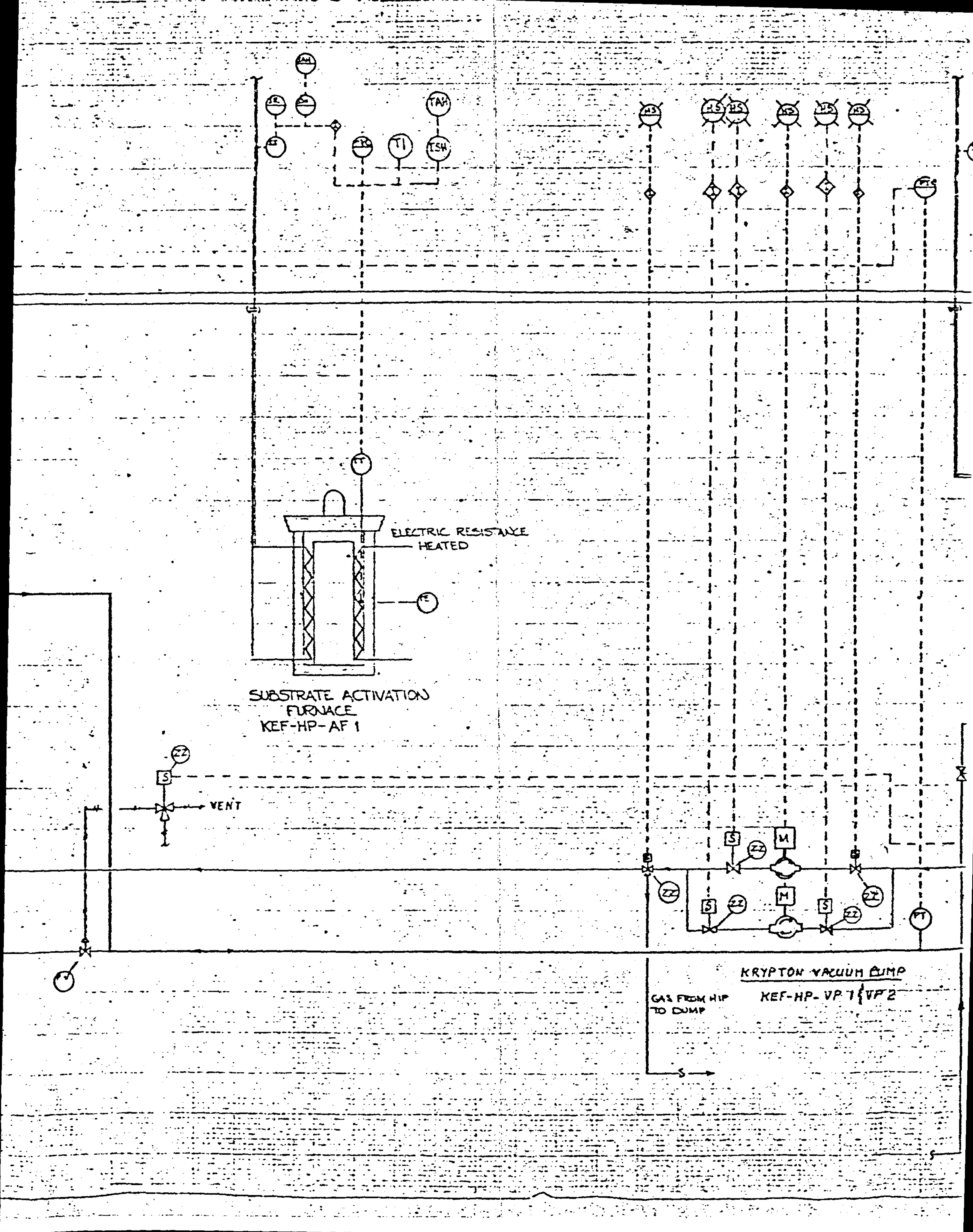


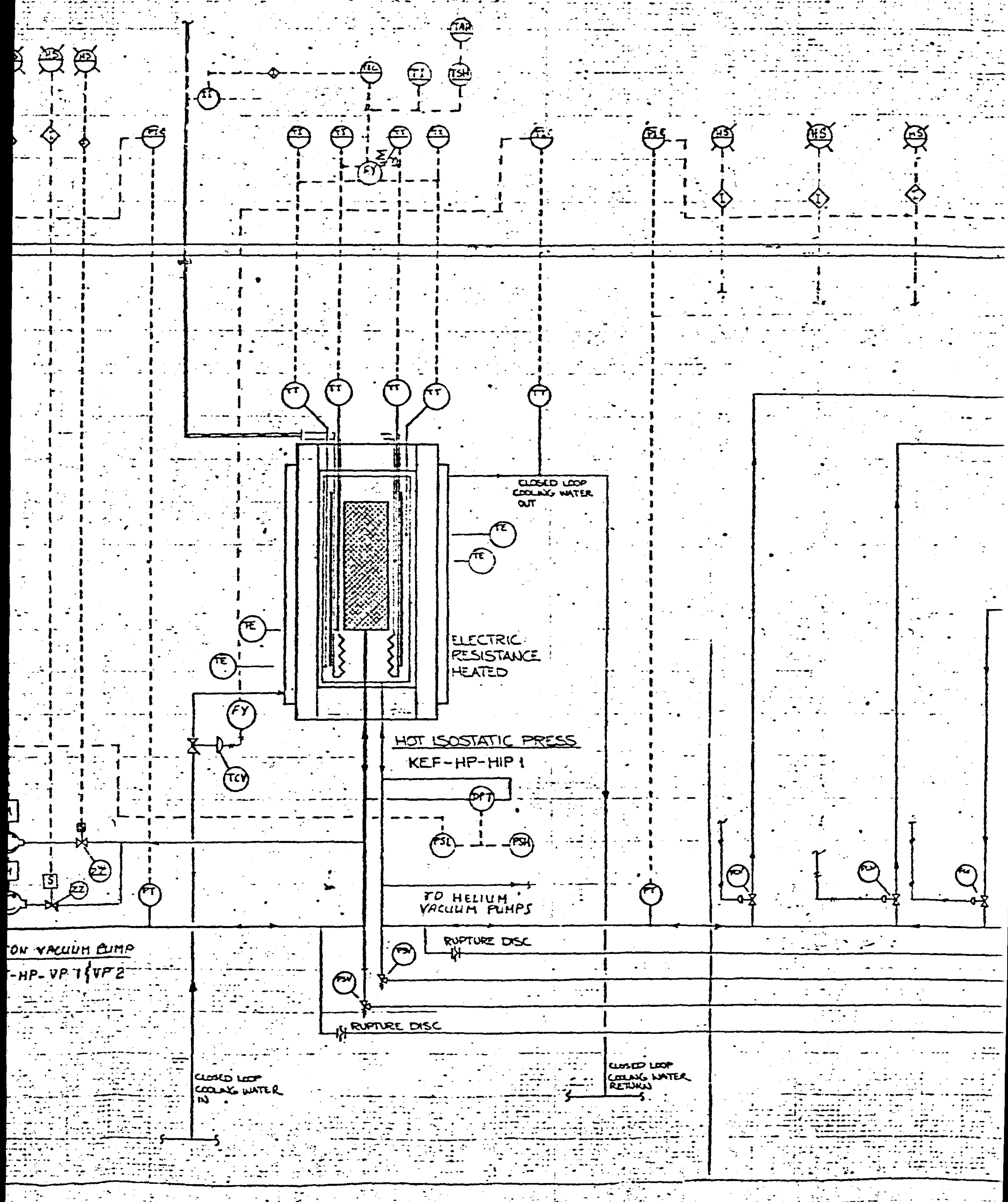
COOLING WATER OUT
PRESSURIZED FEED GAS FILTER
KEF-HP-F1
REMOVEABLE SINTERED METAL SEPTUM
AMBIENT AIR
GAS MIX
GAS MIX
GAS MIX
GAS MIX
GAS MIX
GAS MIX
GAS MIX
GAS MIX
AMBIENT AIR
KEF-HP TK 2
CLOSED LOOP COOLING WATER OUT


SOLENOID ON/OFF VALVES ON INLET&OUTLET OF 8 LAG STORAGE CYLINDERS TYPICAL OF 16
SOLENOID ON/OFF VALVES ON INLET&OUTLET OF 2 LAG STORAGE CYLINDERS TYPICAL OF 4
AMBIENT AIR
TANK SHELL
TANK SHELL
TANK SHELL
TANK SHELL
TANK SHELL
TANK SHELL
TANK SHELL
TANK SHELL
AMBIENT AIR
GAS MIX
GAS MIX
AMBIENT AIR
TO PRESS RELIEF ACC (TYP FOR 2)
PRESSURIZED FEED GAS MIXTURE RUN TANK
KEF-HP-TK3
TRANSFER HP TO RUN TANK

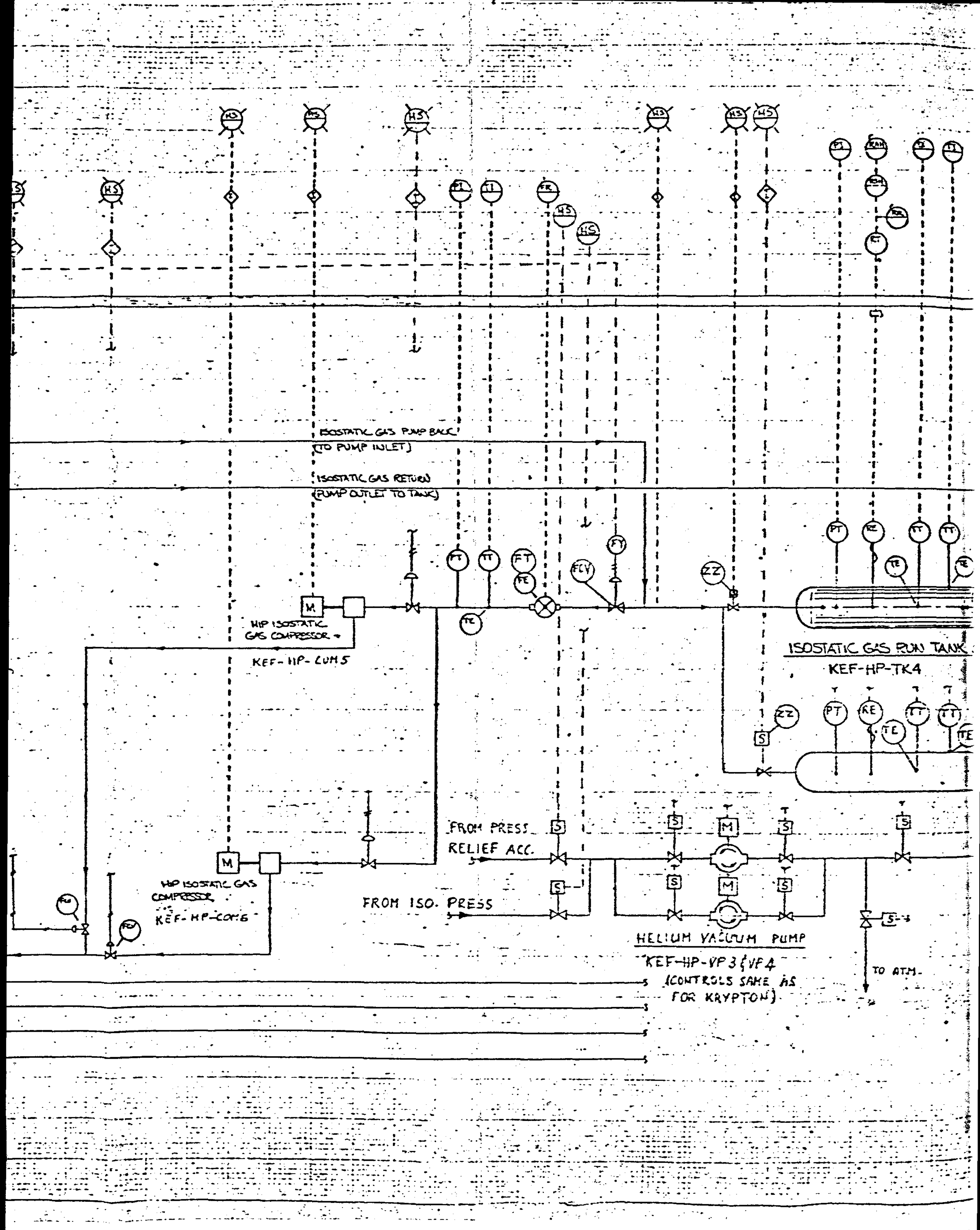


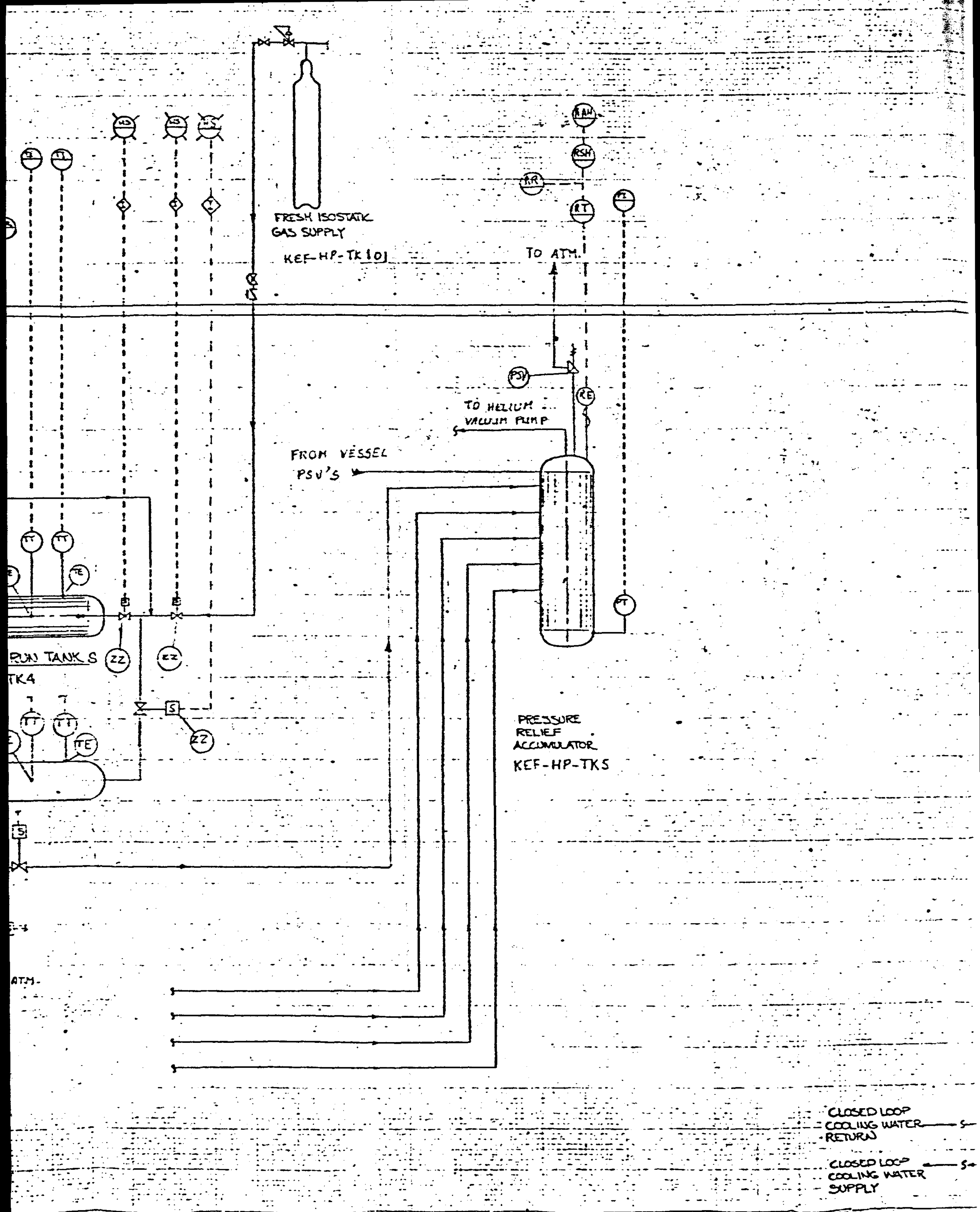
TANK SHELL
TANK SHELL
(SEE TYP. DETAIL)
HIP KR FEED COMPRESSOR KEF-HP-COM3
VENT
IAS
TYPICAL FOR HIGH PRESSURE VALVES.
HIP KR FEED COMPRESSOR KEF-HP-COM4
PRESSURISED GAS MIX TRANSFER RJN TANK TO LAG STORAGE

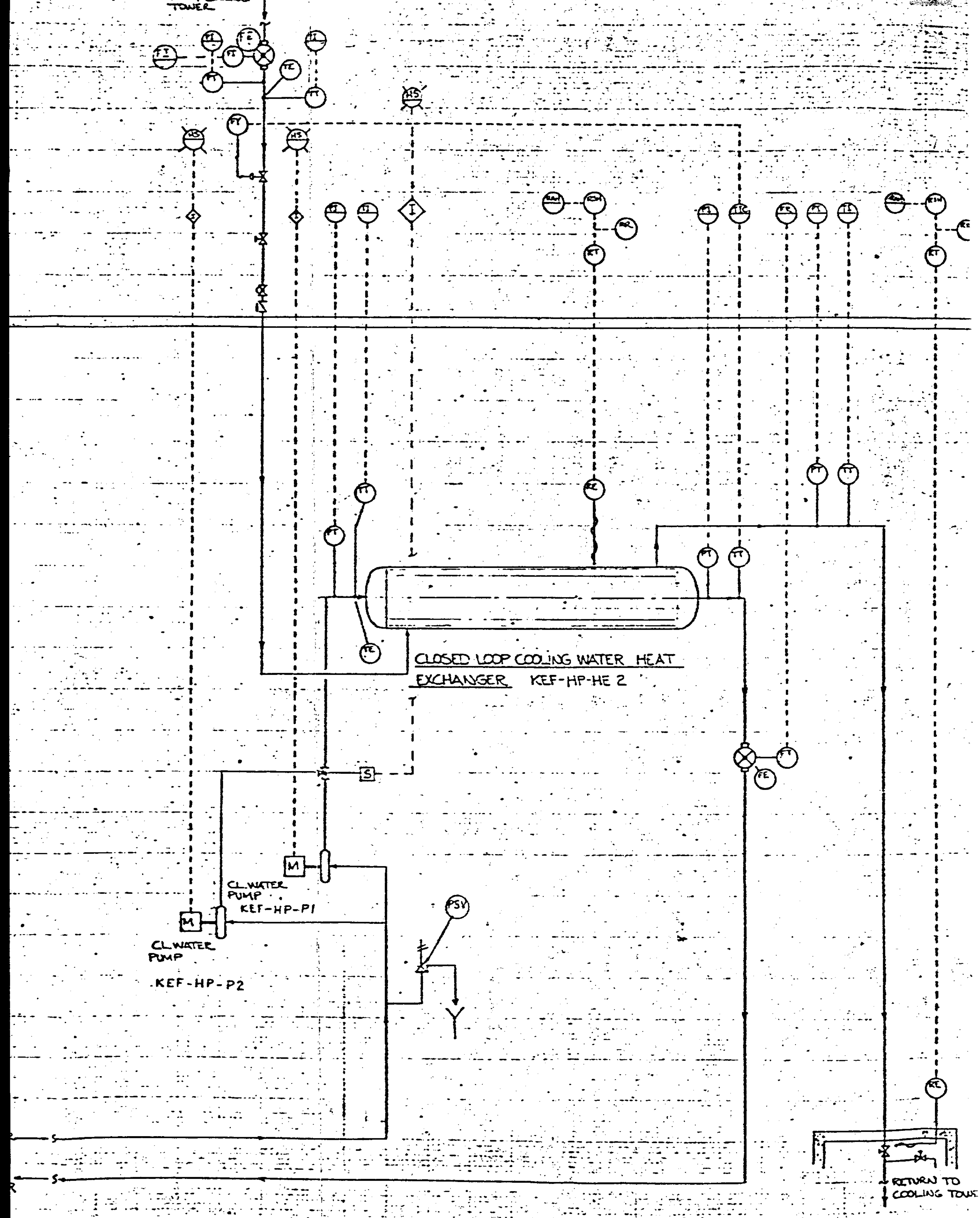

TAH
TI
TSH
HS
PT
TE
ELECTRIC RESISTANCE
HEATED
SUBSTRATE ACTIVATION
FURNACE
KEF-HP-AF 1
ZZ
S
VENT
M
KRYPTON VACUUM PUMP
KEF-HP- VP 1 & VP 2
GAS FROM HIP
TO DUMP



CLOSED LOOP COOLING WATER OUT
ELECTRIC RESISTANCE HEATED
HOT ISOSTATIC PRESS
KEF-HP-HIP 1
TO HELIUM VACUUM PUMPS
RUPTURE DISC
RUPTURE DISC
ON VACUUM PUMP
-HP-VP 1 { VP 2
CLOSED LOOP COOLING WATER IN
CLOSED LOOP COOLING WATER RETURN


ISOSTATIC GAS PUMP BACK (TO PUMP INLET)
ISOSTATIC GAS RETURN (PUMP OUTLET TO TANK)
HP ISOSTATIC GAS COMPRESSOR
KEF-HP-COM5
ISOSTATIC GAS RUN TANK
KEF-HP-TK4
FROM PRESS RELIEF ACC.
HP ISOSTATIC GAS COMPRESSOR
KEF-HP-COM6
FROM ISO. PRESS
HELIUM VACUUM PUMP
KEF-HP-VP3 & VP4
(CONTROLS SAME AS FOR KRYPTON)
TO ATM.


FRESH ISOSTATIC GAS SUPPLY
KEF-HP-TK101
TO ATM.
TO HELIUM VACUUM PUMP
FROM VESSEL PSV'S
PSV
RE
RT
RSH
RAH
RR
PT
PRESSURE RELIEF ACCUMULATOR
KEF-HP-TK5
RUN TANKS
TK4
ZZ
TT
TE
ATM.
CLOSED LOOP COOLING WATER RETURN
CLOSED LOOP COOLING WATER SUPPLY


TOWER
CLOSED LOOP COOLING WATER HEAT EXCHANGER KEF-HP-HE 2
CL.WATER PUMP KEF-HP-P1
CL.WATER PUMP KEF-HP-P2
PSV
RETURN TO COOLING TOWE

PIPING & INSTRUMENTATION DIAGRAM

PRECONCEPTUAL DESIGN

85 KRYPTON ENCAPSULATION

HIGH PRESSURE

7/3/01

[redacted]

6154-3-HP-M-2

ER

8 7 6 5

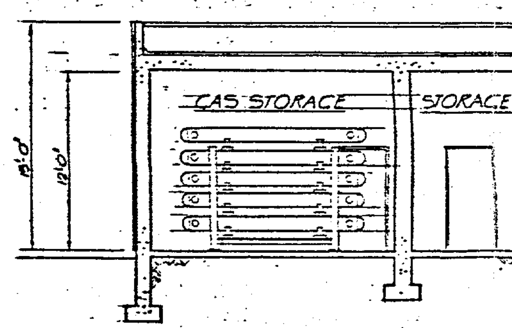
G

F

E

D

C

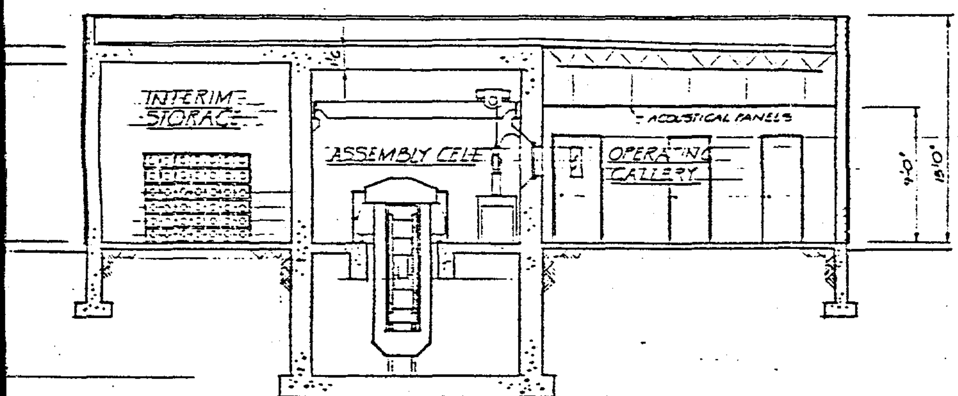



B

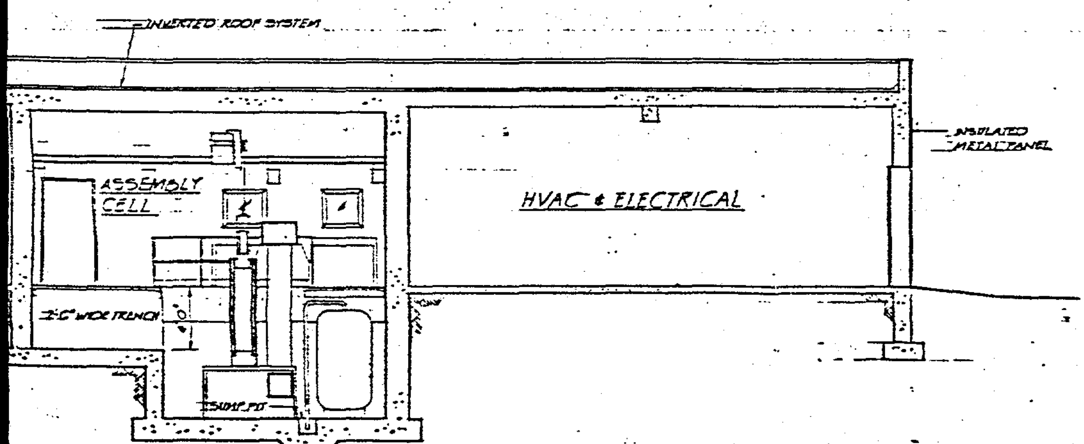
A

57

8 7 6 5




SECTION C-C




SECTION D-D

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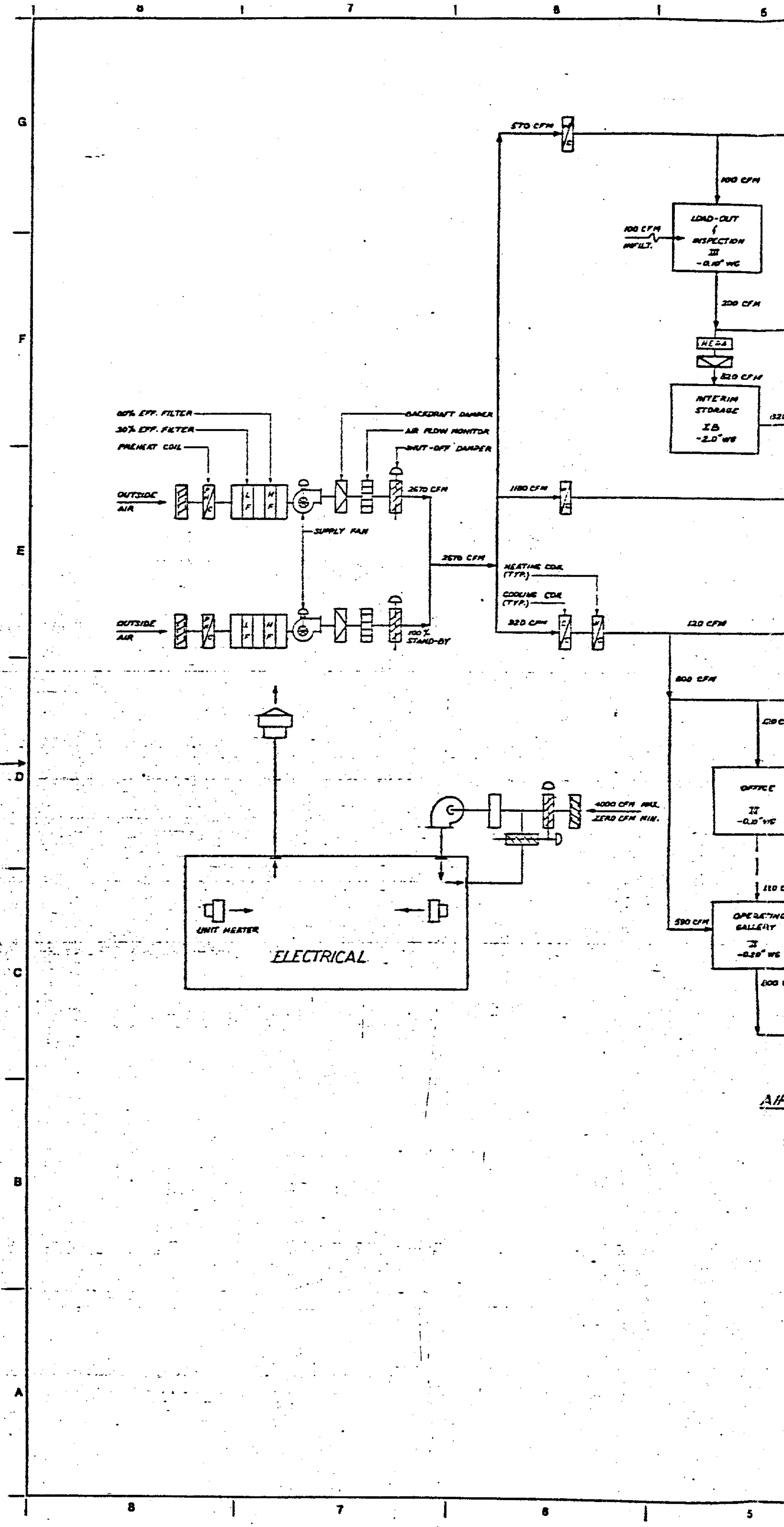
IDAHO FALLS, IDAHO

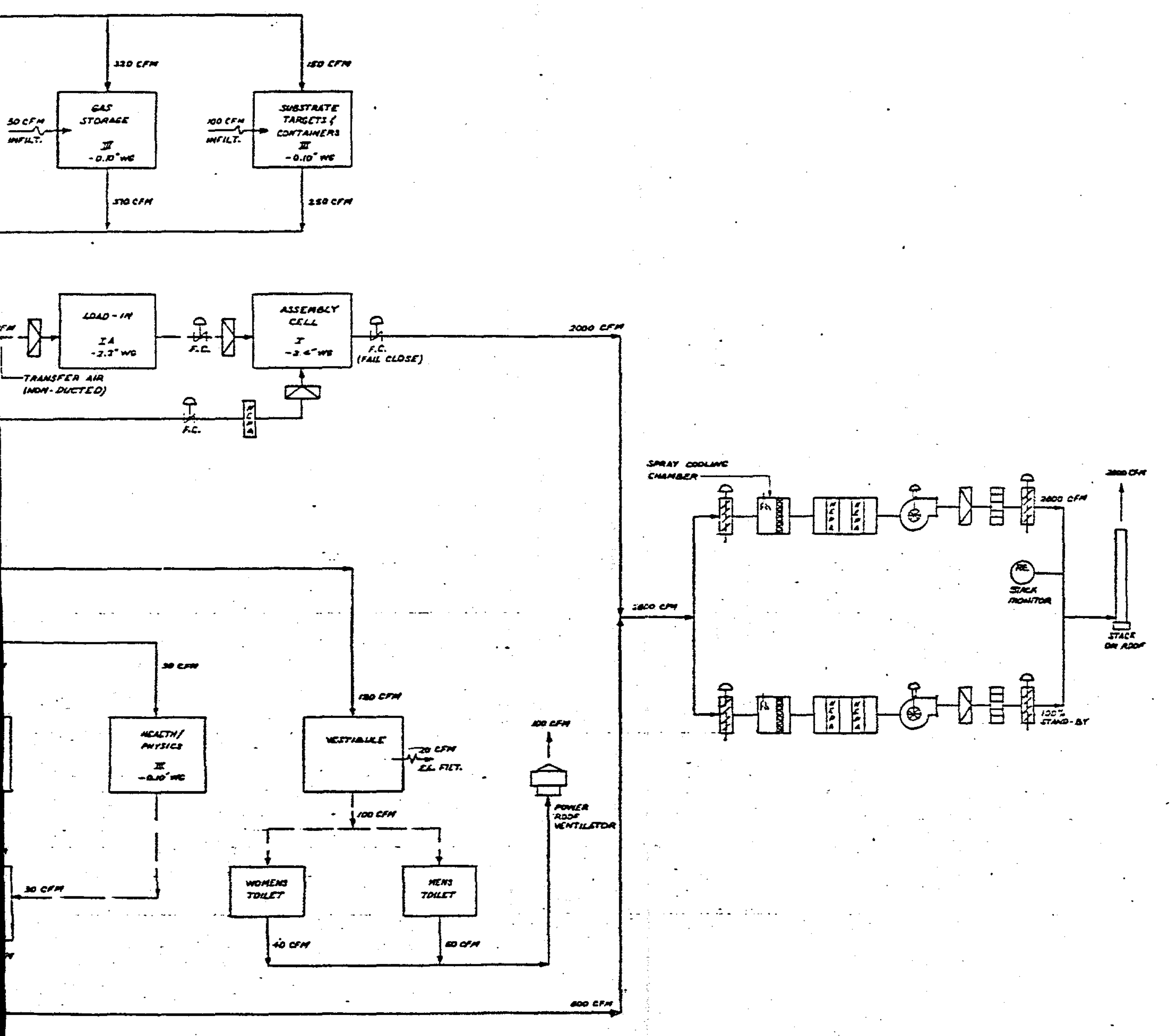
KRYPTON ENCAPSULATION
PRECONCEPTUAL DESIGN
ZEOLITE ENCAPSULATION
BUILDING SECTIONS

G154-3-HP-A-5



570 CFM
100 CFM
LOAD-OUT & INSPECTION III -0.10" WC
100 CFM INFILT.
200 CFM
HEPA
320 CFM
INTERIM STORAGE IB -2.0" WG
80% EFF. FILTER
30% EFF. FILTER
PREHEAT COIL
BACKDRAFT DAMPER
AIR FLOW MONITOR
SHUT-OFF DAMPER
OUTSIDE AIR
2570 CFM
SUPPLY FAN
1180 CFM
2570 CFM
HEATING COIL (TYP.)
COOLING COIL (TYP.)
320 CFM
120 CFM
OUTSIDE AIR
100% STAND-BY
800 CFM
OFFICE
4000 CFM MAX.
ZERO CFM MIN.
UNIT HEATER
ELECTRICAL
590 CFM
OPERATING GALLERY


53




FLOW DIAGRAM

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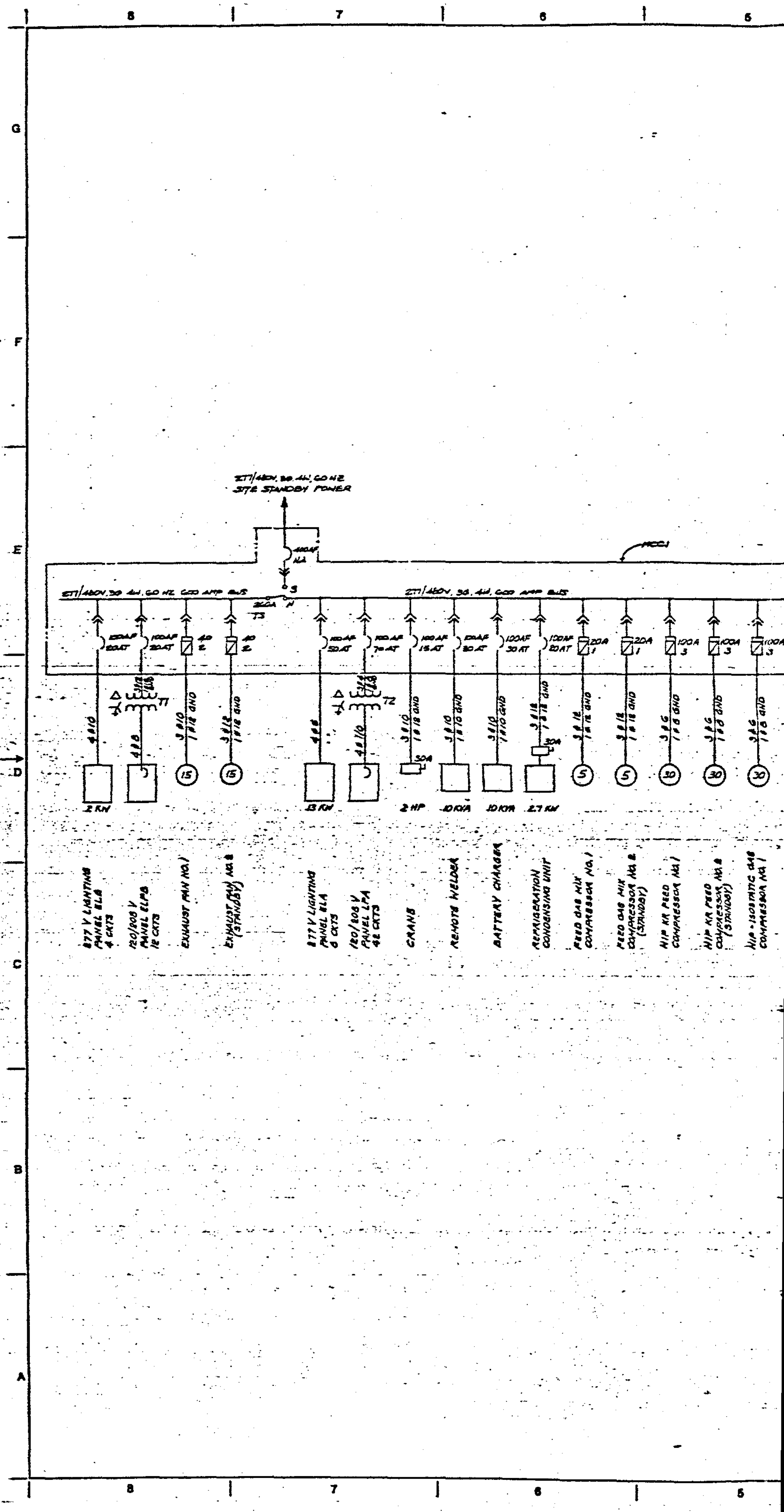
KRYPTON ENCAPSULATION
PRECONCEPTUAL DESIGN

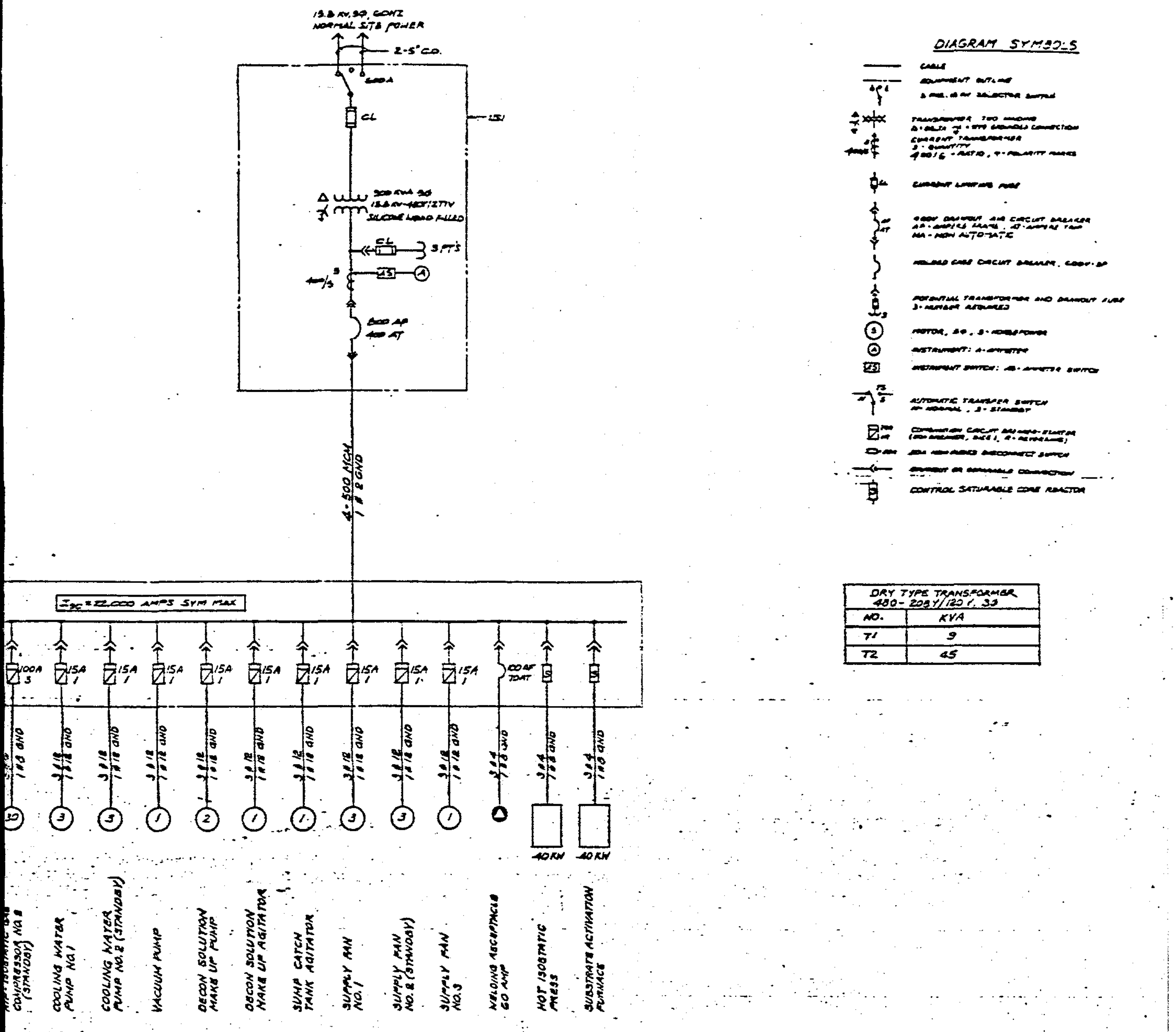
ZEOLITE ENCAPSULATION
HVAC FLOW DIAGRAM

SCALE NONE

6154-3-HP-V-2


STANDBY POWER
MCC1
2 KW
13 KW
2 HP
10 KVA
10 KVA
2.7 KW
277 V LIGHTING PANEL ELA 4 CKTS
120/208 V PANEL ELPB 12 CKTS
EXHAUST FAN NO.1
EXHAUST FAN NO.2 (STANDBY)
277 V LIGHTING PANEL ELA 8 CKTS
120/208 V PANEL LPA 42 CKTS
CRANE
REMOTE WELDER
BATTERY CHARGER
REFRIGERATION CONDENSING UNIT
FEED GAS MIX COMPRESSOR NO.1
FEED GAS MIX COMPRESSOR NO.2 (STANDBY)
HIP KR FEED COMPRESSOR NO.1
HIP KR FEED COMPRESSOR NO.2 (STANDBY)
HIP - ISOSTATIC GAS COMPRESSOR NO.1

59




| DRY TYPE TRANSFORMER 480-208Y/120 V, 3Φ | |
|---|---|
| NO. | KVA |
| T1 | 9 |
| T2 | 45 |

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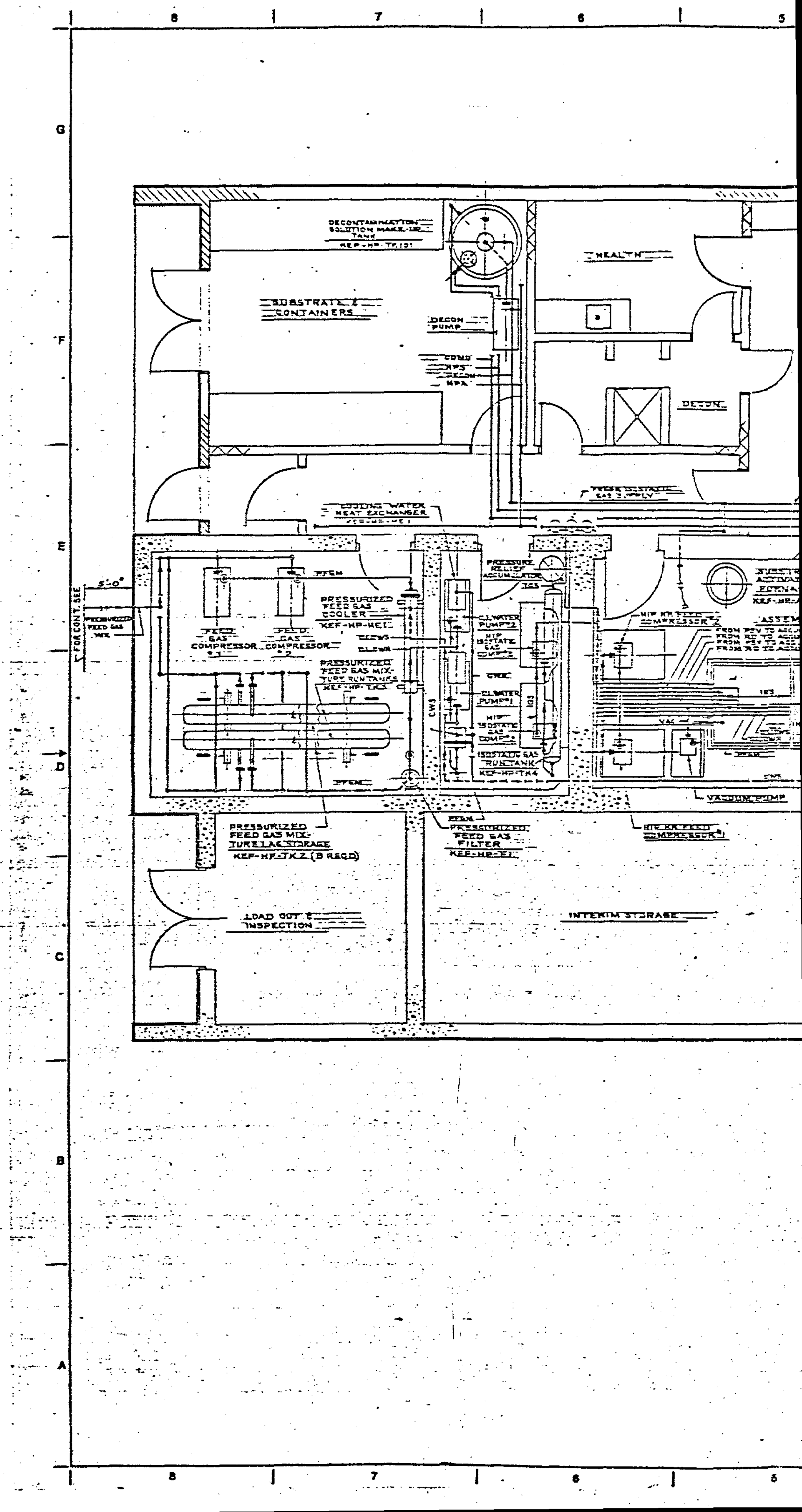
KRYPTON ENCAPSULATION PRECONCEPTUAL DESIGN

ZEOLITE ENCAPSULATION
SINGLE LINE DIAGRAM

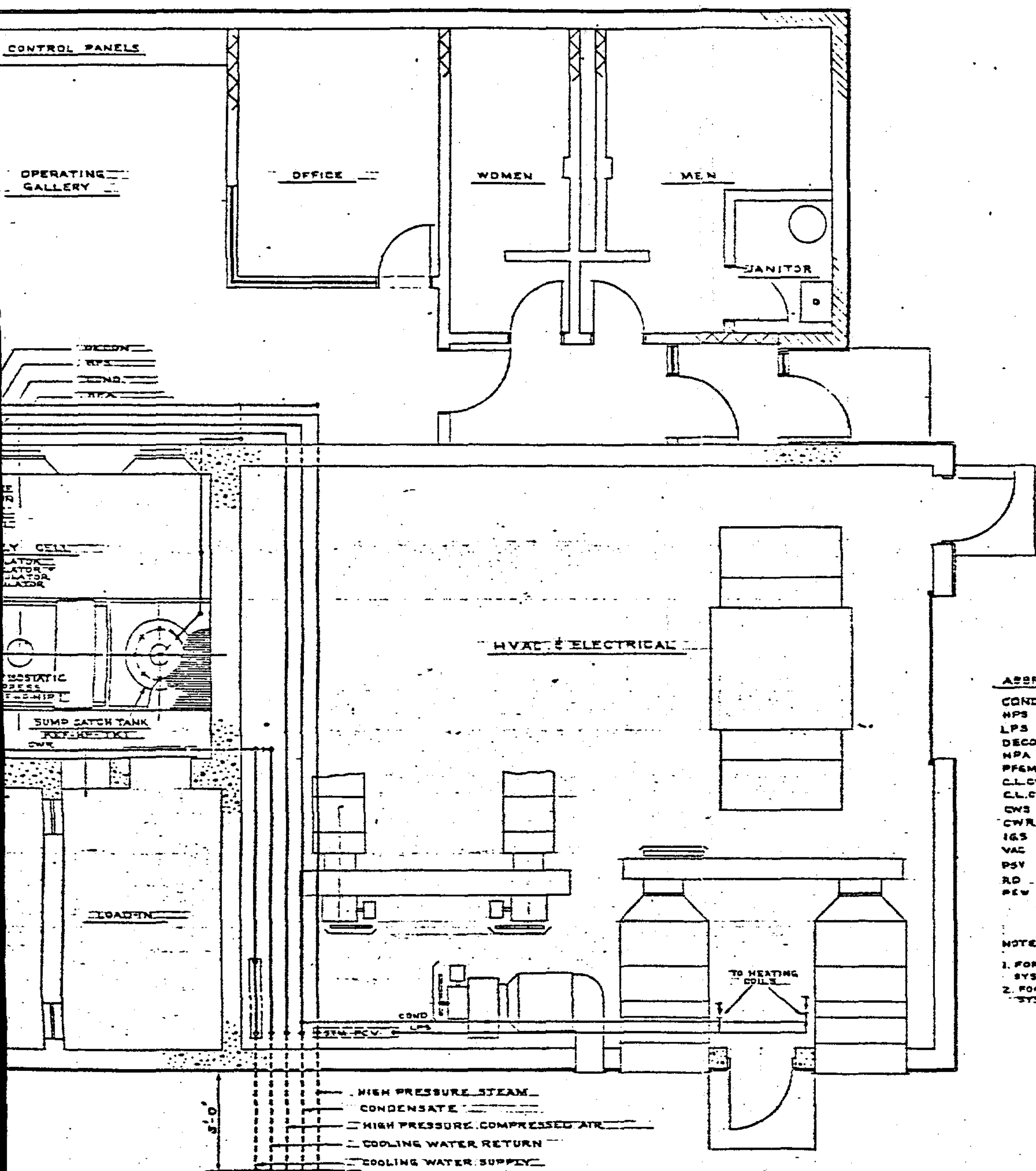
SCALE NONE

6154-3-HP-E-2

PROJECT NO. 6154-3



8
7
6
5
G
F
E
D
C
B
A
DECONTAMINATION SOLUTION MAKE-UP TANK
SUBSTRATE & CONTAINERS
DECON PUMP
HEALTH
DECON
COOLING WATER HEAT EXCHANGER
5'-0"
FOR CONT. SEE
PRESSURIZED FEED GAS MIX
FEED GAS COMPRESSOR #1
FEED GAS COMPRESSOR #2
PFEM
PRESSURIZED FEED GAS COOLER
KEF-HP-HE1
PRESSURIZED FEED GAS MIXTURE RUN TANKS
PRESSURE RELIEF ACCUMULATOR
CL WATER PUMP #2
CL WATER PUMP #1
HIP ISOSTATIC GAS COMP #2
HIP ISOSTATIC GAS COMP #1
ISOSTATIC GAS RUN TANK
KEF-HP-TK4
CWS
VAC
VACUUM PUMP
HIP KR FEED COMPRESSOR #1
HIP KR FEED COMPRESSOR #2
PRESSURIZED FEED GAS MIXTURE LAG STORAGE
KEF-HP-TK2 (8 REQ'D)
PRESSURIZED FEED GAS FILTER
KEF-HP-F1
LOAD OUT & INSPECTION
INTERIM STORAGE




## ABBREVIATIONS

| | |
|---|---|
| COND | CONDENSATE |
| HPS | HIGH PRESSURE STEAM |
| LPS | LOW PRESSURE STEAM |
| DECON | DECONTAMINATION SOLUTION |
| HPA | HIGH PRESSURE COMPRESSED AIR |
| PFGM | PRESSURIZED FEED GAS MIX |
| C.L.CWS | CLOSED LOOP COOLING WATER SUPPLY |
| C.L.CWR | CLOSED LOOP COOLING WATER RETURN |
| CWS | COOLING WATER SUPPLY (SITE) |
| CWR | COOLING WATER RETURN (SITE) |
| IGS | ISOSTATIC GAS SUPPLY |
| VAC | VACUUM |
| PSV | PRESSURE SAFETY VALVE |
| RD | RUPTURE DISC |
| PEW | PROCESS EQUIPMENT WASTE |

NOTES:

1. FOR ISOMETRICS OF PROCESS PIPING SYSTEMS SEE DWG SK-P-2
2. FOR CONTAMINATED & SANITARY WASTE SYSTEMS SEE DWG SK-P-3

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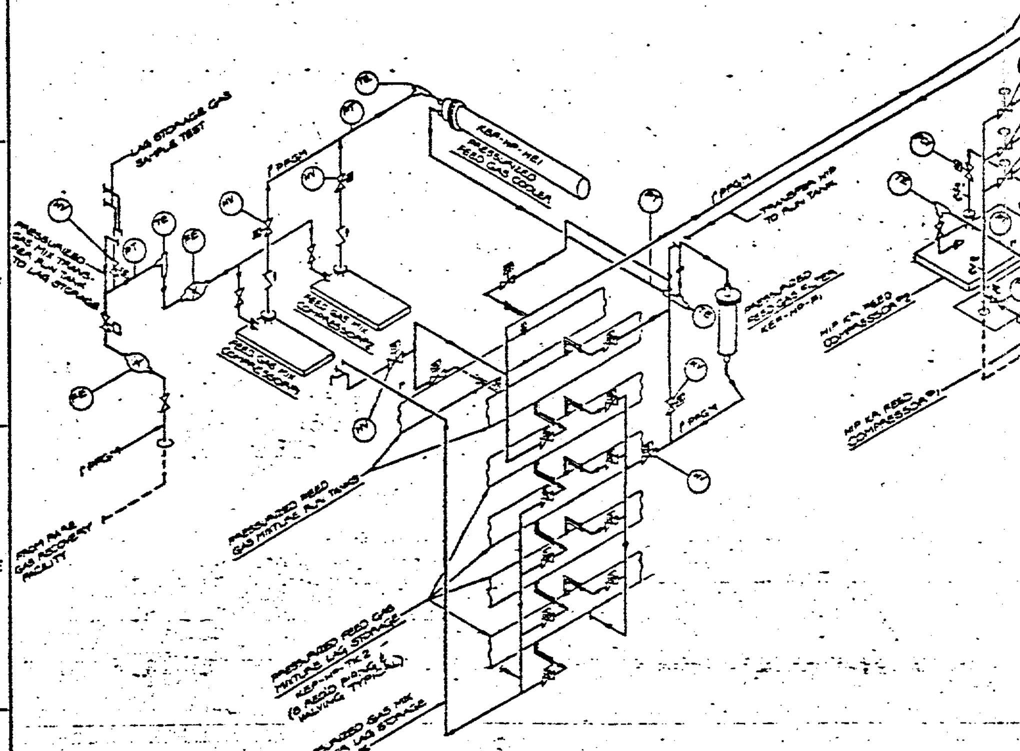
KRYPTON ENCAPSULATION PRECONCEPTUAL DESIGN

ZEOLITE ENCAPSULATION

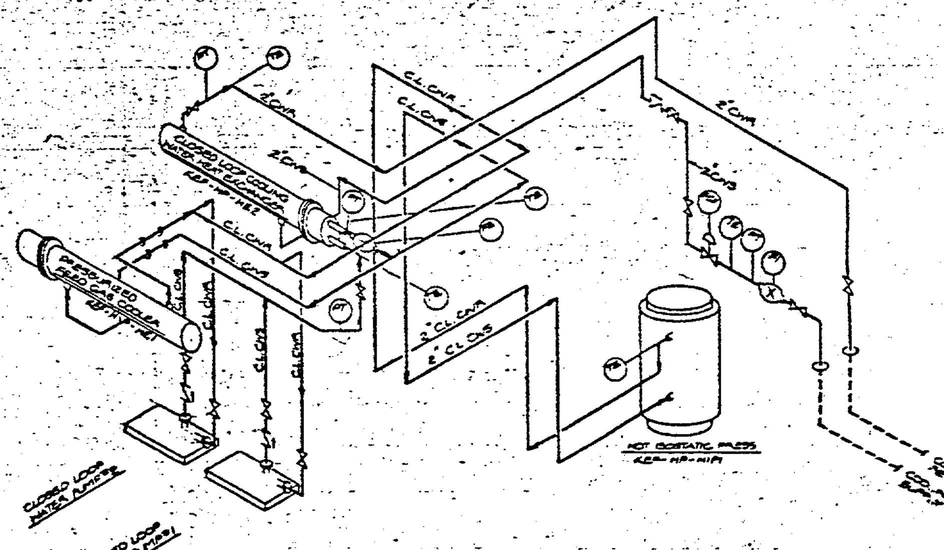
PIPING PLAN

6154-3-HP-P-4



PRESSURIZED FEED GAS MIX SYSTEM

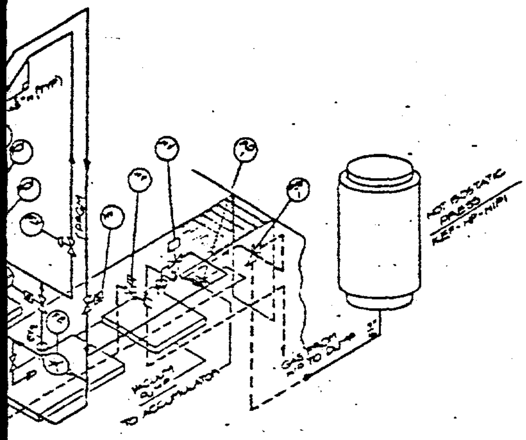
NO SCALE

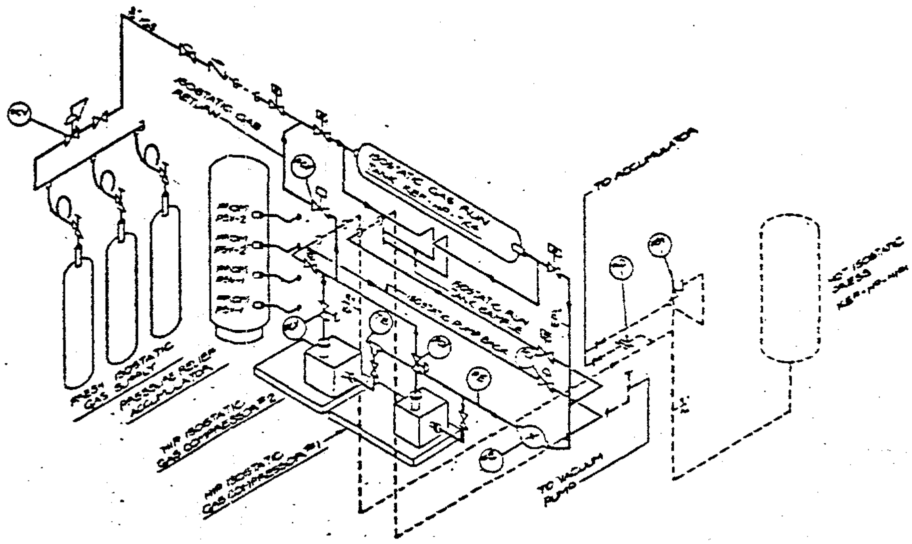


PROCESS COOLING WATER SYSTEM

NO SCALE

61

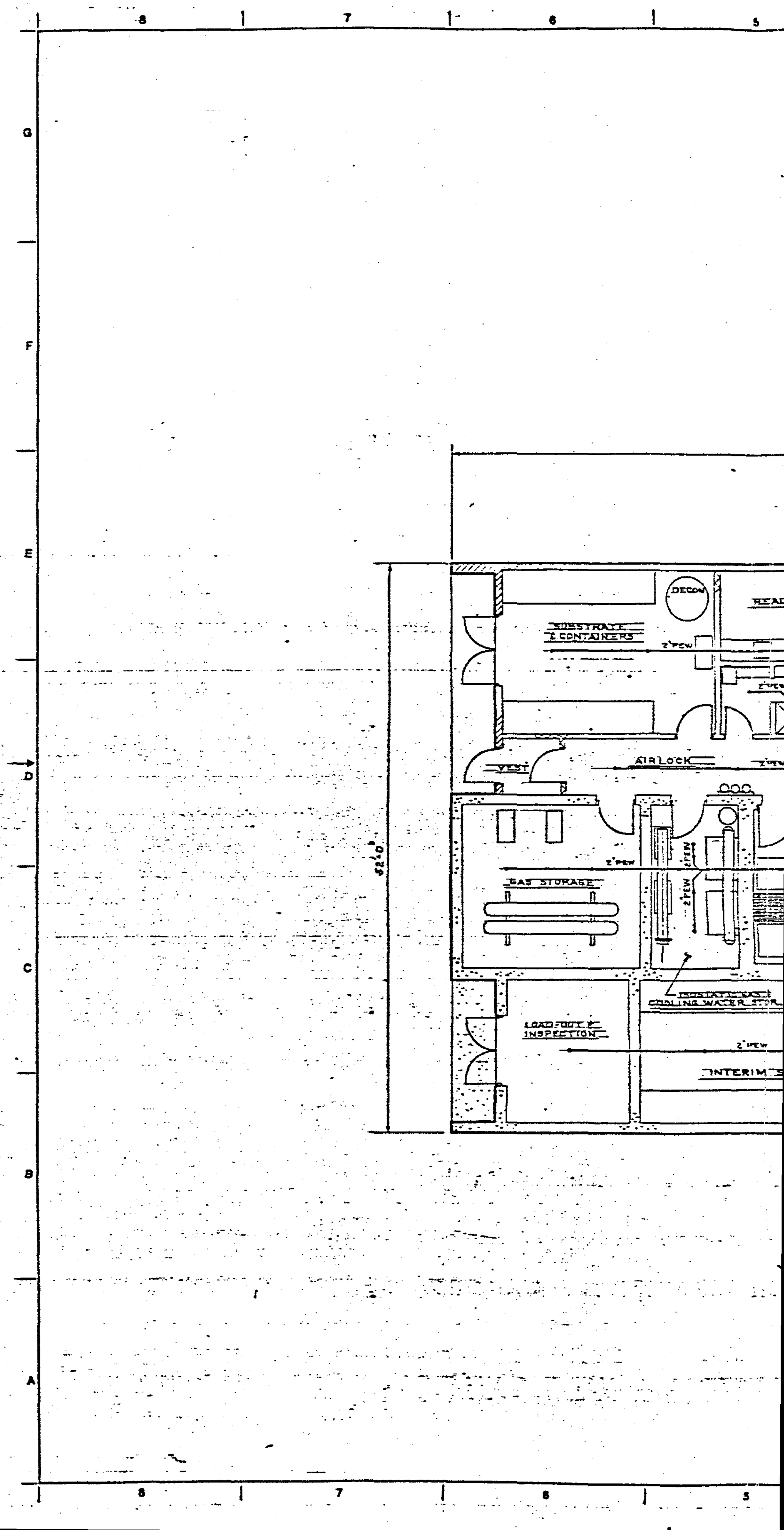


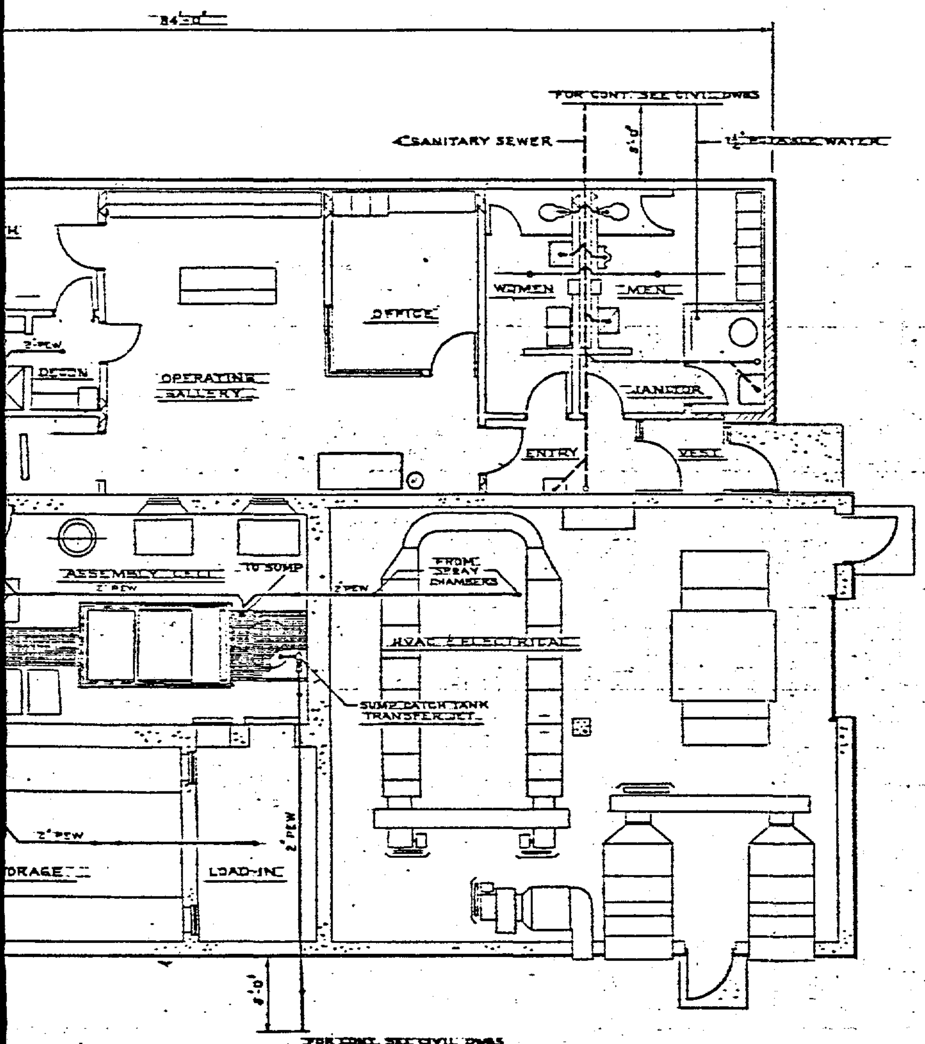

ISOSTATIC GAS SUPPLY SYSTEM

NO SCALE

| | |
|---|---|
| REVISIONS | |
| THE RALPH M. PARSONS COMPANY<br>ARCHITECTS-ENGINEERS<br>PASADENA, CALIFORNIA | |
| U.S. DEPARTMENT OF ENERGY<br>IDAHO OPERATIONS OFFICE<br>IDAHO FALLS, IDAHO | |
| KRYPTON ENCAPSULATION<br>PRECONCEPTUAL DESIGN<br>ZEOLITE ENCAPSULATION<br>ISOMETRICS | |
| INDEX CODE NUMBER | 6154-3-HP-P-5 |


DECON
SUBSTRATE & CONTAINERS
AIRLOCK
VEST
GAS STORAGE
52'-0"
COOLING WATER STOR.
LOAD-OUT & INSPECTION
INTERIM
2" PEW

62

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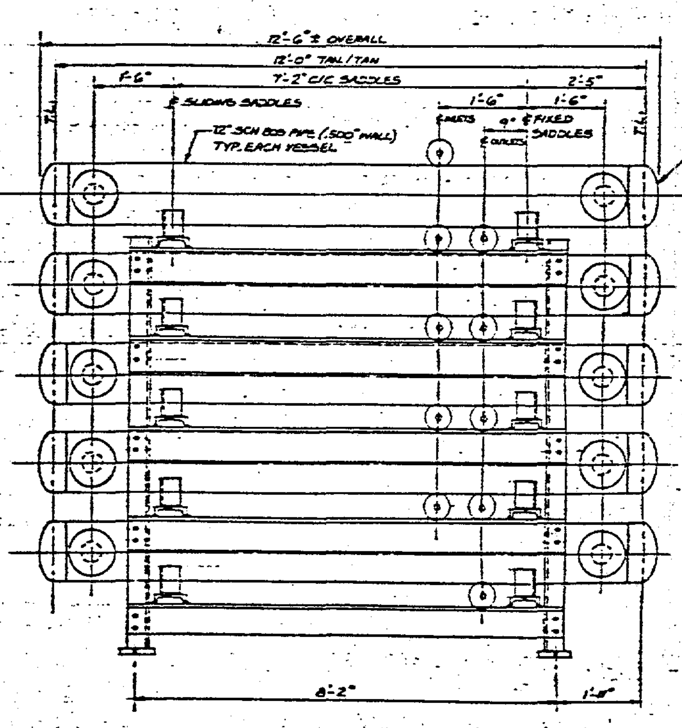
KRYPTON ENCAPSULATION
PRECONCEPTUAL DESIGN

ZEOLITE ENCAPSULATION

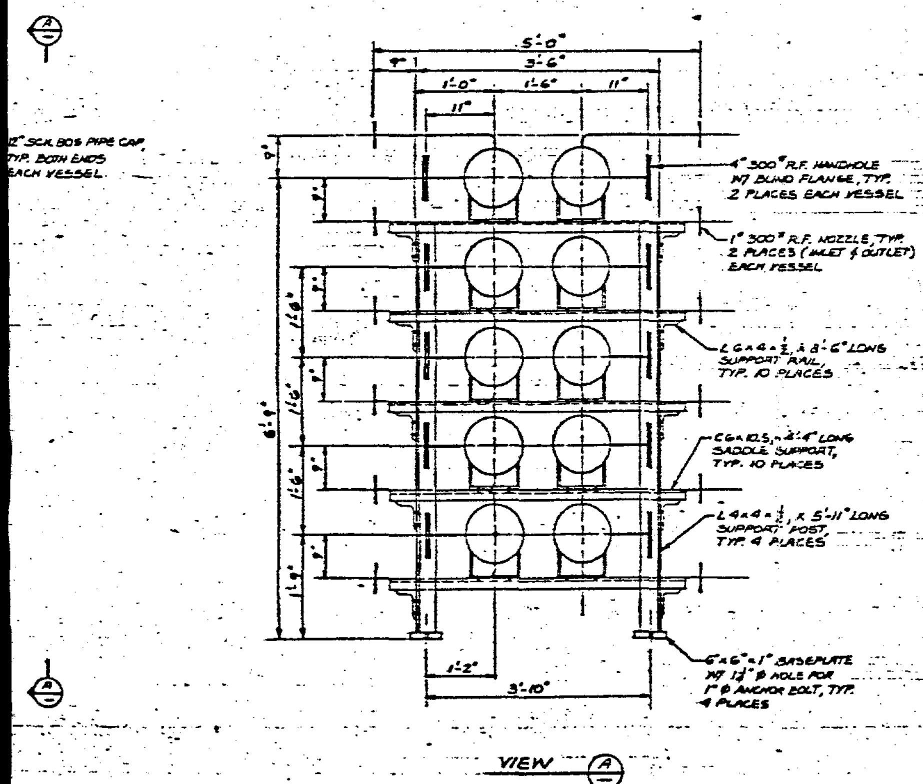
SANITARY & PROCESS DRAIN SYSTEM

6154-3-HP-P-6


12'-6" ± OVERALL
12'-0" TAN/TAN
1'-6"
7'-2" C/C SADDLES
2'-5"
℄ SLIDING SADDLES
1'-6"
1'-6"
12" SCH 80S PIPE (.500" WALL)
TYP. EACH VESSEL
9"
℄ FIXED SADDLES
8'-2"

ELEVATION

3

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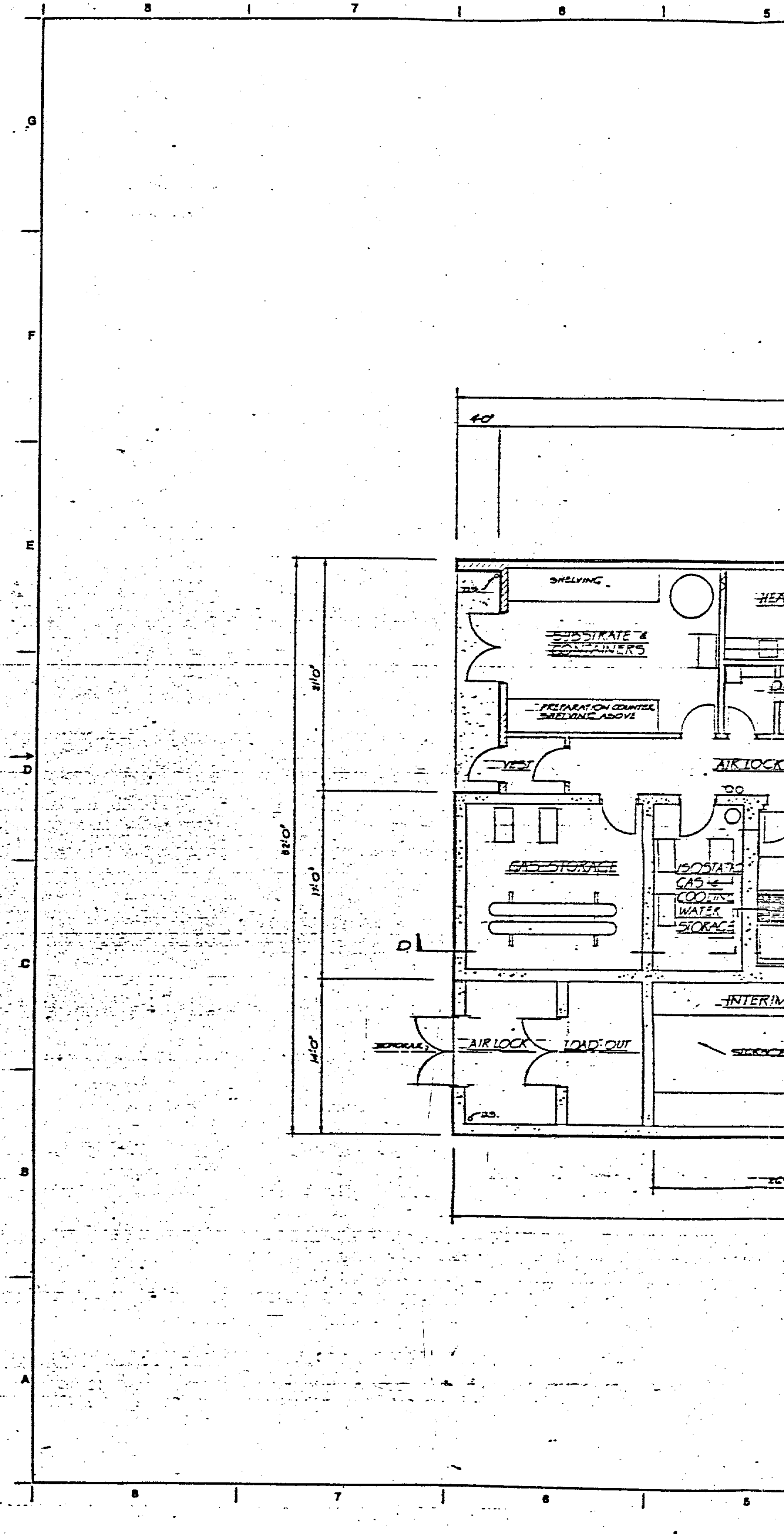
KRYPTON ENCAPSULATION PRECONCEPTUAL DESIGN

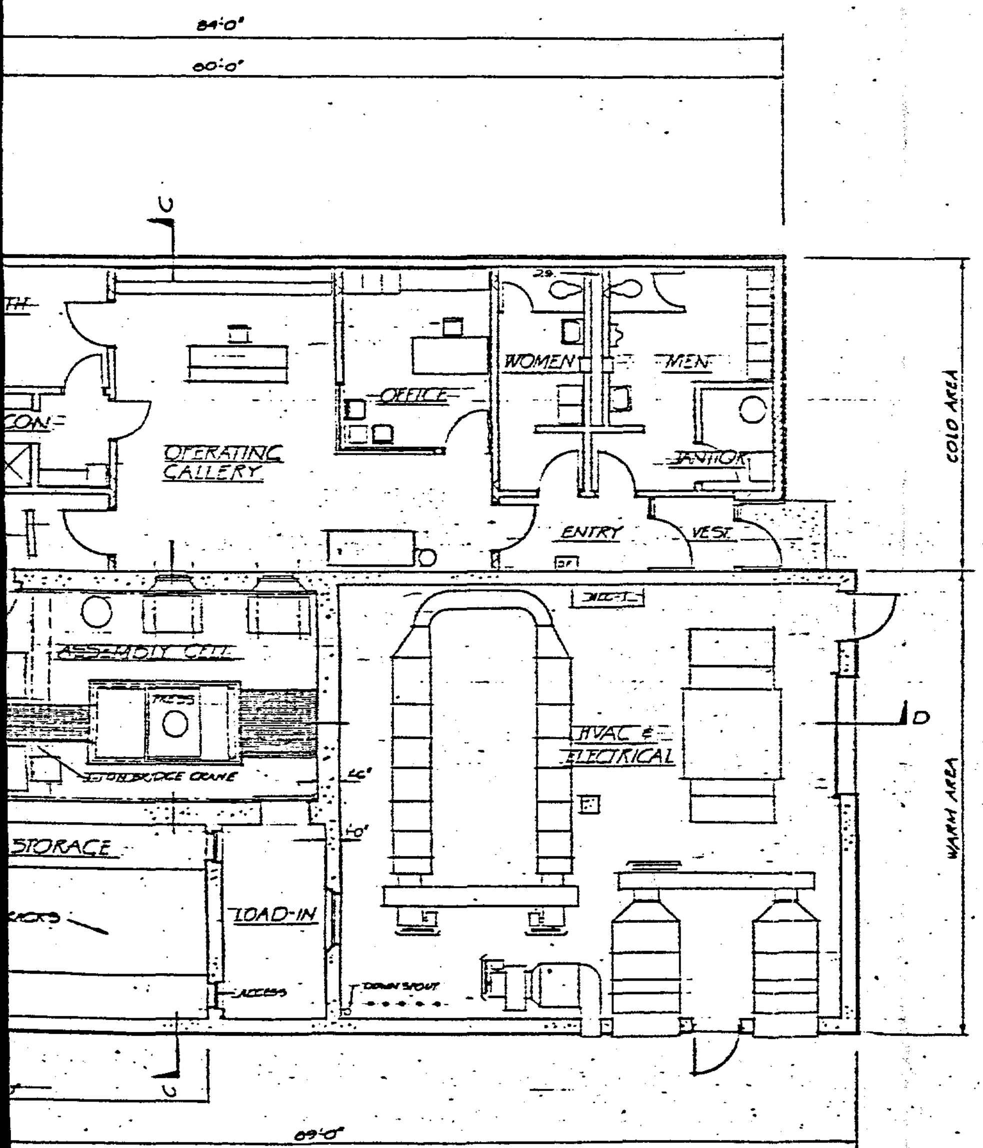
ZEOLITE ENCAPSULATION LAG STORAGE TANKS

DWG NO. G154-3-HP-P-7

PROJECT NO. G154-3


SHELVING
SUBSTRATE &
CONTAINERS
PREPARATION COUNTER,
SHELVING ABOVE
VEST
AIR LOCK
GAS STORAGE
ISOSTATS
GAS
COOLING
WATER
STORAGE
AIR LOCK
LOAD OUT
82'0"
21'0"
17'0"
14'0"
40'

64




WALL LEGEND

- REINFORCED CONCRETE
- CONCRETE BLOCK
- 3" METAL STUDS WITH 5/8" GYPSUM BOARD

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KRYPTON ENCAPSULATION
PRECONCEPTUAL DESIGN
ZEOLITE ENCAPSULATION
GROUND FLOOR PLAN

C154-3-HP-A-4

# APPENDIX B

## MAJOR EQUIPMENT LISTS

## APPENDIX B-1

## ION IMPLANTATION/SPUTTERING MAJOR EQUIPMENT LIST

| Equipment No. | Name |
|---|---|
| KEF-II-TK1 | Sump Catch Tank |
| KEF-II-TK101 | Decontamination Solution Make-Up Tank |
| KEF-II-TK2 | Pressurize Feed Gas Mixture Lag Storage Tanks (8 required) |
| KEF-II-TK3 | Pressurized Feed Gas Mixture Run Tank |
| KEF-II-TK4 | Low Pressure Feed Gas Mixture Run Tank |
| KEF-II-TK5 | Pressure Relief Accumulator |
| KEF-II-AG1 | Sump Catch Tank Agitator |
| KEF-II-AG101 | Decontamination Solution Make-Up Tank Agitator |
| KEF-II-COM1&2 | Feed Gas Compressor (2 required) |
| KEF-II-P101 | Decontamination Solution Pump |
| KEF-II-P1&2 | Closed Loop Cooling Water Pump (2 required) |
| KEF-II-VP1&2 | Sputtering Chamber Vacuum Pump (2 required) |
| KEF-II-VP3&4 | Krypton Vacuum Pump (2 required) |
| KEF-II-HE1 | Pressurized Feed Gas Cooler |
| KEF-II-HE2 | Closed Loop Cooling Water Heat Exchanger |
| KEF-II-F1 | Pressurized Feed Gas Filter |
| -- | Sump Liquid Sampler |
| -- | Sump Catch Tank Liquid Sampler |
| -- | Sump Eductor |
| -- | Sump Catch Tank Eductor |
| KEF-II-SC1-8 | Sputtering Chamber (8 required) |

APPENDIX B-1 (cont'd)

ION IMPLANTATION/SPUTTERING
MAJOR EQUIPMENT LIST

| Equipment No. | Name |
|---|---|
| -- | Mini-Trailer Robo-Carrier |
| -- | 5T/2-1/2T Bridge Crane |
| -- | Automatic Welder |
| -- | Leak Detector |
| -- | Master-Slave Manipulator (4 required) |
| -- | 2T Monorail Hoist |

# APPENDIX B-2

## ZEOLITE ENCAPSULATION MAJOR EQUIPMENT LIST

| Equipment No. | Name |
|---|---|
| KEF-HP-TK1 | Sump Catch Tank |
| KEF-HP-TK101 | Decontamination Solution Make-Up Tank |
| KEF-HP-TK2 | Pressurized Feed Gas Mixture Lag Storage Tanks (8 required) |
| KEF-HP-TK3 | Pressurized Feed Gas Mixture Run Tanks (2 required) |
| KEF-HP-TK4 | Isostatic Gas Run Tanks (2 required) |
| KEF-HP-TK102 | Isostatic Gas Supply Cylinders (3 required) |
| KEF-HP-TK5 | Pressure Relief Accumulator |
| KEF-HP-AG1 | Sump Catch Tank Agitator |
| KEF-HP-AG101 | Decontamination Solution Make-Up Tank Agitator |
| KEF-HP-COM1&2 | Feed Gas Mixture Compressors (2 required) |
| KEF-HP-COM3&4 | HIP Krypton Feed Compressor (2 required) |
| KEF-HP-COM5&6 | HIP Isostatic Gas Compressor (2 required) |
| KEF-HP-P101 | Decontamination Solution Pump |
| KEF-HP-P1&2 | Closed Loop Cooling Water Pump (2 required) |
| KEF-HP-VP1&2 | Krypton Vacuum Pump (2 required) |
| KEF-HP-VP3&4 | Helium Vacuum Pump (2 required) |
| KEF-HP-HE1 | Pressurized Feed Gas Cooler |
| KEF-HP-HE2 | Closed Loop Cooling Water Heat Exchanger |
| KEF-HP-F1 | Pressurized Feed Gas Filter |

APPENDIX B-2 (cont'd)

ZEOLITE ENCAPSULATION
MAJOR EQUIPMENT LIST

| Equipment No. | Name |
|---|---|
| -- | Sump Liquid Sampler |
| -- | Sump Catch Tank Liquid Sampler |
| -- | Sump Eductor |
| -- | Sump Catch Tank Eductor |
| KEF-HP-AF1&2 | Substrate Activation Furnace (2 required) |
| KEF-HP-HIP1 | Hot Isostatic Press |
| -- | Mini-Trailer Robo-Carrier (2 required) |
| -- | 5T/2-1/2T Bridge Crane |
| -- | Automatic Welder |
| -- | Leak Detector |
| -- | Master-Slave Manipulator (4 required) |
| -- | 2T Monorail Hoist |

# APPENDIX C

## OUTLINE SPECIFICATIONS

# APPENDIX C-1

## ION IMPLANTATION/SPUTTERING OUTLINE SPECIFICATIONS

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1.0 EARTHWORK

Earthwork shall include the removal of all vegetation, trash and debris, and excavation for foundations. Trash and debris shall be removed to a sanitary land fill. Excavated material suitable for backfilling shall be stock piled on site for later use. Cuts over 4 feet high shall be shored or have side slopes a minimum of 1-1/2 to 1. Backfilling of excavated areas shall be compacted to 95 percent of maximum dry density in accordance with ASTM D 1557, Method D.

2.0 STRUCTURAL

2.1 CONCRETE

2.1.1 Applicable Publications. Concrete shall conform to ACI-318, "Building Code Requirements for Reinforced Concrete", and to the requirements of the following publications of the American Concrete Institute. These publications will be used to the extent they are applicable:

ACI-304 "Recommended Practice for Measuring, Mixing and Placing Concrete"

ACI-305 "Recommended Practice for Hot Weather Concreting"

ACI-306 "Recommended Practice for Cold Weather Concreting"

ACI-308 "Recommended Practice for Curing Concrete"

ACI-315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures"

ACI-347 "Recommended Practice for Concrete Formwork"

2.1.2 Concrete Formwork. Forms shall be constructed to conform, within the tolerances specified, to the required shapes, dimensions, lines, elevations, and positions of the cast-in-place concrete members as indicated. Forms shall be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

2.1.3 Cast-In-Place Concrete. Concrete shall be standard density concrete (150 pounds per cubic foot) unless noted otherwise. The minimum compressive strength of concrete will be 3000 psi at 28 days. Portland Cement shall conform to ASTM C150. Reinforcing steel shall conform to ASTM A615, Grade 60. Wire mesh for slabs shall conform to ASTM A 185.

2.1.4 Grout. Grout shall be sufficiently fluid to ensure complete filling of all sections of units or areas requiring grout, but not so thin as to allow segregation of aggregate. All grouting shall be done in accordance with manufacturer's printed instructions. Grout shall be a non-shrink type.

2.2 METALS

2.2.1 Applicable Publications. The requirements of the following publications shall be used to the extent they are applicable:

American Institute of Steel Construction (AISC) "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings"

American Institute of Steel Construction (AISC) "Specification for Structural Joints Using ASTM A325 and A490 Bolts"

American Welding Society (AWS) "Structural Welding Code" (AWS D1.1)

2.2.2 Structural Steel. Structural steel shall conform to ASTM A36. Fabrication and erection shall conform to AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings".

2.2.3 Bolting. Structural steel connections shall conform to "Specification for Structural Joints Using ASTM A325 or A490 Bolts". Structural stainless steel connections shall be similar to structural steel type connections, except that the mechanical properties of the bolts, nuts, and washers shall conform to the latest revision of ASTM A193 for Class 2, Grade B8, Type 304.

2.2.4 Welding. E308L electrode series shall be used to weld 304L stainless steel. Welding shall conform to the AWS Structural Welding Code, AWS D1.1, for carbon steel, to the ASME Boiler and Pressure Vessel Code for stainless steel, and to the requirements of the latest revisions of the following publications to the extent they are applicable:

"Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes", AWS A5.9

"Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes", AWS A5.9

"Specification for Flux-Cored Corrosion-Resisting Chromium and Chromium-Nickel Steel Electrodes", AWS A5.22

"Specification for Aluminum and Alumionum Alloy Welding Rods and Bare Electrodes", AWS A5.10

2.2.5 Masonry. Masonry units shall conform to ASTM C90, Grade N, Type I for 8 inch or 12 inch block. Reinforcing steel for masonry construction shall conform to ASTM A615, Grade 60 for deformed billet steel bars.

## 3.0 ARCHITECTURAL

### 3.1 WOODS AND PLASTICS

#### 3.1.1 Rough Carpentry

Rough carpentry shall be nailers, blocking, striping, and miscellaneous. Any member in contact with concrete or masonry shall be pressure preservative treated.

#### 3.1.2 Finish Carpentry

Finish carpentry shall be bult-in wood shelving, cabinets, hardwood shower seats, etc.

### 3.2 THERMAL AND MOISTURE PROTECTION

#### 3.2.1 Preformed Metal Siding

Ribbed siding panels, 22 gauge, lap type joint with insulation.

#### 3.2.2 Building Insulation

Building insulation shall be U.L. listed with flame spread under 25 and smoke developed and fuel contributed under 50. Insulation shall be in thicknesses as indicated on the drawings.

#### 3.2.3 Inverted Roof System

Dow Chemical Co., 3-1/2 inch thick styrofoam RM brand insulation shall be placed directly over the roofing membrane.

a. Built up Roofing

Roofing shall be 3-ply, 20 year bondable type, applied directly over substrate, John-Mansville or equal.

b. Polyester Formed Fabric

Dow Chemical Co. approved fabric shall be placed loosely over the insulation.

c. Crushed Stone

A crushed stone ballast of 1-1/2 inch shall be placed over the polyester formed fabric. Stone top covering shall be 3/4 inch to 1 inch in diameter.

3.2.4 Sheet Metal

Parapet flashing, counter flashing, base flashing, and flashing at roof penetrations shall be 24 and 22 Ga galvanized steel.

3.2.5 Sealants and Caulking

Sealants and caulking shall be silicone, polysulphide or polyurethane base, non-saf, gun-approved as pourable, selected as best suitable for applicable conditions.

3.3 DOORS AND WINDOWS

3.3.1 Metal Doors and Frames

Doors and frames shall be standard commercial type, conforming to the Steel Door Institute (SDI) standards as follows:

Doors: Flush panel, seamless; interior doors 18 gauge; exterior doors 16 gauge, galvanized.

Frames: Full welded or knock down construction; interior frames 16 gauge: exterior doors 14 gauge, galvanized.

Fire rated doors and frames, where required, shall conform to the requirements of U.L. and shall bear the appropriate label. All interior doors shall have 6 inch x 2 foot wire glass vision lites except doors leading to toilets, lockers and janitor rooms.

Explosion proof doors shall be able to withstand 1-PSI.

3.3.2 Finish Hardware

Finish hardware shall include mortise-type latchsets, locksets, exit devices, hinges, closers, thresholds, flushbolts, pulls, push/kick plates, door holders, and shall be heavy duty as manufactured by Sargent and Co. or equal. Exposed surfaces of hardware shall have a satin finish or as selected. All building exits shall be provided with panic exit devices.

3.4 FINISHES

3.4.1 Metal Studs

Except as otherwise noted all metal studs shall be 4 inches x 20 gauge, non-bearing screwable type, punched for utility lines, complete with top and bottom runners.

3.4.2 Gypsum Board

Gypsum board shall be 5/8 inch thick tapered edge throughout. Water resistant gypsum board shall be used in toilet rooms and janitors room. Type "X" shall be used in 1-hour fire rated areas.

3.4.3 Ceramic Tile

Ceramic tile work shall include regular Portland cement sitting beds and ceramic tile floors, wainscots and walls. Tilework and installation shall conform to the American National Standards Institute (ANSI) and the Tile Council of America (TCA).

3.4.4 Acoustical Ceilings

Acoustical ceilings shall be suspended exposed metal "T" grid system with lay-in acoustical units. Exposed "T" members shall be aluminum or steel with applied matte white enamel finish. Acoustical units shall be 24 inches x 48 inches x 5/8 inches. Acoustical material shall be U.L. listed with flame spread under 25 and smoke developed and fuel contributed under 50.

3.4.5 Cement Plaster

Cement plaster shall be installed on metal lath and steel framing on walls and ceilings where scheduled, including all necessary trim and accessories.

3.4.6 Resilient Flooring

a. Floor coverings in the Decon area, air lock and gallery shall be 200 vinyl chloride, 2 mm thick flooring as distributed by Dynamit Nobel of America Inc., or approved equal. Material shall be manufactured as a homogenous polyvinyl chloride with the pattern and color extending through the butt thickness and shall conform to Federal Specifications SS-T-312, L-F475, and ASTM E84. Material shall have chemical resistance to acids, bases, dye stuffs, and solvents and shall be noncombustible or self-extinguishing. Installation shall be made as a monolithic, seamless floor by heat welding and fusion, or by butt welding edges of material sheets together. Flooring shall be butt welded directly to 6" high Mipolam flexible vinyl cove.

b. All other areas such as offices and hallways shall have vinyl asbestos tile flooring as manufactured by Armstrong Cork Co. or equal. The tiles shall be 12 inches x 12 inches x 1/8 inch commercial quality. The base shall be four inches high top set vinyl cove base with pre-formed internal and external corners.

### 3.4.7 Painting

Except as excluded herein, all surfaces of new work shall be properly prepared, primed, and finished, including walls, ceilings, miscellaneous exposed materials, equipment, piping, hangers, conduits, grilles, etc., which normally require painting.

The following items shall not be painted:

- Surfaces receiving a special protective coating
- Concrete floors
- Anodized aluminum, chromed, or stainless metals
- Factory-finished items and equipment

The following items shall be primed or shop-coated prior to delivery to job site:

- Metal doors and frames
- Structural steel
- Miscellaneous metal work

Paints, primers, and finishes shall be ready-mixed and equal to first-line products as manufactured by:

Devoe and Reynolds, Inc.
Pratt and Lambert, Inc.
E. I. DuPont de Nemours and Co.
Rust-Oleum Corporation
Glidden Company
Benjamin Moore and Co.

a. Painting Schedule. All painting shall be two coats applied over a primer coat. The primer coat shall be appropriate for the surfaces to be painted and compatible with the types of finish coat used.

b. Interior Surfaces

| Surface | Finish |
|---|---|
| Concrete | 1 coat masonry flock filler<br>2 coats interior alkyd semigloss enamel |
| Galvanized Metal | 1 coat zinc dust-zinc oxide primer<br>1 coat interior enamel undercoat<br>1 coat interior alkyd semigloss enamel |

| | |
|---|---|
| Ferrous Metal | 1 coat zinc, iron oxide, alkyd resin-type metal primer<br>1 coat enamel undercoat<br>1 coat alkyd semigloss enamel |

c. Exterior Surfaces

| Surface | Finish |
|---|---|
| Ferrous Metal | 1 coat alkyd-oil resin-type metal primer<br>2 coats semigloss enamel |
| Galvanized Metal | 1 coat zinc dust-zinc oxide primer<br>2 coats semigloss enamel |

3.4.8 Special Coatings

Special coatings shall be Ameron system decontaminable special protective coating for floors, walls, and ceilings, or equal.

Concrete floors:

| | |
|---|---|
| Prime sealer | Nu-Klad 108 |
| Intermediate coat | Amercoat 66 |
| Top coat | Amercoat 66 (2 coats) |

Concrete Walls:

| | |
|---|---|
| Prime sealer | Nu-Klad 108 |
| Filler | Nu-Klad 114 |
| Intermediate coat | Amercoat 66 |
| Top coat | Seal gloss Amercoat 66 |

Structural Steel, Decking, Carbon Steel Doors and Frames:

| | |
|---|---|
| Primer | Amercoat 77 |
| Cleaner (for galvanized) | Galvaprep |
| Intermdiate coat | Amercoat 66 |
| Top coat | Amercoat 66 |

Protective Coating for Stainless Steel Embedded in Concrete:

| | |
|---|---|
| Double coating | Thurmalox 70 |

## 3.5 SPECIALTIES

### 3.5.1 Metal Toilet Partitions

Ceiling hung toilet partitions and wall hung urinal screen shall be products of Sanymetal Products or equal, "Century Type" with a baked enamel finish.

### 3.5.2 Toilet Accessories

Toilet accessories shall be products of Bobrick Washroom Equipment Co., or equal, including:

a. Mirror
b. Soap dispenser
c. Towel dispenser and waste receptacle
d. Sanitary napkin dispenser
e. Toilet tissue dispenser
f. Seat cover dispenser

### 3.5.3 Louvers

Louvers shall be products of Construction Specialties, Inc., or equal, mullion type louvers Model 4100 standard blade or as applicable and shall be constructed of extruded aluminum, 6063-T52 alloy, furnished with 1/2 inch mesh birdscreen.

### 3.5.4 Signs and Directories

Signs shall be products of Vomar Products, Inc., or equal.

### 3.5.5 Lockers and Benches

Lockers and benches shall be the products of Lyon Metal Products, or equal.

a. Lockers. Lockers shall be single tier-type, 12 inches wide, 18 inches deep, 72 inches high with baked enamel finish. Lockers shall be curb mounted.

b. Benches. Benches shall be constructed of hardwood seats, finished with three coats of plastic sealer mounted on enameled steel pedestals.

# 4.0 EQUIPMENT

## 4.1 PROCESS EQUIPMENT

### 4.1.1 Sump Catch Tank

Equipment No. KEF-II-TK1. 42 in. diameter by 6 ft.-6 in. tall, constructed of ASME SA-240 Grade 304L stainless steel. Design and fabrication per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 at 15 PSIG and 100°F. Capacity shall be 500 gallons. Equipped with an electric motor driven agitator (Equip. No. KEF-II-AG1) and an internal spray header for decontamination solutions with inlet, outlet, vent, and instrumentation connections and agitator mount.

### 4.1.2 Decontamination Solution Make-Up Tank

Equipment No. KEF-II-TK101. 42 in. diameter by 4 ft.-0 in. tall, constructed of ASME SA-240 Grade 304L stainless steel. Design and fabrication per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 at 15 PSIG and 200°F. Capacity shall be 300 gallons. Equipped with an electric motor driven agitator (Equip. No. KEF-II-AG101) and a steam heating coil with inlet, outlet, vent, and instrumentation connections and agitator mount.

### 4.1.3 Pressurized Feed Gas Mixture Lag Storage Vessels, Pressurized Feed Gas Mixture Run Tank, Low Pressure Feed Gas Mixture Run Tank

Equipment No. KEF-II-TK2 (eight required), KEF-II-TK3 (one required), and KEF-II-TK4 (one required). 12 in. nominal diameter pipe (Sch. 80S) by 12 ft.-0 in. long, constructed of ASME SA-312 Grade TP316L stainless steel. Design and fabrication per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 at 1270 PSIG and 300°F. Capacity shall be 9.5 cubic feet. Equipped with inlet, outlet, and instrumentation connections. The ten vessels shall be stacked two wide by five high in a structural steel frame as shown on Drawing No. P-6.

### 4.1.4 Pressure Relief Accumulator

Equipment No. KEF-II-TK5. 18 in. nominal diameter pipe (Sch. 40S) by 4 ft.-6 in. long, constructed of ASME SA-312 Grade TP316L stainless steel. Design and fabrication per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 at 500 PSIG and 200°F. Capacity shall be 8 cubic feet. Equipped with inlet, outlet, and instrumentation connections.

### 4.1.5 Feed Gas Mixture Compressor

Equipment No. KEF-II-COM1&2 (two required). Single stage, diaphragm type with hydraulic fluid providing the pulsating motion to compress Krypton-85 gas from an inlet pressure of 340 psig at 70°F, to a discharge pressure of 500 psig. Compressor displacement shall be 1 CFM at 400 rpm. A triple diaphragm shall be used with a detection system to indicate either compressed gas or hydraulic fluid leakage through the diaphragm. Parts in contact with krypton shall be Type 316 stainless steel, other parts may be manufacturer's standard for the application. The compressor shall be electric motor belt driven. Maximum compressor speed shall be 400 rpm, electric motor speed shall be 1800 rpm. The electric motor shall be 460V, 3 phase, 60 Hertz. Each compressor and drive shall be assembled and mounted on a structural frame.

4.1.6 Decontamination Solution Pump

Equipment No. KEF-II-P101. Centrifugal, horizontal, electric motor driven pump. Motor speed shall be 1800 rpm. Parts in contact with decontamination solutions shall be Type 316 stainless steel. Pump capacity shall be 50 gpm with 40 feet TDH.

4.1.7 Closed Loop Cooling Water Pump

Equipment No. KEF-II-P1&2 (two required). Centrifugal, horizontal, electric motor driven pump. Motor speed shall be 1800 rpm. Pump material shall be ductile iron. Pump capacity shall be 100 gpm with 60 feet TDH.

4.1.8 Krypton Vacuum Pump

Equipment No. KEF-II-VP1&2 (two required). Cam and piston, compound vacuum pump, capable of displacing 3 CFM minimum at $10^{-2}$ Torr. Metals in contact with the process shall be Type 316 stainless steel. Other materials in contact with the process shall be compatible with Krypton-85. Pump shall be motor driven, single or three phase, 230/460V, 60 hertz. Maximum motor speed shall be 1800 rpm.

4.1.9 Pressurized Feed Gas Cooler

Equipment No. KEF-II-HE1. Shell and tube type heat exchanger with 20,000 BTU/hr. duty. Materials is contact with krypton gas shall be Type 316 stainless steel, other materials may be carbon steel. Design and fabrication per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, and TEMA R requirements. Design pressure for gas side shall be 600 PSIG, with 200°F inlet temperature and 110°F maximum outlet temperature. Design pressure for water side shall be 100 PSIG, with 95°F inlet temperature.

4.1.10 Closed Loop Cooling Water Heat Exchanger

Equipment No. KEF-II-HE2. Shell and tube type heat exchanger with 2,000,000 BTU/hr. duty. Materials shall be carbon steel with admiralty tubes. Design and fabrication per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, and TEMA R requirements. Design pressure shall be 100 PSIG, with closed loop water inlet temperature 130°F and outlet temperature 95°F, and cooling water inlet temperature 85°F.

4.1.11 Pressurized Feed Gas Filter

Equipment No. KEF-II-F1. Inlet filter with removable sintered metal element. Filter rating shall be 2 micron with 2 CFM flow and 500 PSIG pressure, with no more than 10 PSI pressure drop. Materials in contact with Krypton-85 shall be Type 316 stainless steel.

4.1.12 Sump Liquid Sampler
Sump Cath Tank Liquid Sampler

Manually initiated, isolating, plunger type, air powered, solenoid valve actuated liquid sampler.

4.1.13 Sump Eductor
Sump Catch Tank Eductor

Air or steam operated liquid eductor, 30 gpm transfer rate, Type 304L stainless steel.

4.1.14 Sputtering Heads

(Eight required). Pedestal mounted vertical connector assembly, in groups of four, with guide pins, remotely operated, insulated connectors for target, substrate, filament, and anode power, target and jacket cooling water supply and return, and gas and air supply, constructed of Type 316 stainless steel.

4.1.15 Shielded Cooling Jackets

(Eight required). Lead and Type 316 stainless steel-clad cooling jacket assembly with guide pins, guide holes, and seals to mate with target/substrate assembly and with sputtering head, and with insulated connections for cooling water supply and return.

4.2 MECHANICAL EQUIPMENT

4.2.1 Mini-Trailer Robo-Carrier

(2 required). Remotely operated, automatically controlled electric cart and platform lift assembly, with vertical and horizontal canister cradles, with pneumatic push/pull piston, and with pre-programmed positioning capability.

4.2.2 In-Cell Bridge Crane

Remotely operated bridge crane with 12-ft. 0-in. span and 5-ton top mounted trolley and hoist, and with two 1/2-ton underslung auxiliary trollies and hoist, as manufactured by Edder Corp. or Approved Equal.

#### 4.2.3 Remote Welder

Fully remote automatic welding station as manufactured by Astro-Arc or Dimetrics Corporation or Approved Equal.

#### 4.2.4 Leak Detection System

Fully remote automatic leak detection system with automatically calibrated helium detector.

#### 4.2.5 Master-Slave Manipulators

(Four required). Model "F" type master-slave manipulators, for assistance and maintenance of automatic welder and remote leak detection system, as manufactured by Central Research or Approved Equal.

## 5.0 HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS

### 5.1 SUPPLY FANS

Supply fans shall be single-width, single-inlet, non-overloading centrifugal type with airfoil blades, V-belt drive and TEFC motors, AMCA Class II construction, and variable inlet vortex vane damper capacity control. Capacity shall be 5000 cfm at 3-inches wg static pressure and 5-hp. Fans shall be Buffalo Forge Co. type BL-Aerofoil, size 400, or Approved Equal.

### 5.2 EXHAUST FANS

Exhaust fans shall be designed and constructed to operate continuously prior to, after, but not necessarily during an Operating Basis Earthquake (OBE). Fans shall be single-width, single-inlet non-loading centrifugal type with airfoil blades, V-belt drive and TEFC motors, AMCA Class III construction, and variable inlet vortex vane damper capacity control. Capacity shall be 5000 cfm at 10-inches wg static pressure and 15 hp. Fans shall be Buffalo Forge Co. type BL-Aerofoil, size 365, or Approved Equal.

### 5.3 VENT FANS

Vent fans shall be tubular in-line flow type having an airfoil centrifugal wheel. The fans shall be V-belt driven by a TEFC motor mounted on the tubular fan housing. Capacity shall be 18000 cfm at 1.0-inches wg static pressure and 15 hp. One of the fans shall be provided with variable inlet vortex vane damper capacity control. Fans shall be New York Blower Co. Tubular Acoustafoil type, size T-309, or Approved Equal.

### 5.4 POWER ROOF VENTILATORS

Power roof ventilators shall be low silhouette, all aluminum construction, spun housing type. Fans shall be centrifugal type with direct drive. Capacity shall be 150 cfm at 0.38 inches wg static pressure.

5.5 PREHEAT COILS

Preheat coils shall be 2-row, non-freeze, finned tube, low pressure steam type. Coil capacity shall be 5000 cfm and 315,000 Btu/hr at 15 psig steam pressure, with -20°F entering and +40°F leaving air temperatures.

5.6 HEATING COILS

Heating coils shall be 1-row, finned tube type designed for modulating control with steam at 15 psig pressure.

5.6.1 Contaminated Areas

Heating coil serving the Load-out, Gas Storage, and Substrate areas shall have a capacity of 550 cfm and 25,000 Btu/hr with +40°F entering and 90°F leaving air temperatures. Coil face area shall be 1.0 square feet.

Heating coil serving the Process Cell shall have a capacity of 3150 cfm and 85,000 Btu/hr with $+40_{0}F$ entering and 70°F leaving air temperatures. Coil face area shall be 5.0 square feet.

5.6.2 Non-Contaminated Areas

Heating coil serving the Office, Health/Physics, Operating Gallery, and Vestibule shall have a capacity of 1170 cfm and 53,000 Btu/hr with +40°F entering and +90°F leaving air temperature. Coil face area shall be 2.0 square feet.

5.7 COOLING COIL

Cooling coil shall be finned tube type for direct expansion refrigerant service. Coil shall be provided with a liquid refrigerant distributor. Coil capacity shall be 1170 cfm and 30,000 Btu/hr. Coil shall have a face area of 2.5 square feet and be six rows deep.

5.8 SUPPLY AIR FILTER BOXES

Supply air filter boxes shall be the side loading type containing a guide track for prefilters and a separate guide track for high efficiency filters. Prefilters shall have an efficiency of 30% per ASHRAE Standard 52-76. High efficiency filters shall have an efficiency of 90% per ASHRAE Standard 52-76. Filter boxes shall be Farr Co. side loading model 3P Universal Glide/Pack with type 30/30 prefilters and type HP-200 high efficiency filters, or Approved Equal. Filter box capacity shall be 5000 cfm and shall have 4-24" x 24" x 4" prefilters and 4-24" x 24" x 12" high efficiency filters.

5.9 EXHAUST AIR HEPA FILTER PLENUMS

Filter plenums shall contain two stages of side loading, bag-out HEPA filters and provisions for remote in-place DOP testing of each HEPA filter. Filter plenums and filters shall be as manufactured by Flanders Filter, Inc. Each plenum shall consist of the following:

1) Upstream first test section, T-I, including DOP injection port, DOP diffusers, and upstream challenge aerosol concentration sample port.

2) First stage of HEPA filters in a model E-4, side loading, bag-out housing.

3) Center combination test section, T-C, including DOP injection port, DOP diffusers, and sample port for measuring first stage downstream sample concentration or second stage upstream sample concentration.

4) Second stage of HEPA filters in a model E-4, side loading bag-out housing.

5) Last test section, T-O, including DOP diffusers and sample port for measuring second stage downstream concentration.

Capacity of each filter plenum shall be 6000 cfm. Each filter shall be 24" x 24" x 11-1/2" and arranged in the plenum 2-wide by 3-high.

5.10 SPRAY COOLING CHAMBER

A spray water chamber shall be provided upstream of each exhaust air HEPA filter plenum. Each spray chamber shall be of stainless steel all welded construction. One bank of spray nozzles shall be provided together with moisture eliminators, and drain sump. Capacity shall be 5000 cfm with a face area of 10 square feet.

5.11 UNIT HEATERS

Unit heaters shall be horizontal suspended type with steam heating coil, propeller fan, and adjustable discharge air louvers. Capacity shall be 50,000 Btu/hr with 15 psig steam pressure. Unit heaters shall be Trane Co. model 60-S, or approved equal.

5.12 AIR COOLED CONDENSING UNIT

Air cooled condensing unit shall be for split system service and shall include an air cooled condenser, hermetic refrigerant compressor, and automatic control system. The unit shall have a capacity of 30,000 Btu/hr with 95°F ambient air. Unit shall be Carrier Corp. model 38GS042, or approved equal.

## 6.0 PLUMBING

### 6.1 SCOPE OF WORK

The Contractor shall provide all labor, materials, equipment, and tools necessary for the installation of interior plumbing piping, plumbing fixtures, and plumbing piping extending out to 5 ft from the building where a break is made between plumbing and exterior sewage, drainage, and water piping materials.

The work shall include, but shall not be limited to the following:

#### 6.1.1 System

Furnishing and installing a complete plumbing system consisting of soil, waste and vent lines and hot and cold water distribution.

#### 6.1.2 Fixtures, Trim, and Accessories

Furnishing and installing plumbing fixtures, trim and accessories.

#### 6.1.3 Sewer and Water Lines

Furnishing and installing sewer and water lines from building to 5 ft-0 in. outside of building.

#### 6.1.4 Flashing

Furnishing and installing flashing and counterflashing for items of this system.

### 6.2 MATERIALS OF CONSTRUCTION

#### 6.2.1 Waste and Vent

Above ground 1-1/2 in. and smaller shall be Schedule 40 galvanized steel pipe with coated cast iron drainage type screwed fittings. 2 in. and larger shall be service weight cast iron soil pipe and fittings (Bell and Spigot Type or No-Hub).

#### 6.2.2 Sewer

Below grade or slab shall be Bell and Spigot service weight cast iron soil pipe with neoprene compression gaskets to ASTM C 564. Above grade shall be standard weight cast iron Bell & Spigot or No-Hub.

6.2.3 Domestic Hot and Cold Water Piping

Materials shall be Schedule 40 galvanized carbon steel pipe and fittings to ASTM A 120 with 300 lb rating. Hot water piping shall be insulated.

6.2.4 Steel Pipe Unions

Galvanized 300 lb malleable iron, railroad ground joint type.

6.2.5 Valves

Valves shall be gate valves 150 lb. Screwed bronze ISRS, Crane No. 431 or Approved Equal, or ball valves 300 lb. Screwed brass with TFE seals, Pacific No. 1-B or Approved Equal.

6.2.6 Partition Stops

Repcal B98 or Approved Equal, loose key type, hose bibb, with flange.

6.2.7 Strainer

Sporlan or Approved Equal.

6.2.8 Sleeves

Sleeves shall be of 24 gauge galvanized iron or steel, for use wherever pipes pass through concrete floors and foundations.

6.3 PLUMBING FIXTURES

6.3.1 Water Closet. American Standard No. 2502.011 white vitreous china, siphon jet wall hung, Sloan Royal No. 110 flush valve, white open front seat less cover. J. R. Smith No. 100 carrier.

6.3.2 Urinal (Mark - UR). American Standard No. 6500.011 white vitreous china, wall hung, Sloan Royal NO. 186-11 flush valve with 1-1/4 in. top spud, wall and spud flanges, vacuum breaker, with adjustable floor support.

6.3.3 Lavatory (Mark - L-1). American Standard No. 0350.132 20 by 18, wall hung, white vitreous china, No. 2248.284 faucet with pop-up drain, No. 2303.063 loose key angle stop supply pipes, No. 4401.014 adjustable P-Trap. Adjustable type concealed lavatory, floor support carrier, with four point locking.

6.3.4 Shower (SH). Sloan Royal No. AC-10 Ac-to-matic with 3 gpm flow control. Stainless steel, built-in mixing valve with 1/2 in. inlet ports.

6.3.5 Floor drain (FD-1). Josam 30000A cast iron body, nickel bronze strainer.

6.3.6 Roof Drain (RD). Josam 21000 Series, large dome, bottom outlet with standard clamp ring and gravel stop, gasket, dome, and body and to include deck clamp, drain receiver, and stationary extension collar.

6.3.7 Overflow Drain (OD). Josam 21000-16 Series, large dome, bottom outlet with standard clamp ring and gravel stop, gasket, dome, and body and to include deck clamp, drain receiver, and stationary extension collar.

6.3.8 Cleanouts (types)

(1) Ordinary: Zurn A-1305

(2) Floor Type: Zurn Z-1326-1 or Z-1326-10, for setting with top flush and square with floor.

(3) Wall Type: Zurn with Z-1310 chrome plated cover plate.

6.3.9 Water Hammer Arresters (WHA). Water hammer arresters shall be Zurn Shocktrol 1700 Series, Smith 5000 Series, or Approved Equal.

6.3.10 Roof Drainage. Piping for the roof drainage system will be carbon steel, hot-dipped galvanized, ASTM A53, Gr "B", Std. Wt. threaded ends. Fittings will be 125# cast iron, ASTM A126, Grade B, hot-dipped galvanized, threaded ends.

6.4 EQUIPMENT

6.4.1 Electric Water Coolers

The cooler capacity shall be in accordance with Sunroc Model NSF-8-D or Approved Equal. The cabinet shall be constructed of 19-20 gauge welded stainless steel, with a removable front panel, a stainless steel base, and a Type 300 series stainless steel top. A chrome plated brass hand operated bubbler on a raised mount shall have a built-in pressure regulator. The Contractor shall furnish a reciprocating type hermetically sealed motor compressor with an air cooled condenser and a tube type cooling unit for Type 12 refrigerant, an insulated power cable, and an enclosed, adjustable thermostat. Electrical specifications are 1/4 hp, 115 V, 60 Hz, single phase. The cooler shall bear the Underwriters Laboratory (UL) label.

6.4.2 Electrical Water Heaters

The heater shall bear the Underwriters Laboratory (UL) label. Each heater shall have a steel glass lined tank with a magnesium anode, 4 bolt flange, inconel sheathed, rod-type heating element with pre-wired terminal leads, and immersion type thermostat switching a magnetic contactor(s). The heater shall have a minimum 3 inch glass fiber insulation with a round steel shell. Each heater shall be provided with an ASME rated temperature and pressure relief valve.

## 7.0 ELECTRICAL

This section applies to all electrical equipment and components, which will be used on the Ion Implantation/Sputtering Facility. All items are commercially available and shall comply with applicable codes and standards. The power and services required are available from the existing Site utilities. Conduit only will be stubbed out 5 ft from the building for 13.8 kV normal and 480 volt standby power connections.

### 7.1 CONDUIT

All conduit systems shall be UL approved, rigid steel, zinc-coated or 304L seamless stainless steel, Schedule 40 pipe. The minimum conduit size shall be 3/4 in. for power, unless otherwise noted, and 1/2 in. for exposed communication, control and instrumentation. Insulated bushings shall be provided at all terminals, where hubs are not used. Flexible metallic conduit shall be liquid tight. Expansion type conduit fittings shall be used across building expansion joints.

### 7.2 WIREWAYS AND AUXILIARY GUTTERS

Wireways and auxiliary gutters used in dry locations shall be preformed with screw type covers.

### 7.3 CABLES, 5 kV

The 5 kV dc target cables shall be No. 8 AWG, non-shielded, single-conductor Class B, concentric-stranded copper conductors, ethylene-propylene rubber insulation, Okonite Okoguard Okoseal, or equal. Cross-link polyethylene insulation is not acceptable. The 3000 Vdc target system is solidly grounded.

### 7.4 BUILDING WIRE, 600 VOLT

Single conductors for power, lighting, and miscellaneous control shall be 600 volt, code type, 90°C, RHH-RHW,USE,FP1 with chlorosulfonated, polyethylene jacket for No. 2 AWG and larger, Okonite Okolon, or equal. Type THHN-THWN shall be used for conductors smaller than No. 2 AWG. The minimum control wire size shall be No. 14 AWG, and No. 12 AWG for all other wiring. All conductors shall be stranded copper except that lighting and branch circuits with wiring No. 10 AWG and smaller may be solid. Aluminum wire is not acceptable.

7.5 HIGH RADIATION WIRE

All wiring, single or multi-conductor, within high radiation areas and through shielding walls shall be No. 12 AWG minimum, Class IE, 600 volt wire rated for $10^7$ R minimum total integrated dosage, as manufactured by American Insulated Wire Corp., Boston Insulated Wire and Cable Co., PSC, Div. M.W. Riedel, or The Rockbestos Co. Wiring inside the high radiation areas shall be multi-conductor with a special chlorosulfonated, polyethylene overall jacket suitable for decontamination with water, nitric acid, oxalic acid, and Turco No. 4502.

7.6 UNIT SUBSTATION, 13.8 KV TO 480 VOLT

The indoor unit substation shall consist of a three-position, manually operated, 600 amp, 15 kV primary fused interrupter switch, a silicone insulating fluid transformer, a secondary main and feeder draw-out air circuit breakers. The rating and the equipment quantity shall be as shown on the Single Line Diagrams. The 480 volt breakers shall have static long time (L), short time (S), and ground (G) tripping characteristics. The buses shall be copper with silver plated joints and connections. A manually operated overhead hoist shall be provided to remove the 480 volt air circuit breakers.

7.7 DISTRIBUTION TRANSFORMERS

The quiet type distribution, three-phase transformers, rated 480-208Y/120 volt, shall be general purpose dry type in an indoor enclosure and shall have 220°C insulation temperature classification and 150°C winding temperature rise for 30 kVA and larger, and 185°C insulation temperature and 115°C winding temperature rise for 25 kVA and smaller. Full capacity NEMA standard taps shall be provided on the high voltage winding.

7.8 MOTORS

Motors shall be of sufficient size for the duty to be performed. All motors shall have full nameplate horsepower available with a service factor of 1.0 at 3000 ft elevation and 1.15 at sea level. Unless otherwise specified, all motors shall be totally enclosed, and shall have a continuous duty classification based on a 40°C, ambient temperature of reference. Crane and monorail motors shall be rated for 30 minute intermittant duty. Motors shall be the premium efficiency type. The motors shall have the following factory guaranteed minimum efficiencies in accordance with IEEE 112 Test Procedures and shall have the efficiency index letter stamped on the motor nameplate:

| HP | % Efficiency | HP | % Efficiency | HP | % Efficiency |
|---|---|---|---|---|---|
| 1 | 78.5 | 10 | 88.9 | 50 | 92.0 |
| 1 1/2 | 81.5 | 15 | 89.8 | 60 | 92.0 |
| 2 | 81.5 | 20 | 90.6 | 75 | 93.3 |
| 3 | 84.0 | 25 | 90.6 | 100 | 93.3 |
| 5 | 84.0 | 30 | 91.4 | 125 | 93.3 |
| 7 1/2 | 88.9 | 40 | 92.0 | 150 | 94.3 |

The motor insulation shall be Class F minimum. Motors in high radiation areas shall have Class H insulation and shall be rated for $2 \times 10^7$ R total minimum gamma radiation dosage. The high radiation area motors shall be suitably coated in the field with Crouse-Hinds "Corro-Free S-602" Cat. No. ETU2, or equal. The motor voltage rating shall be selected as follows:

1/2 hp through 150 hp: 460 volt, 3 phase, 60 hertz

1/3 hp and smaller: 115 volt, single phase, 60 hertz

Motors 1/4 hp and 1/3 hp in a batch process shall be rated 460 volts, 3 phase, 60 hertz. Polyphase motors shall be NEMA Design B minimum, squirrel cage type, having normal starting torque and low starting current; single-phase motors shall be capacitor start type, except that motors rated 1/6 hp and less may be split phase type. Gear motors shall be Class II or III, in accordance with the gear loading requirements. Motors 5 hp and larger shall have full load power factor of 0.85 minimum. Motors 5 hp and larger with a full load power factor less than 0.85 shall be corrected to at least 0.90, utilizing a power factor corrective device located at the motor. Two-speed motors shall be the two-winding type. Motors connected to the site standby power shall be capable of starting on a voltage reduction of 20 to 30 percent. A copper grounding lug shall be provided in terminal connection box of all 460 volt, 3 phase motors.

## 7.9 STARTERS

Combination magnetic starters with 120 volt transformer and control shall be provided for 460 volt, 3 phase motors that are 1/2 hp through 150 hp, and manual starters shall be provided for all 115 volt, single phase motors smaller than 1/2 hp.

## 7.10 MOTOR CONTROL CENTERS

The motor control center (MCC1) and split bus motor control center MCC2 shall be 277/480 V, 3 phase, 4 wire, 60 hertz, free-standing, dead-front, dead-rear, copper bus only, NEMA Class II, Type B wiring consisting of vertical sections containing phase busing, terminals, copper ground bus, wireways, and housing modular plug-in type equipment drawers behind interlocked hinged doors Westinghouse Type Five Star, or equal. The enclosures shall be NEMA 1. All operating handles and controls shall be externally operable. An individual, 480-120 volt control transformer with secondary fuse shall be provided for each motor starter. Each starter shall have a HAND-OFF-AUTO selector switch in the cover. The motor control center shall be braced for a minimum of 22,000 ampere symmetrical short circuit. The automatic transfer switch, with solid state control and located in the standby section of the motor control center MCC2, shall be rated 260 amp, 480 volt, 3 phase, 3 pole, 60 Hz, and suitable to withstand a 22,000 amp short-circuit fault. Upon power failure, the transfer switch shall automatically start the Site diesel generator system. The return to normal power shall be manual. In the event the standby power fails and normal power is available, the transfer switch shall have an override to transfer automatically to normal power. Two each tandem pilot lights shall be provided to indicate the contact position. The transfer switch shall be ASCO Model 940326099 with accessories 6C, 9A, 9B and 28, or equal.

### 7.11 PANELBOARDS

The panelboards shall be dead front, copper bus, 4 wire, circuit breaker type. Circuit breakers shall be E Frame minimum and rated for ac or dc operation. The circuit breakers shall have a minimum interrupting rating of 10,000 rms symmetrical amperes for 208 volt panelboards and 14,000 rms symmetrical amperes for 277/480 volt lighting panelboards. A ground bus with screw terminals shall be provided. Neutral buses shall be isolated. Enclosures shall be NEMA 1, surface mounted. Panelboards of sizes and ratings, as shown on the drawings, shall be provided to serve the ventilating, lighting, and miscellaneous power loads. Ground fault interrupter (GFI) breakers rated 120 Vac only shall be provided, as required by National Electrical Code.

### 7.12 RECEPTACLES

Convenience outlets shall conform with NEMA Standard configuration 5-15R and shall be 3 wire, duplex, grounding type, 120 Vac, 15 amp, Hubbell Cat. 5262, or equal.

Receptacles for 480 volt, 3 phase service shall be 60 amp, 4 pole, 3 wire type, with spring door and combined with a non-fused, heavy-duty, horsepower rated disconnect switch, Crouse-Hinds WSRD 63542 or equal. The mating male plugs shall be Crouse-Hinds APJ 6485, or equal, for 60 amp service.

### 7.13 HIGH RADIATION AREA CONNECTORS

The remote electromechanical manipulator operated, 304 stainless steel, connectors shall be rated for $10^7$ R total integrated dosage minimum and 600 volts. The connector shall be suitably sealed for decontamination with nitric acid, oxalic acid and Turco No. 4502. The receptacle and plug assembly shall be Gulton Lormec Series 9588 and 9405 respectively, or equal.

### 7.14 SAFETY SWITCHES

Safety switches shall be the heavy-duty type, horsepower rated, 600 volt, 3 pole, with current rating and fusing, as shown on the drawings. The enclosure shall be NEMA 1.

7.15 TOGGLE SWITCHES

Toggle switches installed for the control of incandescent, high pressure sodium, and fluorescent lighting luminaires shall be heavy-duty, general purpose, UL approved devices. Toggle switches shall be specification grade, single-pole, Hubbell Cat No. 1221 or 1221-I, or equal.

7.16 LIMIT SWITCHES

The non-plug-in limit switches shall be heavy-duty type, 600 volts, 10 amp continuous rating contacts, single pole, double throw (SPDT) or electrically independent double pole, double throw (DPDT). The limit switches shall be Micro Switch Type HDLS Series, or equal.

7.17 BOXES AND FITTINGS

Outlet boxes shall be rust-resistant, cast-iron alloy boxes with threaded hubs or bosses for conduit connection. Pullboxes and their covers shall be constructed of galvanized steel.

7.18 RELAYS

Control relays shall be magnetically operated relays with 120 Vac coils, and contacts rated for 10 amp inductive at 120 volt continuous duty. Timing relays shall be magnetic relays with an adjustable pneumatic timing mechanism and a minimum 5 amp continuous contact rating.

7.19 GENERAL LIGHTING

Commercial type recessed fluorescent luminaires with acrylic lenses and high power factor and energy saving ETL, Class P ballasts and 4 ft, cool white, rapid start fluorescent lamps with wattage not to exceed 35 watts shall be used in offices, control room, toilet and similar areas. Ballasts shall not contain PCB capacitors. Industrial type fluorescent luminaires with upward component and porcelain enamel reflectors shall be utilized in other low bay areas. Lighting in the high bay areas shall utilize high pressure sodium (HPS) luminaires. Exterior HPS wall mounted luminaires shall be provided. Special cell HPS luminaires, suitable for remote removal, shall be provided, as required.

The emergency lighting shall be provided by fully automatic 120/277 V supply, lead calcium rechargeable batteries, Holophane Cat. No. M-12-2A-X, or equal.

7.20 LIGHTNING PROTECTION

Lightning protection, complete with UL Master "C" label, shall be provided.

7.21 GROUNDING

A No. 4/0 AWG soft drawn bare copper ground loop with 3/4 in. by 10 ft. copper-clad steel ground rods, shall be provided and connected to the Site duct bank ground system. One insulated instrumentation ground bus plate and cable shall be furnished in the control room. The cable shall be connected to the facility ground system at only one point. The maximum facility ground resistance shall be five ohms. The lowest level of building reinforcing bar shall be grounded. The shielding window liners shall be grounded.

7.22 CATHODIC PROTECTION

Cathodic protection shall be provided for all direct buried metallic lines and underground tanks.

7.23 TERMINAL BOXES

Control terminal box enclosures shall be NEMA 1 sheet steel construction with hinged door, lock and steel equipment mounting panel(s). Barriers shall be steel, full depth and height, finished the same as the enclosures. The interior of the enclosure shall be finished with white enamel. The exterior shall be painted with color, as directed.

7.24 TERMINAL BLOCKS

All power and control wiring shall be terminated on accessible terminal blocks. The 600 volt, melamine, rail mounted, terminal blocks shall be Weidmuller Type SAK, or equal. A snap-in preprinted unique wire number marker shall be provided. Hand lettered terminal identification is not acceptable. Terminal connectors shall be the vibration proof, pressure clamp type.

7.25 TELEPHONE SYSTEM

Telephone cabinets shall be provided, as required. Conduit only shall be installed in the building, as required. The telephone system wiring will be by Others.

7.26 CELL SPEAKER SYSTEM

A cell speaker system shall be provided for monitoring audio sounds inside the cell. The system shall consist of a microphone with box mounted on a remotely removable Gulton plug in the cell and connected to a speaker in the control room.

7.27 FIRE ALARM DETECTION SYSTEM

The fire detection system shall include control panels, annunciators, initiating devices, signal conduits, and wire necessary for a complete and operational system. The final connection to the Site fire alarm system will be by Others. The system shall be Pyr-A-Larm System 3, or equal. The system shall consist of a multiplexer and enclosed terminal board, thermal detectors, manual stations, public address speakers, control panel audible devices, remote annunciator and control panels. The detection devices shall be capable of being interchanged without any changes required to the wiring, control panel or to the mounting base. The supervision shall not require additional wires other than the pair used for detection or alarm. The system shall be capable of being expanded at any time up to the maximum capacity of the system. The system shall be capable of having ionization, thermal, and photoelectric detecting devices, control relays, and manual stations connected across the same pair of wires. The system shall be electrically supervised against both short and open wire faults in the detection circuit, the manual station alarm circuit, and an open in the system alarm and trouble relay coils. An open wiring fault occurring in these circuits shall cause an audible and visual trouble indication at the control panel. A fire alarm signal shall override trouble signals. In the event of a trouble signal resulting from trouble on an initiating zone, a fire signal from another zone shall appear on the panel and remain until the panel is reset, at which time the trouble signal will reappear. Alarm initiating zones shall be as shown on the drawings. A separate switch monitor shall be provided to control waterflow alarms separately from other alarm signals.

7.27.1 Alarm System

The system shall function as follows when any sprinkler flow switch operates, or thermal detector in the HVAC fire protection system operates:

A. The main and remote annunciator panel alarm devices shall annunciate audible and visual indicators of a fire alarm.

B. The visible indicator shall indicate the zone location and the device initiating the fire alarm. The audible indicator shall produce the same sound for all fire alarms.

C. An alarm indicating lamp shall light in the base of the HVAC detector initiating the alarm.

D. Panel locks into alarm until manually reset.

E. Exhaust duct detector circuits shall be provided to energize the HVAC fire protection chamber fire water system for HEPA filters.

F. Supply duct detector circuits shall be provided to shut down the supply fan(s).

G. The alarm shall be manually transmitted as a voice alarm throughout the building over the fire alarm PA speakers.

7.27.2 Fire Supervisory Signals.

The supervisory alarm initiating devices shall include post indicator valve (PIV) switches, OS and Y valve switches, dry pipe system low air pressure switches, trouble signals from each of the Halon and $CO_2$ systems, and the Pyr-A-Larm Panel system trouble indicators. The supervisory alarm system shall function when any of these devices operate, as follows:

A. The main control panel shall annunciate audible and visual indicators of a supervisory alarm. The audible indicator shall provide a different sound than the fire alarm audible indicator.

B. The main panel locks the visual alarm indicator on, until manually reset. The audible indicator can be silenced by operating the alarm normal switch.

C. The main panel relays the supervisory alarm signal via a separate transmitter to the Site fire supervisory alarm system.

7.28 EVACUATION ALARM SYSTEM

The evacuation system shall be completely independent of any other system. Speaker wiring may be installed in same conduit as fire alarm. No voice communication is required. The evacuation alarm system shall include an evacuation alarm panel, supervised public address speakers, initiating devices, a tone generator, signal conduits, and wire necessary for a complete and operational system. The system shall be Pyr-A-Larm System 3, or equal. No voice communication is required.

The system shall be electrically supervised against both short and open wire faults in the initiating circuit, the audible alarm circuit, and an open wire fault in the system alarm and trouble relay coils. An open wiring fault occurring in these circuits shall cause an audible and visual trouble indication at the control panel. A short in the initiating circuit and the audible alarm circuit shall cause an audible and visual trouble indicator at the control panel. The evacuation alarm signal shall override the trouble signals. In the event of a trouble signal resulting from trouble on an initiating zone, an evacuation signal from another zone shall appear on the panel and remain until the circuit is reset, at which time the trouble signal will reappear. If a second evacuation alarm signal is initiated after a prior signal has been silenced, the selected evacuation signal shall sound even if the control circuit has not been reset. The evacuation alarm system shall shut off automatically after 5 minutes.

The System 3 evacuation shall also provide the following functions:

A. Receive "ALERT" and "EVACUATION" signals from the Site evacuation system.

B. Provide local building status on "EVACUATION" mode only to the Site evacuation system.

C. Provide alarm signal over two No. 14 AWG wires to the Health Physic office.

D. Provide for remote monitoring of the building trouble status.

7.28.1 Local Alarm

This system shall provide an "ALERT" signal, with the panel mounted front cover switch in the "DOWN" position, consisting of continuous, non-varying audible siren tone or an "EVACUATION" signal, with the switch in the "UP" position, consisting of continuous cyclic audible siren tone the cycle to be "ON" for 5 seconds and "off" for 5 seconds. Each signal shall be initiated by operating any remote and one control room manual alarm switch. Any switch shall initiate the signal, but if more than one is operated at the same time, the switch turned to "EVACUATE" will take precedence over all other switches. Initiation of an "ALERT" or "EVACUATION" signal from any control point within the building shall be shown by an indicating light on the evacuation alarm panel. In addition, an audible panel alarm buzzer shall be actuated. The audible alarm can be silenced by operating the "ALARM-NORMAL" switch to the opposite position but the light shall remain on until all switches or contacts are returned to normal position.

7.28.2 Site Wide Alarm.

A separately maintained toggle switch with "Lock-out" pin in the "DOWN" position, located in the control room, shall provide the Site wide alarm system an "ALERT" signal with the switch in the "DOWN" position or an "EVACUATION" signal with the switch in the "UP" position over two No. 14 AWG wires to connection in the Security Building.

# 8.0 PIPING MATERIALS

## 8.1 SCOPE OF WORK

The Contractor shall provide labor, materials, equipment, and tools necessary to fabricate, test, inspect, document, deliver to the site, field fabricate and/or install, and field inspect and test all piping materials in the quantities defined and as located by the drawings, and in accordance with this specification.

## 8.2 OUTLINE SPECIFICATIONS

The Piping Service Classes to be used are

| Class | Service |
|---|---|
| D | Process Equipment Waste |
| N | High Pressure Steam, Low Pressure Steam, Condensate, High Pressure Air, Vacuum |
| P | Low Pressure Air |
| Q | Cooling Water Supply And Return |
| V | Pressurized Feed Gas |

## SERVICE INDEX
(FOR GENERAL REFERENCE ONLY; SEE LINE CLASS FOR SPECIFIC DETAILS)

| LATEST REV PAGE 1 | 2 | 3 | 4 | 5 | CLASS | FLANGE RATING | MAX PRESS | TEMP RANGE | SERVICE | PIPE MATL | | BOLTS / GASKETS | SMALL FITTINGS | VALVES | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | CRSN | ALLOW | | | BODY | TRIM |
| | | | | | D | 150# ANSI RF | Per B16.5 | 100°F | Process Equipment Waste | 304L SS | | B7 / Spiral Wound | 304L SS BW | 304L SS | 304 SS |
| | | | | | N | 150# ANSI RF | Per B16.5 | 365°F | High Pressure Steam, Low Pressure Steam, Condensate High Pressure Air, Vacuum | Carbon Steel | | Alloy A193-B7 / Grafoil | 3000# C.S. Scrd | Carb Stl | 12 Cr. |
| | | | | | P | 125# FF | Per B16.5 | 200°F | Low Pressure Air | Carbon Steel | | Steel 307-B / Grafoil | 150# MI | Bronze & C.I. | Bronze |
| | | | | | Q | 125# FF | Per B16.5 | 200°F | Cooling Water Supply and Return | Carbon Stl. Galv. | | Steel A307-B | 300# M.I. | Bronze & C.I. | Bronze |
| | | | | | V | 300# RF | Per B16.5 | 200°F | Pressurized Feed Gas | 316L SS | | B7 / Spiral Wound | 316L SS BW | 316 SS | 316 SS |

| | |
|---|---|
| RATING: 150# | CORROSION ALLOWANCE — |
| FACING: Raised Face | PRESSURE LIMIT — Per B16.5 |
| MATERIAL: 304L Stainless Steel | TEMPERATURE LIMIT — 100°F |

| CODE NUMBER | EN-CODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | --------------------PIPE------------------ | | |
| | | 2" and smaller | Stainless Steel, ASTM A312, Grade TP304L, Schedule 80S Threaded Ends | | |
| | | 3" and larger | Stainless Steel, ASTM A312, Grade TP304L, Schedule 40S, Buttweld Ends | | |
| | | | -----------------FITTINGS----------------- | | |
| | | 2" and smaller | 3000# 304L Stainless Steel, Threaded Ends, ASTM A182, Grade F304L, Schedule 80S | | |
| | | | -----------------FITTINGS----------------- | | |
| | | 3" and larger | Seamless Stainless Steel, ASTM A403, Grade WP304L or ASTM A182 Grade F304L Buttweld Ends, Schedule 40S Bore | | |
| | | | ----------------THREADOLET---------------- | | |
| | | 2" and smaller | 3000# 304L Stainless Steel, Threaded, ASTM A182, Grade | | |
| | | | ------------------WELDOLETS--------------- | | |
| | | 3" and larger | Forged 304L Stainless Steel, ASTM A182, Grade F304L, Schedule 40 Bore | | |
| | | | ---------------SWAGE NIPPLES-------------- | | |
| | | 2" and smaller | 304L Stainless Steel, ASTM A403, Grade WP304L Schedule 80 Bore, Threaded Ends | | |
| | | | -------------------UNIONS----------------- | | |
| | | 2" and smaller | 3000# 304L, Stainless Steel, ASTM A182, Grade F304L, Schedule 80 Bore, Ground Joint Type, Integral Seats, Threaded Ends | | |
| | | | -------------------PLUGS------------------ | | |
| | | 2" and smaller | 304L Stainless Steel, ASTM A182, Grade F304L, Round Head Type Threaded End | | |
| | | | --------------------CAPS------------------ | | |
| | | 2" and smaller | 3000# 304L Stainless Steel, ASTM A182, Grade F304L, Threaded End | | |
| | | | ------------------FLANGES----------------- | | |
| | | 2" and smaller | 150# ANSI, Raised Face, Threaded Type, 304L Stainless Steel, ASTM A182, Grade F304L Schedule 80S Bore | | |

| CODE NUMBER | ENCODER | SIZE FROM | TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|---|
| | | | | ------------------FLANGES CONT'D----------- | | |
| | | 3" and larger | | 150# ANSI, Raised Face, Weld Neck Type 304L Stainless Steel ASTM A182 Grade F304L Schedule 40S Bore | | |
| | | | | -----------------ORIFICE FLANGES----------- | | |
| | | 1" and larger | | 300# ANSI Raised Face Weld Neck Type, Forged Stainless Steel, ASTM A182 Grade F304L, Schedule 40S Bore with 1/2" Scrd Taps | | |
| | | | | ---------------BRANCH CONNECTIONS---------- | | |
| | | Header | | Branch — Use | | |
| | | 2" and smaller | | Full or Reducing — Full or Reducing Tee | | |
| | | 3" and larger | | Full Size — Full Size Tee or Weldolet | | |
| | | | | 2" and smaller — Threadolet | | |
| | | | | ---------PIPING INSTRUMENT CONNECTIONS----- | | |
| | | | | Temperature Conn's — 1-1/2" Flgd. | | |
| | | | | Pressure Conn's — 1/2" Threaded | | |
| | | | | Orifice Tap Conn's — 1/2" Threaded | | |
| | | | | ---------------GASKETS-------------------- | | |
| | | | | Spiral-Wound Metallic Type, T304L Stainless Steel Spiral Windings with Grafold Filler 1/8" Thick 304 Stainless Steel Centering Ring | | |
| | | | | ------------------BOLTING------------------ | | |
| | | | | Stud Bolt, 304 Stainless Steel, ASTM A193 Grade B7 with 2 Heavy Hex Nuts, ASTM A194 Grade 2H | | |
| | | | | -----------------PIPE BENDS---------------- | | |
| | | | | Bends (Minimum) 5 Times the Normal Diameter may be used in place of Threaded Fittings | | |
| | | | | -----------------Y-STRAINERS--------------- | | |
| | | 2" and smaller | | 316 Stainless Steel Body, ASTM A351, Grade CF8M, Threaded Ends, 316 or 304 Stainless Steel Screen with .045 Diameter Perforations, Threaded Blowoff Connection<br>Acceptable Model<br>Armstrong Fig. No. E7SC - 1/2" thru 1 1/4"<br>Armstrong Fig. No. E7SC - 1 1/2" thru 2" | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ------------------Y-STRAINERS-------------- | | |
| | | 3" and larger | 316 Stainless Steel Body, ASTM A351, Grade CF8M, Flanged Ends, 316 or 304 Stainless Steel Screen with .045 Diameter Performations, Threaded Blow-Off Connection<br>Acceptable Model<br>Armstrong Fig. No. E7FL-3" thru 10" | | |
| | | | ----------------STEAM TRAPS---------------- | | |
| | | 1/2" - 3/4" | Steam Trap, Threaded Ends, Impulse Type, 1-1/4 CR - 1/2 Moly Body, Stainless Steel Bonnet, Seat, and Disc, Integral Strainer and Blow-Off<br>Acceptable Model<br>Yarway Fig. No. 720 | | |
| | | | ---------------THREAD COMPOUND------------ | | |
| | | | Use "Liquid O Ring" for Pipe Threads | | |
| | | | ------------------GATE VALVES------------ | | |
| | | 2" and smaller | 150# ANSI Threaded Ends OS&Y, Bolted Bonnet, Body & Bonnet - 316L Stainless Steel, Casting - ASTM A351, Grade CF3M, Forging ASTM 182, Grade F316L, Trim 316 Stainless Steel, Packing - Reinforced TFE, Bonnet Gasket - Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Aloyco Fig. No. 110 | | |
| | | | ------------------GATE VALVES------------ | | |
| | | 3" and larger | 150# ANSI, Flanged Ends, OS&Y, Bolted Bonnet, Body and Bonnet 316 Stainless Steel, Casting - ASTM A351, Grade CF8M, Forging - ASTM A182, Grade F316, Packing Reinforced TFE, Bonnet Gasket, Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Aloyco Fig. No. 117 | | |

| CODE NUMBER | ENCODER | SIZE FROM | TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|---|
| | | | | -----------------GLOBE VALVE--------------- | | |
| | | 2" and smaller | | 150# ANSI, Threaded Ends, OS&Y, Bolted Bonnet, Body and Bonnet 316L Stainless Steel, Casting ASTM A351, Grade CF3M, Forging ASTM A182, Grade F316L, Packing Reinforced TFE, Bonnet Gasket - Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Aloyco Fig. No. 314 | | |
| | | 3" and larger | | 150# ANSI - Flanged Ends, RF, OS&Y, Bolted Bonnet, Body and Bonnet 316 Stainless Steel Casting ASTM A351, Grade CF8M, Forging ASTM A182, Grade F316 Packing Reinforced TFE, Bonnet Gasket - Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Aloyco Fig. No. 317 | | |
| | | | | ------------------BALL VALVES-------------- | | |
| | | 2" and | | 150# ANSI, Threaded Ends, Handle Operated, Body and Ends, 316L Stainless Steel, Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316, Seats and Seals Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Worchester Controls<br>Fig. No. W5966TSES7 | | |
| | | | | ------------------BALL VALVES-------------- | | |
| | | 3" and 4" | | 150# ANSI Flanged Ends, Handle Operated, Body and Ends, 316 Stainless Steel, Castings - ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316, Seats and Seals - Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Hills-McCanna Fig. No. S15156RS6 | | |
| | | | | ----------------CHECK VALVES--------------- | | |
| | | 2" and smaller | | 150# ANSI, Threaded Ends, Swing Type, Bolted Bonnet, Body and Bonnet 316L Stainless Steel Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316L, Bonnet Gasket Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Powell Fig. No. 2341 | | |

| CODE NUMBER | ENCODER | SIZE FROM | SIZE TO | DESCRIPTION | NOTES | REV |
| --- | --- | --- | --- | --- | --- | --- |
| | | | | ------------------CHECK VALVES--------------- | | |
| | | 3" and larger | | 150# ANSI - Flanged Ends - RF Swing Type, Bolted Bonnet, Body and Bonnet 316 Stainless Steel, Castings ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316, Bonnet Gasket - Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Aloyco Fig. No. 377 | | |

| SERVICE: | High Pressure Steam, Low Pressure Steam, Condensate, High Pressure Air, Vacuum | CLASS N PAGE 1 OF 4 |
|---|---|---|
| RATING: 150# FACING: Raised Face MATERIAL: Carbon Steel | CORROSION ALLOWANCE — PRESSURE LIMIT — Per B16.5 TEMPERATURE LIMIT — 365 °F | |

| CODE NUMBER | EN-CODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | --------------------PIPE-------------------- | | |
| | | 2" and smaller | Carbon Steel, ASTM A53 Grade B, Extra Strong Threaded Ends | | |
| | | 3" and larger | Carbon Steel, ASTM A53 Grade B, Standard Weight Beveled Ends | | |
| | | | -----------------FITTINGS----------------- | | |
| | | 2" and smaller | 3000# Carbon Steel, Threaded Ends ASTM A105 | | |
| | | | ------------------FITTINGS----------------- | | |
| | | 3" and larger | Seamless or Welded Carbon Steel, Buttweld Ends, Standard Weight, ASTM A234 Grade WPB | | |
| | | | -----------------THREADOLETS--------------- | | |
| | | 2" and smaller | 3000# Forged Carbon Steel, ASTM A105, Schedule 80 Bore, Conforming to Bonney Forge | | |
| | | | ------------------WELDOLETS---------------- | | |
| | | 3" and larger | Forged Carbon Steel, Standard Weight, ASTM A105, Schedule 40 Bore, Conforming to Bonney Forge | | |
| | | | ---------------SWAGE NIPPLES-------------- | | |
| | | 2" and smaller | Carbon Steel, Threaded Ends, ASTM A234, Grade WPB, Extra Strong | | |
| | | | -------------------UNIONS------------------ | | |
| | | 2" and smaller | 3000# Forged Carbon Steel, ASTM A105, Schedule 80 Bore, Ground Joint Type with Integral Seats, Threaded Ends | | |
| | | | --------------------PLUGS------------------ | | |
| | | 2" and smaller | Forged Carbon Steel, Round Head Type, Threaded End | | |
| | | | --------------------CAPS------------------- | | |
| | | 2" and smaller | 3000# Forged Carbon Steel, ASTM A105, Schedule 80 Bore, Threaded | | |
| | | | -------------------FLANGES----------------- | | |
| | | 2" and smaller | 150# ANSI, Raised Face Ends, Carbon Steel, ASTM A105, Threaded XS Bore | | |

| CODE NUMBER | ENCODER | SIZE FROM | SIZE TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|---|
| | | 3" and larger | | 150# ANSI, Raised Face Slip-On Type, Carbon Steel, ASTM A105 | | |
| | | 1" and larger | | 150# ANSI, Raised Face Blind Flange, Carbon Steel ASTM A105 | | |
| | | | | ------------------ORIFICE FLANGES---------- | | |
| | | 1" and larger | | 300# ANSI, Raised Face Weld-Neck Type, Forged Carbon Steel, ASTM A105 Bore to Match Pipe, with 1/2" Scrd Taps | | |
| | | | | -------------BRANCH CONNECTIONS------------ | | |
| | | <u>Header</u> | | <u>Branch</u> — <u>Use</u> | | |
| | | 2" and smaller | | Full or Reduced Size — Full or Reducing Tee | | |
| | | 3" and larger | | Full Size — Full Size Tee | | |
| | | | | 2" and smaller — Threadolet | | |
| | | | | --------PIPING INSTRUMENT CONNECTIONS------ | | |
| | | | | Primary Instrument Conn's to Piping | | |
| | | | | Temperature Conn's — 1-1/2" Fldg | | |
| | | | | Pressure Conn's — 1/2" Threaded | | |
| | | | | Orifice Tap Conn's — 1/2" Threaded | | |
| | | | | -------------------GASKETS----------------- | | |
| | | | | Grafoil Flange Gasket, Flat Ring, 1/16" thick, John Crane or Approved Equal | | |
| | | | | ------------------BOLTING----------------- | | |
| | | | | Alloy Stud Bolt, ASTM A193 Grade B7 with 2 Heavy Hex Nuts, ASTM A194 Grade 2H | | |
| | | | | -----------------Y-STRAINER---------------- | | |
| | | 2" and smaller | | 600#, Carbon Steel Body, ASTM A216, Grade WCB, Threaded Ends, 304 Stainless Steam Screen with 0.45 Diameter Perforations<br>Acceptable Model<br>Armstrong Fig. No. B15C | | |
| | | | | ------------------Y-STRAINER-------------- | | |
| | | 3" and larger | | 150# ANSI, Raised Face Flanged Ends, Carbon Steel Body, ASTM A216 Grade WCB, 304 Stainless Steel Screen with 0.045" Diameter Perforations<br>Acceptable Model:<br>Armstrong Fig. No. BIFL | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ----------------STEAM TRAPS----------------- | | |
| | | 1/2" - 3/4" | Steam Trap, Screwed Ends, Impulse Type, 1-1/4 Cr-1/2 Moly Body, Stainless Steel Bonnet, Seat and Disc, Integral Strainer and Blow-off<br>Acceptable Model:<br>Yarway Fig. No. 720 | | |
| | | | ---------------THREAD COMPOUND------------- | | |
| | | | Use "Liquid O Ring" for Pipe Threads | | |
| | | | ---------------GATE VALVES----------------- | | |
| | | 2" and smaller | 800# Threaded Ends, OS&Y Seal Welded Bonnet, Body and Bonnet, Carbon Steel, Forgings - ASTM A105, Trim F6<br>Acceptable Model<br>Vogt Fig. No. 2801 thru 2808 | | |
| | | | ---------------GATE VALVES----------------- | | |
| | | 3" and larger | 150# ANSI Flanged Ends, Raised Face OS&Y Bolted Bonnet, Body and Bonnet Carbon Steel, Castings - ASTM A216, Grade WCB, Forgings ASTM A105, Trim No. 4<br>Acceptable Model<br>Pacific Fig. No. 150-4 | | |
| | | | ---------------GLOBE VALVES---------------- | | |
| | | 2" and smaller | 800# Threaded Ends, OS&Y Seal Welded Bonnet, Body and Bonnet, Carbon Steel, Forgings - ASTM A105, Trim F6<br>Acceptable Model<br>Vogt Fig. No. 2821 thru 2828 | | |
| | | | ---------------GLOBE VALVES---------------- | | |
| | | 3" and larger | 150# ANSI Flanged Ends, Raised Face OS&Y Bolted Bonnet, Body and Bonnet Carbon Steel, Castings - ASTM A216, Grade WCB, Forgings ASTM A105, Trim No. 4<br>Acceptable Model<br>Pacific Fig. No. 160-4 | | |
| | | | ---------------CHECK VALVES---------------- | | |
| | | 2" and smaller | 800# Threaded Ends, Bolted Bonnet Horizontal Piston Type, Body and Bonnet, Carbon Steel, Forgings - ASTM A105, Trim F6<br>Acceptable Model<br>Vogt Fig. No. 701 thru 708 | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | --------------CHECK VALVES CONT'D----------- | | |
| | | 3" and larger | 150# ANSI Flanged Ends, Raised Face Bolted Bonnet, Swing Type, Body and Bonnet Carbon Steel, Castings - ASTM A216, Grade WCB, Forgings ASTM A105, Trim No. 4 Acceptable Model Pacific Fig. No. 180-4 | | |
| | | | ----------------BALL VALVES---------------- | | |
| | | 2" and smaller | 150# ANSI, Threaded Ends, Handle Operated, Body and Ends, Carbon Steel, Castings, ASTM A216, Grade WCB, SEats and Seals, Reinforced TFE, Trim 316 Stainless Steel Acceptable Model Worcester Controls Fig. No. W5944RSE | | |
| | | | --------------PLUG VALVES------------------ | | |
| | | 2" and smaller | 300# Threaded Ends Carbon Steel Body, Cover, Plug, and Cover Bolts, Castings ASTM A216, Grade WCB, Teflon or Approved Equal Sleeve and Diaphragm, Wrench Operated, Extra Strong Bore Acceptable Model Tufline Fig. No. 0366SE Non. Lubricated | | |

| SERVICE: | Low Pressure Air | CLASS P PAGE 1 OF 3 |
|---|---|---|

| RATING: | 125# | CORROSION ALLOWANCE — | |
|---|---|---|---|
| FACING: | Flat Face | PRESSURE LIMIT — | Per B16.1 |
| MATERIAL: | Carbon Steel | TEMPERATURE LIMIT — | 200°F |

| CODE NUMBER | EN-CODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ------------------PIPE------------------- | | |
| | | 2" and smaller | Carbon Steel, ASTM A53, Grade B, Schedule 40 Bore, Threaded Ends | | |
| | | 3" and larger | Carbon Steel, ASTM A53, Grade B, Standard Weight, Beveled Ends | | |
| | | | -----------------FITTINGS----------------- | | |
| | | 2" and smaller | 150# Malleable Iron, ASTM A47, Threaded Ends | | |
| | | 3" and larger | Seamless Carbon Steel ASTM A234, Grade WPB Standard Weight, Beveled Ends | | |
| | | | ----------------THREADOLET---------------- | | |
| | | 2" and smaller | 3000# Carbon Steel, ASTM A105, Conforming to Bonnet Forge | | |
| | | | --------------SWAGE NIPPLES--------------- | | |
| | | 2" and smaller | Carbon Steel, Thread Both Ends, ASTM A53, Grade B, Schedule 40 Bore | | |
| | | | -----------------UNIONS------------------ | | |
| | | 2" and smaller | 150# Malleable Iron, ASTM A197, Ground Joint Type with Integral Seats, Threaded Ends | | |
| | | | ------------------PLUGS------------------ | | |
| | | 2" and smaller | Carbon Steel, ATM A105 Round Head Type, Threaded | | |
| | | | ------------------CAPS------------------- | | |
| | | 2" and smaller | 3000# Forged Carbon Steel, ASTM A105, Schedule 40 Bore, Threaded | | |
| | | | ------------THREAD COMPOUND-------------- | | |
| | | | Use "Liquid O Ring" for Pipe Threads | | |
| | | | -----------PIPE BENDS-------------------- | | |
| | | | Bend (Minimum 5 times the normal diameter) may be used in place of Threaded Fittings | | |
| | | | ----------------FLANGES----------------- | | |
| | | 2" and smaller | 150# ANSI, Flat Face, Threaded Ends, Carbon Steel, ASTM A105 Schedule 40 Bore | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | 3" and larger | 150# ANSI, Flat Face, Slip-On Type, Carbon Steel, ASTM A105, Schedule 40 Bore | | |
| | | 1/2" and larger | 150# ANSI, Flat Face Blind Flange Carbon Steel ASTM A105 | | |
| | | | ---------------ORIFICE FLANGES------------- | | |
| | | 1" and larger | 300# ANSI, Raised Face, Weld-Neck Type, Carbon Steel, ASTM A105, Schedule 40 Bore with 1/2 Scrd Taps | | |
| | | | ------------BRANCH CONNECTIONS------------- | | |
| | | | Branch — Use | | |
| | | 2" and smaller | Full or Reduced Size — Full or Reducing Tee | | |
| | | 3" and larger | Full Size — Full size tee | | |
| | | | 2" and smaller — Threadolet | | |
| | | | -----------PIPING INSTRUMENT CONNECTIONS--- | | |
| | | | Primary Instr. Conn's to Piping | | |
| | | | Temperature Conn's — 1" Scrd | | |
| | | | Pressure Conn's — 1/2" Scrd | | |
| | | | -----------------GASKETS------------------ | | |
| | | | Grafoil Flange Gasket, Flat Ring, 1/16" thick, John Crane or Approved Equal | | |
| | | | -----------------BOLTING----------------- | | |
| | | | Hex Head Machine Bolt with Hex Nut, ASTM A307 Grade B | | |
| | | | -----------------Y-STRAINER---------------- | | |
| | | 2" and smaller | 300" - Bronze Body ASTM B-62 Threaded Ends, 304 or 55 Screen with 0.045 Perforations<br>Acceptable Model<br>Armstrong Fig. No. F7SC-300 | | |
| | | 3" and larger | 150# ANSI, Flanged, Raised Face, Carbon Steel Body, ASTM A216, Grade WCB, 304 S.S. Screen with 0.045 Diameter Perforations<br>Acceptable Model<br>Armstrong Fig. No. BIFL | | |
| | | | ---------------THREAD COMPOUND------------- | | |
| | | | Thread Compound use "Liquid O Ring" for Pipe Threads | | |

| CODE NUMBER | ENCODER | SIZE FROM | TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|---|
| | | 2" and smaller | | ---------------GATE VALVES------------------<br>150# Threaded Ends, Rising Stem, Integral Seat, Body and Bonnet - Bronze ASTM B62, Trim Manufacturer's Standard<br>Acceptable Model<br>Crane Fig. No. 431 | | |
| | | 3" and larger | | ---------------GATE VALVES-----------------<br>125# ANSI Flanged Ends, Flat Face, OS&Y, Bolted Bonnet Body and Bonnet Cast Iron, ASTM A126, Class B, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 465 1/2 | | |
| | | 2" and smaller | | -----------------GLOBE VALVES--------------<br>200# Threaded Ends, Rising Stem, Union Bonnet, Integral Seat, Body and Bonnet - Bronze ASTM B61 - Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 70 | | |
| | | 3" and larger | | -----------------GLOBE VALVES--------------<br>125# ANSI Flanged Ends, Flat Face, OS&Y, Bolted Bonnet Body and Bonnet Cast Iron, ASTM A126, Class B, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 351 | | |
| | | 2" and smaller | | -----------------CHECK VALVES--------------<br>200# Threaded Ends, Swing Type, Screwed Bonnet, Body and Bonnet Bronze ASTM B61, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 36 | | |
| | | 3" and larger | | -----------------CHECK VALVES-------------<br>125# ANSI, Flanged, Flat Face, Swing Type, Bolted Bonnet, Body and Bonnet Cast Iron - ASTM A126, Class B, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 373 | | |
| | | 2" and smaller | | ---------------BALL VALVES----------------<br>300# - Threaded Ends, Handle Operated Body Bronze ASTM B61, Ball Stem and External Parts - Bronze, Seat and Body Seal TFE<br>Acceptable Model<br>Jamesbury Fig. No. A11TT | | |

| SERVICE: Cooling Water Supply and Return | CLASS PAGE 1 OF 3 |
|---|---|

| | | | |
|---|---|---|---|
| RATING: | 125# | CORROSION ALLOWANCE | — |
| FACING: | Flat Face | PRESSURE LIMIT | — Per B16.1 |
| MATERIAL: | Carbon Steel | TEMPERATURE LIMIT | — 200°F |

| CODE NUMBER | EN-CODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | -------------------PIPE------------------- | | |
| | | 2" and smaller | Carbon Steel, Galvanized, ASTM A120, Extra Strong, Threaded and Coupled Ends | | |
| | | 3" and larger | Carbon Steel, ASTM A53, Grade B, Standard Weight, Beveled Ends | | |
| | | | ----------------FITTINGS------------------ | | |
| | | 2" and smaller | 300# Galvanized Malleable Iron, Threaded Ends, ASTM A197 | | |
| | | 3" and larger | Black, Seamless or Welded Carbon Steel, Buttweld Ends, Standard Weight, ASTM A284, Grade WPB | | |
| | | | ----------------SWAGE NIPPLES-------------- | | |
| | | 2" and smaller | 300# Galvanized Malleable Iron ASTM A197, Threaded Ends | | |
| | | | ------------------UNIONS----------------- | | |
| | | 2" and smaller | 300# Galvanized Malleable Iron ASTM A197, Ground Joint Type with Bronze to Iron Seat, Threaded Ends | | |
| | | | ------------------PLUGS------------------ | | |
| | | 2" and smaller | 300# Galvanized Malleable Iron ASTM A197, Solid Square Head Type, Threaded End | | |
| | | | ---------------------FLANGES-------------- | | |
| | | 2" and smaller | 150# ANSI, Flat Face Screwed Flange, Galvanized Steel, ASTM A105 | | |
| | | | 150# ANSI, Flat Face Blind Flange, Galvanized Steel, ASTM A105 | | |
| | | 3" and larger | 150# ANSI, Flat Face Slip-on Type, Carbon Steel, ASTM A105 | | |
| | | | 150# ANSI, Flat Face Blind Flanges, Carbon Steel ASTM A105 | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | --------------------ORIFICE FLANGES--------- | | |
| | | | 300# ANSI, Raised Face Weld-Neck Type, Forged Carbon Steel, ASTM A105 with 1/2" Scrd Taps | | |
| | | 2" and smaller | Extra Strong Bore | | |
| | | 3" and larger | Standard Weight Bore | | |
| | | | ----------------BRANCH CONNECTIONS--------- | | |
| | | | Branch — Use | | |
| | | 2" and smaller | Full or Reduced Size — Full or Reducing Tee | | |
| | | 3" and larger | Full Size — Full size tee | | |
| | | | 2" and smaller — Threadolet | | |
| | | | -----------PIPING INSTRUMENT CONNECTIONS--- | | |
| | | | Primary Instr. Conn's to Piping | | |
| | | | Temperature Conn's — 1" Scrd | | |
| | | | Pressure Conn's — 1/2" Scrd | | |
| | | | Secondary Piping — Use this class | | |
| | | | ------------------GASKETS------------------ | | |
| | | | Grafoil Flange Gasket, Flat Ring, 1/16" thick, John Crane or Approved Equal. | | |
| | | | -----------------BOLTING------------------ | | |
| | | | Hex Head Machine Bolt with Hex Nut, ASTM A307 Grade B | | |
| | | | --------------THREAD COMPOUND-------------- | | |
| | | | Use "Liquid O Ring" for Pipe Threads | | |
| | | | ----------------GATE VALVES---------------- | | |
| | | 2" and smaller | 150# Threaded Ends, Rising Stem, Integral Seat, Body and Bonnet - Bronze ASTM B62, Trim Manufactures Standard<br>Acceptable Model<br>Crane Fig. No. 431 | | |
| | | | ----------------GATE VALVES---------------- | | |
| | | 3" and larger | 125# ANSI - Flanged Ends, Flat Face, OS&Y Bolted Bonnet, Body and Bonnet Cast Iron ASTM A126, Class B, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 465 1/2 | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ----------------GLOBE VALVE---------------- | | |
| | | 2" and smaller | 200# Threaded Ends, Rising Stem, Union Bonnet, Integral Seat, Body and Bonnet - Bronze ASTM B61 - Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 70 | | |
| | | 3" and larger | 125# ANSI - Flanged Ends, Flat Face, OS&Y Bolted Bonnet, Body and Bonnet Cast Iron ASTM A126, Class B, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 351 | | |
| | | | ----------------CHECK VALVES--------------- | | |
| | | 2" and smaller | 200# Threaded Ends, Swing Type, Screwed Bonnet, Body and Bonnet Bronze, ASTM B61, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 36 | | |
| | | | ----------------CHECK VALVES--------------- | | |
| | | 3" and larger | 125# ANSI, Flanged, Flat Face, Swing Type, Bolted Bonnet, Body and Bonnet Cast Iron, ASTM A126, Class B, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 373 | | |
| | | | ----------------BALL VALVES---------------- | | |
| | | 2" and smaller | 300# Threaded Ends, Handle Operated, Body Bronze, ASTM B61, Ball, Stem and External Parts - Bronze, Seat and Body Seal TFE<br>Acceptable Model<br>Jamesbury Fig. No. A11TT | | |

| SERVICE: | Pressurized Feed Gas | CLASS V PAGE 1 OF 2 |
|---|---|---|

| | | | |
|---|---|---|---|
| RATING: | 300# | CORROSION ALLOWANCE — | |
| FACING: | Raised Face | PRESSURE LIMIT — | Per B16.5 |
| MATERIAL: | Stainless Steel | TEMPERATURE LIMIT — | 200°F |

| CODE NUMBER | EN-CODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ------------------PIPE--------------------- | | |
| | | 1/2" - 10" | Stainless Steel, ASTM A312 Grade TP316L, Schedule 40S, Beveled Ends | | |
| | | | ----------------FITTINGS------------------ | | |
| | | 1/2" - 10" | Seamless Stainless Steel, ASTM A403 Grade WP316L, Buttwelding Ends Schedule 40S | | |
| | | | -------------------FLANGES----------------- | | |
| | | 1/2" - 10" | 300# ANSI, Raised Face Weld-Neck Type, Forged Stainless Steel ASTM A182 Grade F316, Schedule 40S Bore | | |
| | | | ----------------ORIFICE FLANGES------------ | | |
| | | 2" - 10" | 300# ANSI, Raised Face Weld-Neck Type, Forged Stainless Steel ASTM A182 Grade F316, Schedule 40S Bore, with 1/2" Socketweld Taps | | |
| | | | --------------BRANCH CONNECTIONS----------- | | |
| | | Header | Branch — Use | | |
| | | 1/2" - 10" | Full or Reducing — Full or Reducing Tees | | |
| | | | ---------PIPING INSTRUMENT CONNECTIONS----- | | |
| | | | Primary Instrument Connections to Piping | | |
| | | | Temperature Conn's — 1-1/2" Flgd | | |
| | | | Pressure Conn's — 1/2" BW | | |
| | | | Orifice Tap Connections — 1/2" SW | | |
| | | | -----------------GASKETS------------------- | | |
| | | 1/2" - 10" | Grafoil Flange Gasket, Flat Ring, 1/16" Thick, John Crane or Approved Equal | | |
| | | | ------------------BOLTS-------------------- | | |
| | | | Alloy Stud Bolts, ASTM A193 Grade B7, with 2 Heavy Hex Nuts, ASTM A194 Grade 2H | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ----------------GLOBE VALVES--------------- | | |
| | | 1/2" - 6" | 300# ANSI, Buttweld Ends, OS&Y, Bolted Bonnet, 316 Stainless Steel Body, 316 Stainless Steel Trim, Grafoil Packing, Sch 40S Bore<br>Acceptable Model:<br>Aloyco Fig. No. 2316A or 2316 | | |
| | | 1/2" - 6" | 300# ANSI, Raised Face Flanged Ends, OS&Y Bolted Bonnet, 316 Stainless Steel Body and Trim, Grafoil Packing<br>Acceptable Model<br>Aloyco Fig. No. 2317A or 2317 | | |
| | | | -------------------BALL VALVES------------- | | |
| | | | 300 ANSI, Buttweld Ends, 316 S.S. Body, Ball, Stem, and External Parts, Polyfill or Approved Equal Seat, Metal "S" Gasket or Approved Equal Body Seal, Lever Operated | | |
| | | 1/2" - 4" | Schedule 40S Bore | | |
| | | 6" only | Schedule 40S Bore<br>Acceptable Model: Worcester Controls<br>Fig. No. W5966PMBWS7 (1/2" - 4")<br>Fig. No. W4566PMBWS7 (6" only) | | |
| | | | ---------------PLUG VALVE------------------ | | |
| | | 1/2" - 3" | 300# ANSI, Butt-Weld Ends, 316 Stainless Steel Body, Cover, and Plug, Stainless Steel Cover Bolts, UHMW Polyethylene or Approved Equal Sleeve and Diaphragm, Wrench Operated, Sch 40S Bore | | |
| | | 4" - 10" | Ditto, except Enclosed Gear Operated<br>Acceptable Model:<br>Tufline Fig. No. 1366BW, Non-lubricated | | |
| | | | -----------------CHECK VALVES-------------- | | |
| | | 1/2" - 10" | 300# ANSI, Buttweld Ends, Swing Type, Bolted Cover, 316 Stainless Steel Body, 316 Stainless Steel Trim, Sch 40S Bore<br>Acceptable Model:<br>Aloyco Fig. No. 2376 | | |

## 9.0 COATING AND WRAPPING

### 9.1 SCOPE OF WORK

The Contractor shall provide all material, labor, equipment, and tools necessary for the preparation and application of corrosion resistant coatings for exterior surfaces of carbon and stainless steel pipe, flanges, valves, and fittings in direct buried service.

### 9.2 MATERIALS OF CONSTRUCTION

The following materials or Approved Equal are acceptable:

| MATERIALS | MANUFACTURER | MFR's CODE | SERVICE TEMPERATURE |
|---|---|---|---|
| Tape Primer | Polyken Div | No. 927 | -30°F to 200°F |
| Primary Tape | of the | No. 980 | -30°F to 200°F |
| Filler Tap | Kendall Co., | No. 931 | -30°F to 200°F |
| Joint Tape | Boston, Mass. | No. 930 | -30°F to 200°F |

### 9.3 EQUIPMENT

The pipe wrapping shall be electrically inspected with a Tinker & Rasor Model AP or APW or Approved Equal holiday detector set at a minimum dc voltage of 150 times the mil thickness of the coating to detect any wrapping flaws.

## 10.0 FIRE PROTECTION

### 10.1 SCOPE OF WORK

This Specification establishes the requirements for the design, fabrication, and installation including furnishing labor, materials, tools, and equipment, and performing operations necessary for engineering, detailing, inspection, testing, documentation, delivery to jobsite and installing Underwriters Laboratories (UL) and/or Factory Mutual (FM) approved automatic fire sprinkler systems, fire hose cabinets, and fire hose racks.

### 10.2 MATERIALS OF CONSTRUCTION

Sprinkler heads for offices and other finished areas shall be UL and/or FM approved, pendant type with ceiling plate, a temperature rating of 212 deg F, and a standard 1/2-inch orifice size. Sprinkler heads for all other areas shall be UL and/or FM approved brass upright type, with a standard 1/2-inch orifice size and a temperature rating of 212 deg F except near heat sources where the temperature rating shall be in accordance with NFPA Standard No. 13, Table 3-16.6.4.

Water flow detectors shall be provided and installed according to NFPA Standard No. 72A. Wiring and conduits shall be provided and installed by the Contractor.

Piping shall comply with the ANSI and ASTM standards. Pipe hangers shall be in accordance with requirements of the Underwriters' Laboratories, Inc., for use in sprinkler systems.

| | |
|---|---|
| Pipe: | Carbon Steel, ASTM A 53, Grade B, Standard Weight |
| Screwed Fittings: | Cast Iron ASTM A 126 conforming to ANSI B16.4 & B16.1 or Malleable Iron, ASTM A 197 conforming to ANSI B16.3 |
| Flanges: | Cast Iron ASTM A 126 conforming to ANSI B16.1 |
| Couplings and Unions: | As per NFPA Standard No. 13 |
| Valves: | (1) Class 175 WWP Iron Body, Bronze Mounted, OS&Y Gate Valves for all sizes larger than 2 inches |
| | (2) Class 175 WWP Iron Body Swing Alarm Check Valve |
| | (3) Class 175 WWP Iron Body Dry Pipe Valve |

## 10.3 EQUIPMENT

### 10.3.1 Alarm Check Valves

The alarm check valves shall be Viking Model F-1 Alarm Check Valve with retarding chambers and complete trim packages, or Approved Equal. A water motor gong local alarm shall be included with each wet pipe system.

### 10.3.2 Fire Hose Racks, Fire Hose and Extinguisher Cabinets

Fire hose racks and fire hose cabinets shall be of the surface mounted type and shall be provided and installed at the approximate locations shown on the drawings. All fire hose racks and cabinets shall be installed in compliance with NFPA Standard No. 14 for Class II service and NFPA Standard No. 13 for combined systems. All fire hose cabinets shall be sized to house a 2-1/2 gallon water-type fire extinguisher in addition to the hose and appurtenances.

APPENDIX C-2

ZEOLITE ENCAPSULATION OUTLINE SPECIFICATIONS

1.0 EARTHWORK

2.0 STRUCTURAL

3.0 ARCHITECTURAL

4.0 EQUIPMENT

5.0 HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS

6.0 PLUMBING

7.0 ELECTRICAL

8.0 PIPING MATERIALS

9.0 COATING AND WRAPPING

10.0 FIRE PROTECTION

# APPENDIX C-2
# ZEOLITE ENCAPSULATION
# OUTLINE SPECIFICATIONS

## 1.0 EARTHWORK

Earthwork shall include the removal of all vegetation, trash and debris, and excavation for foundations. Trash and debris shall be removed to a sanitary land fill. Excavated material suitable for backfilling shall be stock piled on site for later use. Cuts over 4 feet high shall be shored or have side slopes a minimum of 1-1/2 to 1. Backfilling of excavated areas shall be compacted to 95 percent of maximum dry density in accordance with ASTM D 1557, Method D.

## 2.0 STRUCTURAL

### 2.1 CONCRETE

2.1.1 Applicable Publications. Concrete shall conform to ACI-318, "Building Code Requirements for Reinforced Concrete", and to the requirements of the following publications of the American Concrete Institute. These publications will be used to the extent they are applicable:

ACI-304 "Recommended Practice for Measuring, Mixing and Placing Concrete"

ACI-305 "Recommended Practice for Hot Weather Concreting"

ACI-306 "Recommended Practice for Cold Weather Concreting"

ACI-308 "Recommended Practice for Curing Concrete"

ACI-315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures"

ACI-347 "Recommended Practice for Concrete Formwork"

2.1.2 Concrete Formwork. Forms shall be constructed to conform, within the tolerances specified, to the required shapes, dimensions, lines, elevations, and positions of the cast-in-place concrete members as indicated. Forms shall be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

2.1.3 Cast-In-Place Concrete. Concrete shall be standard density concrete (150 pounds per cubic foot) unless noted otherwise. The minimum compressive strength of concrete will be 3000 psi at 28 days. Portland Cement shall conform to ASTM C150. Reinforcing steel shall conform to ASTM A615, Grade 60. Wire mesh for slabs shall conform to ASTM A 185.

2.1.4 Grout. Grout shall be sufficiently fluid to ensure complete filling of all sections of units or areas requiring grout, but not so thin as to allow segregation of aggregate. All grouting shall be done in accordance with manufacturer's printed instructions. Grout shall be a non-shrink type.

2.2 METALS

2.2.1 Applicable Publications. The requirements of the following publications shall be used to the extent they are applicable:

American Institute of Steel Construction (AISC) "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings"

American Institute of Steel Construction (AISC) "Specification for Structural Joints Using ASTM A325 and A490 Bolts"

American Welding Society (AWS) "Structural Welding Code (AWS D1.1)

2.2.2 Structural Steel. Structural steel shall conform to ASTM A36. Fabrication and erection shall conform to AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings".

2.2.3 Bolting. Structural steel connections shall conform to "Specification for Structural Joints Using ASTM A325 or A490 Bolts". Structural stainless steel connections shall be similar to structural steel type connections, except that the mechanical properties of the bolts, nuts, and washers shall conform to the latest revision of ASTM A193 for Class 2, Grade B8, Type 304.

2.2.4 Welding. E308L electrode series shall be used to weld 304L stainless steel. Welding shall conform to the AWS Structural Welding Code, AWS D1.1, for carbon steel, to the ASME Boiler and Pressure Vessel Code for stainless steel, and to the requirements of the latest revisions of the following publications to the extent they are applicable:

"Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes", AWS A5.9

"Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes", AWS A5.9

"Specification for Flux-Cored Corrosion-Resisting Chromium and Chromium-Nickel Steel Electrodes", AWS A5.22

"Specification for Aluminum and Alumionum Alloy Welding Rods and Bare Electrodes", AWS A5.10

2.2.5 Masonry. Masonry units shall conform to ASTM C90, Grade N, Type I for 8 inch or 12 inch block. Reinforcing steel for masonry construction shall conform to ASTM A615, Grade 60 for deformed billet steel bars.

## 3.0 ARCHITECTURAL

### 3.1 WOODS AND PLASTICS

#### 3.1.1 Rough Carpentry

Rough carpentry shall be nailers, blocking, striping, and miscellaneous. Any member in contact with concrete or masonry shall be pressure preservative treated.

#### 3.1.2 Finish Carpentry

Finish carpentry shall be bult-in wood shelving, cabinets, hardwood shower seats, etc.

### 3.2 THERMAL AND MOISTURE PROTECTION

#### 3.2.1 Preformed Metal Siding

Ribbed siding panels, 22 gauge, lap type joint with insulation.

#### 3.2.2 Building Insulation

Building insulation shall be U.L. listed with flame spread under 25 and smoke developed and fuel contributed under 50. Insulation shall be in thicknesses as indicated on the drawings.

#### 3.2.3 Inverted Roof System

Dow Chemical Co., 3-1/2 inch thick styrofoam RM brand insulation shall be placed directly over the roofing membrane.

a. Built up Roofing

Roofing shall be 3-ply, 20 year bondable type, applied directly over substrate, John-Mansville or equal.

b. Polyester Formed Fabric

Dow Chemical Co. approved fabric shall be placed loosely over the insulation.

c. Crushed Stone

A crushed stone ballast of 1-1/2 inch shall be placed over the polyester formed fabric. Stone top covering shall be 3/4 inch to 1 inch in diameter.

3.2.4 Sheet Metal

Parapet flashing, counter flashing, base flashing, and flashing at roof penetrations shall be 24 and 22 Ga galvanized steel.

3.2.5 Sealants and Caulking

Sealants and caulking shall be silicone, polysulphide or polyurethane base, non-saf, gun-approved as pourable, selected as best suitable for applicable conditions.

3.3 DOORS AND WINDOWS

3.3.1 Metal Doors and Frames

Doors and frames shall be standard commercial type, conforming to the Steel Door Institute (SDI) standards as follows:

Doors: Flush panel, seamless; interior doors 18 gauge; exterior doors 16 gauge, galvanized.

Frames: Full welded or knock down construction; interior frames 16 gauge: exterior doors 14 gauge, galvanized.

Fire rated doors and frames, where required, shall conform to the requirements of U.L. and shall bear the appropriate label. All interior doors shall have 6 inch x 2 foot wire glass vision lites except doors leading to toilets, lockers and janitor rooms.

Explosion proof doors shall be able to withstand 1-PSI.

3.3.2 Finish Hardware

Finish hardware shall include mortise-type latchsets, locksets, exit devices, hinges, closers, thresholds, flushbolts, pulls, push/kick plates, door holders, and shall be heavy duty as manufactured by Sargent and Co. or equal. Exposed surfaces of hardware shall have a satin finish or as selected. All building exits shall be provided with panic exit devices.

3.4 FINISHES

3.4.1 Metal Studs

Except as otherwise noted all metal studs shall be 4 inches x 20 gauge, non-bearing screwable type, punched for utility lines, complete with top and bottom runners.

3.4.2 Gypsum Board

Gypsum board shall be 5/8 inch thick tapered edge throughout. Water resistant gypsum board shall be used in toilet rooms and janitors room. Type "X" shall be used in 1-hour fire rated areas.

3.4.3 Ceramic Tile

Ceramic tile work shall include regular Portland cement sitting beds and ceramic tile floors, wainscots and walls. Tilework and installation shall conform to the American National Standards Institute (ANSI) and the Tile Council of America (TCA).

3.4.4 Acoustical Ceilings

Acoustical ceilings shall be suspended exposed metal "T" grid system with lay-in acoustical units. Exposed "T" members shall be aluminum or steel with applied matte white enamel finish. Acoustical units shall be 24 inches x 48 inches x 5/8 inches. Acoustical material shall be U.L. listed with flame spread under 25 and smoke developed and fuel contributed under 50.

3.4.5 Cement Plaster

Cement plaster shall be installed on metal lath and steel framing on walls and ceilings where scheduled, including all necessary trim and accessories.

3.4.6 Resilient Flooring

a. Floor coverings in the Decon area, air lock and gallery shall be 200 vinyl chloride, 2 mm thick flooring as distributed by Dynamit Nobel of America Inc., or approved equal. Material shall be manufactured as a homogenous polyvinyl chloride with the pattern and color extending through the butt thickness and shall conform to Federal Specifications SS-T-312, L-F475, and ASTM E84. Material shall have chemical resistance to acids, bases, dye stuffs, and solvents and shall be noncombustible or self-extinguishing. Installation shall be made as a monolithic, seamless floor by heat welding and fusion, or by butt welding edges of material sheets together. Flooring shall be butt welded directly to 6" high Mipolam flexible vinyl cove.

b. All other areas such as offices and hallways shall have vinyl asbestos tile flooring as manufactured by Armstrong Cork Co. or equal. The tiles shall be 12 inches x 12 inches x 1/8 inch commercial quality. The base shall be four inches high top set vinyl cove base with pre-formed internal and external corners.

### 3.4.7 Painting

Except as excluded herein, all surfaces of new work shall be properly prepared, primed, and finished, including walls, ceilings, miscellaneous exposed materials, equipment, piping, hangers, conduits, grilles, etc., which normally require painting.

The following items shall not be painted:

- Surfaces receiving a special protective coating
- Concrete floors
- Anodized aluminum, chromed, or stainless metals
- Factory-finished items and equipment

The following items shall be primed or shop-coated prior to delivery to job site:

- Metal doors and frames
- Structural steel
- Miscellaneous metal work

Paints, primers, and finishes shall be ready-mixed and equal to first-line products as manufactured by:

Devoe and Reynolds, Inc.
Pratt and Lambert, Inc.
E. I. DuPont de Nemours and Co.
Rust-Oleum Corporation
Glidden Company
Benjamin Moore and Co.

a. Painting Schedule. All painting shall be two coats applied over a primer coat. The primer coat shall be appropriate for the surfaces to be painted and compatible with the types of finish coat used.

b. Interior Surfaces

| Surface | Finish |
|---|---|
| Concrete | 1 coat masonry flock filler<br>2 coats interior alkyd semigloss enamel |
| Galvanized Metal | 1 coat zinc dust-zinc oxide primer<br>1 coat interior enamel undercoat<br>1 coat interior alkyd semigloss enamel |

| Surface | Finish |
|---|---|
| Ferrous Metal | 1 coat zinc, iron oxide, alkyd resin-type metal primer<br>1 coat enamel undercoat<br>1 coat alkyd semigloss enamel |

c. Exterior Surfaces

| Surface | Finish |
|---|---|
| Ferrous Metal | 1 coat alkyd-oil resin-type metal primer<br>2 coats semigloss enamel |
| Galvanized Metal | 1 coat zinc dust-zinc oxide primer<br>2 coats semigloss enamel |

3.4.8 Special Coatings

Special coatings shall be Ameron system decontaminable special protective coating for floors, walls, and ceilings, or equal.

Concrete floors:

| | |
|---|---|
| Prime sealer | Nu-Klad 108 |
| Intermediate coat | Amercoat 66 |
| Top coat | Amercoat 66 (2 coats) |

Concrete Walls:

| | |
|---|---|
| Prime sealer | Nu-Klad 108 |
| Filler | Nu-Klad 114 |
| Intermediate coat | Amercoat 66 |
| Top coat | Seal gloss Amercoat 66 |

Structural Steel, Decking, Carbon Steel Doors and Frames:

| | |
|---|---|
| Primer | Amercoat 77 |
| Cleaner (for galvanized) | Galvaprep |
| Intermdiate coat | Amercoat 66 |
| Top coat | Amercoat 66 |

Protective Coating for Stainless Steel Embedded in Concrete:

| | |
|---|---|
| Double coating | Thurmalox 70 |

## 3.5 SPECIALTIES

### 3.5.1 Metal Toilet Partitions

Ceiling hung toilet partitions and wall hung urinal screen shall be products of Sanymetal Products or equal, "Century Type" with a baked enamel finish.

### 3.5.2 Toilet Accessories

Toilet accessories shall be products of Bobrick Washroom Equipment Co., or equal, including:

a. Mirror
b. Soap dispenser
c. Towel dispenser and waste receptacle
d. Sanitary napkin dispenser
e. Toilet tissue dispenser
f. Seat cover dispenser

### 3.5.3 Louvers

Louvers shall be products of Construction Specialties, Inc., or equal, mullion type louvers Model 4100 standard blade or as applicable and shall be constructed of extruded aluminum, 6063-T52 alloy, furnished with 1/2 inch mesh birdscreen.

### 3.5.4 Signs and Directories

Signs shall be products of Vomar Products, Inc., or equal.

### 3.5.5 Lockers and Benches

Lockers and benches shall be the products of Lyon Metal Products, or equal.

a. Lockers. Lockers shall be single tier-type, 12 inches wide, 18 inches deep, 72 inches high with baked enamel finish. Lockers shall be curb mounted.

b. Benches. Benches shall be constructed of hardwood seats, finished with three coats of plastic sealer mounted on enameled steel pedestals.

# 4.0 EQUIPMENT

## 4.1 PROCESS EQUIPMENT

### 4.1.1 Sump Catch Tank

Equipment No. KEF-HP-TK1. 42 in. diameter by 6 ft.-6 in. tall, constructed of ASME SA-240 Grade 304L stainless steel. Design and fabrication per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 at 15 PSIG and 100°F. Capacity shall be 500 gallons. Equipped with an electric motor driven agitator (Equip. No. KEF-HP-AG1) and an internal spray header for decontamination solutions with inlet, outlet, vent, and instrumentation connections and agitator mount.

### 4.1.2 Decontamination Solution Make-Up Tank

Equipment No. KEF-HP-TK101. 42 in. diameter by 4 ft.-0 in. tall, constructed of ASME SA-240 Grade 304L stainless steel. Design and fabrication per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 at 15 PSIG and 200°F. Capacity shall be 300 gallons. Equipped with an electric motor driven agitator (Equip. No. KEF-HP-AG101) and a steam heating coil with inlet, outlet, vent, and instrumentation connections and agitator mount.

### 4.1.3 Pressurized Feed Gas Mixture Lag Storage Vessels, Pressurized Feed Gas Mixture Run Tank, Isostatic Run Tank

Equipment No. KEF-HP-TK2 (eight required), KEF-HP-TK3 (two required), and KEF-HP-TK4 (two required). 12 in. nominal diameter pipe (Sch. 80S) by 12 ft.-0 in. long, constructed of ASME SA-312 Grade TP316L stainless steel. Design and fabrication per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 at 1270 PSIG and 300°F. Capacity shall be 9.5 cubic feet. Equipped with inlet, outlet, and instrumentation connections. The ten vessels shall be stacked two wide by five high in a structural steel frame as shown on Drawing No. P-6.

### 4.1.4 Fresh Isostatic Gas Supply Cylinders

Equipment No. KEF-HP-TK101, (three required) 9 in. nominal diameter by 4 ft. 4 in. tall, constructed of carbon steel. Design pressure 2490 PSIG at 100°F. Capacity shall be 1.54 cubic feet each. Assembled with manifold, individual shut-off valves, pressure reducing station, and inlet and outlet pressure indicators.

### 4.1.5 Pressure Relief Accumulator

Equipment No. KEF-HP-TK5. 18 in. nominal diameter pipe (Sch. 80S) by 4 ft.-6 in. long, constructed of ASME SA-312 Grade TP316L stainless steel. Design and fabrication per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 at 900 PSIG and 200°F. Capacity shall be 8 cubic feet. Equipped with inlet, outlet, and instrumentation connections.

4.1.6 Feed Gas Mixture Compressor

Equipment No. KEF-HP-COM1&2 (two required). Single stage, diaphragm type with hydraulic fluid providing the pulsating motion to compress Krypton-85 gas from an inlet pressure of 340 psig at 70°F, to a discharge pressure of 500 psig. Compressor displacement shall be 1 CFM at 400 rpm. A triple diaphragm shall be used with a detection system to indicate either compressed gas or hydraulic fluid leakage through the diaphragm. Parts in contact with krypton shall be Type 316 stainless steel, other parts may be manufacturer's standard for the application. The compressor shall be electric motor belt driven. Maximum compressor speed shall be 400 rpm, electric motor speed shall be 1800 rpm. The electric motor shall be 460V, 3 phase, 60 Hertz. Each compressor and drive shall be assembled and mounted on a structural frame.

4.1.7 Decontamination Solution Pump

Equipment No. KEF-HP-P101. Centrifugal, horizontal, electric motor driven pump. Motor speed shall be 1800 rpm. Parts in contact with decontamination solutions shall be Type 316 stainless steel. Pump capacity shall be 50 gpm with 40 feet TDH.

4.1.8 Closed Loop Cooling Water Pump

Equipment No. KEF-HP-P1&2 (two required). Centrifugal, horizontal, electric motor driven pump. Motor speed shall be 1800 rpm. Pump material shall be ductile iron. Pump capacity shall be 100 gpm with 60 feet TDH.

4.1.9 Krypton Vacuum Pump
Helium Vacuum Pump

Equipment No. KEF-HP-VP 1 & 2 (two required), and Equipment No. KEF-HP- VP 3 & 4 (two required). Cam and piston, compound vacuum pump, capable of displacing 3 CFM minimum at $10^{-2}$ Torr. Metals in contact with the process shall be Type 316 stainless steel. Other materials in contact with the process shall be compatible with radioactive Krypton-85. Pump shall be motor driven, single or three phase, 230/460V, 60 hertz. Maximum motor speed shall be 1800 rpm.

4.1.10 Pressurized Feed Gas Cooler

Equipment No. KEF-HP-HE1. Shell and tube type heat exchanger with 20,000 BTU/hr. duty. Materials is contact with krypton gas shall be Type 316 stainless steel, other materials may be carbon steel. Design and fabrication per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, and TEMA R requirements. Design pressure for gas side shall be 600 PSIG, with 200°F inlet temperature and 110°F maximum outlet temperature. Design pressure for water side shall be 100 PSIG, with 95°F inlet temperature.

4.1.11 Closed Loop Cooling Water Heat Exchanger

Equipment No. KEF-HP-HE2. Shell and tube type heat exchanger with 200,000 BTU/hr. duty. Materials shall be carbon steel with admiralty tubes. Design and fabrication per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, and TEMA R requirements. Design pressure shall be 100 PSIG, with closed loop water inlet temperature 130°F and outlet temperature 95°F, and cooling water inlet temperature 85°F.

4.1.12 Pressurized Feed Gas Filter

Equipment No. KEF-HP-F1. Inlet filter with removable sintered metal element. Filter rating shall be 2 micron with 2 CFM flow and 500 PSIG pressure, with no more than 10 PSI pressure drop. Materials in contact with Krypton-85 shall be Type 316 stainless steel.

4.1.13 Sump Liquid Sampler
Sump Catch Tank Liquid Sampler

Manually initiated, isolating, plunger type, air powered, solenoid valve actuated liquid sampler.

4.1.14 Sump Eductor
Sump Catch Tank Eductor

Air or steam operated liquid eductor, 30 gpm transfer rate, Type 304L stainless steel.

4.1.15 Hot Isostatic Press

Equipment No. KEF-HP-HIP1. Top loading, single level, graphite, natural convection style hot isostatic pressing furnace with isolated dual gas differential pressure control capability, 30 liter vessel capacity, 8.8 liter container capacity, with electric internal furnace and water cooled pressure vessel shell. Includes top vessel plug, movable plug yoke, pressure control gas system, feed compressors KEF-HP-COM 3 & 4 and KEF-HP-COM 5 & 6, and vacuum pump. Operating pressure 14,700 PSIG at 700°C, 50 kW maximum power, 41,000 BTU/hr heat input, design per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

4.1.16 Substrate Activation Furnace

Equipment No. KEF-HP-AF1 (two required). Electric resistance heated furnace with capacity for 8.8 liter substrate container, 40 kW heat input.

### 4.2 MECHANICAL EQUIPMENT

#### 4.2.1 Mini-Trailer Robo-Carrier

(2 required). Remotely operated, automatically controlled electric cart and platform lift assembly, with vertical and horizontal canister cradles, pneumatic push/pull piston, and pre-programmed positioning capability.

#### 4.2.2 In-Cell Bridge Crane

Remotely operated bridge crane with 12-ft. 0-in. span and 5-ton top mounted trolley and hoist, and with two 1/2-ton underslung auxiliary trollies and hoist, as manufactured by Edder Corp. or Approved Equal.

#### 4.2.3 Remote Welder

Fully remote automatic welding station as manufactured by Astro-Arc or Dimetrics Corporation or Approved Equal.

#### 4.2.4 Leak Detection System

Fully remote automatic leak detection system with automatically calibrated helium detector.

#### 4.2.5 Master-Slave Manipulators

(Four required). Model "F" type master-slave manipulators, for assistance and maintenance of automatic welder and remote leak detection system, as manufactured by Central Research or Approved Equal.

## 5.0 HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS

### 5.1 SUPPLY FANS

Supply fans shall be single-width, single-inlet, non-overloading centrifugal type with airfoil blades, V-belt drive and TEFC motors, AMCA Class II construction, and variable inlet vortex vane damper capacity control. Capacity shall be 2670 cfm at 3.0 inches wg static pressure and 3-hp. Fans shall be Buffalo Forge Co. type BL-Aerofoil, size 270, or Approved Equal.

### 5.2 EXHAUST FANS

Exhaust fans shall be designed and constructed to operate continuously prior to, after, but not necessarily during an Operating Basis Earthquake (OBE). Fans shall be single-width, enclosed radial blade centrifugal type, V-belt drive and TEFC motors, AMCA Industrial Exhauster class. Capacity shall be 2800 cfm at 10-inches wg static pressure and 10 hp. Fans shall be Buffalo Forge Co. Industrial Exhaust model, size 30 MV, or Approved Equal.

5.3 VENT FANS

Vent fans shall be single-width, single-inlet non-overloading centrifugal type with airfoil blades, V-belt drive and TEFC motors, AMCA class III construction, and variable inlet vortex vane damper capacity control. Capacity shall be 4000 cfm at 1-inch wg static pressure and 1-hp. Fan shall be Buffalo Forge Co. type BL-Aerofoil size 270, or approved equal.

5.4 POWER ROOF VENTILATORS

Power roof ventilators shall be low silhouette, all aluminum construction, spun housing type. Fans shall be centrifugal type with direct drive. Capacity shall be 100 cfm at 3/8 inches wg static pressure.

5.5 PREHEAT COILS

Preheat coils shall be 2-row, non-freeze, finned tube, low pressure steam type. Coil capacity shall be 2670 cfm and 168,000 Btu/hr at 15 psig steam pressure, with -20$^{o}$F entering and +40$^{o}$F leaving air temperatures.

5.6 HEATING COIL

Heating coils shall be the 1-row, finned tube type designed for modulating control with steam at 15 psig pressure.

5.6.1 Contaminated Areas

Heating coil serving the Load-out, Gas Storage, and Substrate areas shall have a capacity of 570 cfm and 26,000 Btu/hr with +40$^{o}$F entering and 90$^{o}$F leaving air temperatures. Coil face area shall be 1.0 square feet.

Heating coil serving the Assembly area shall have a capacity of 1180 cfm and 32,000 Btu/hr with +40$^{o}$F entering and 70$^{o}$F leaving air temperatures. Coil face area shall be 2.0 square feet.

5.6.2 Non-Contaminated Areas

Heating coil serving the Office, Health/Physics, Operating Gallery, and Vestibule shall have a capacity of 920 cfm and 41,400 Btu/hr with +40$^{o}$F entering and +90$^{o}$F leaving air temperature. Coil face area shall be 1.5 square feet.

5.7 COOLING COIL

Cooling coil shall be finned tube type for direct expansion refrigerant service. Coil shall be provided with a liquid refrigerant distributor. Coil capacity shall be 920 cfm and 24,000 Btu/hr. Coil shall have a face area of 2.0 square feet and be six rows deep.

5.8 SUPPLY AIR FILTER BOXES

Supply air filter boxes shall be the side loading type containing a guide track for prefilters and a separate guide track for high efficiency filters. Prefilters shall have an efficiency of 30% per ASHRAE Standard 52-76. High efficiency filters shall have an efficiency of 90% per ASHRAE Standard 52-76. Filter boxes shall be Farr Co. side loading model 3P Universal Glide/Pack with type 30/30 prefilters and type HP-200 high efficiency filters, or approved equal. Filter box capacity shall be 2670 cfm and shall have 2-24" x 24" x 4" prefilters and 2-24" x 24" x 12" high efficiency filters.

5.9 EXHAUST AIR HEPA FILTER PLENUMS

Filter plenums shall contain two stages of side loading, bag-out HEPA filters and provisions for remote in-place DOP testing of each HEPA filter. Filter plenums and filters shall be as manufactured by Flanders Filter, Inc. Each plenum shall consist of the following:

1) Upstream first test section, T-I, including DOP injection port, DOP diffusers, and upstream challenge aerosol concentration sample port.

2) First stage of HEPA filters in a model E-4, side loading, bag-out housing.

3) Center combination test section, T-C, including DOP injection port, DOP diffusers, and sample port for measuring first stage downstream sample concentration or second stage upstream sample concentration.

4) Second stage of HEPA filters in a model E-4, side loading bag-out housing.

5) Last test section, T-O, including DOP diffusers and sample port for measuring second stage downstream concentration.

Capacity of each filter plenum shall be 3000 cfm. Each filter shall be 24" x 24" x 11-1/2" and arranged in the plenum 3-wide by 1-high.

5.10 SPRAY COOLING CHAMBER

A spray water chamber shall be provided upstream of each exhaust air HEPA filter plenum. Each spray chamber shall be of stainless steel all welded construction. One bank of spray nozzles shall be provided together with moisture eliminators, and drain sump. Capacity shall be 2800 cfm with a face area of 5.6 square feet.

5.11 UNIT HEATERS

Unit heaters shall be horizontal suspended type with steam heating coil, propeller fan, and adjustable discharge air louvers. Capacity shall be 50,000 Btu/hr with 15 psig steam pressure. Unit heaters shall be Trane Co. model 60-S, or approved equal.

5.12 AIR COOLED CONDENSING UNIT

Air cooled condensing unit shall be for split system service and shall include an air cooled condenser, hermetic refrigerant compressor, and automatic control system. The unit shall have a capacity of 24,000 Btu/hr with 95°F ambient air. Unit shall be Carrier Corp. model 38GS024, or approved equal.

## 6.0 PLUMBING

### 6.1 SCOPE OF WORK

The Contractor shall provide all labor, materials, equipment, and tools necessary for the installation of interior plumbing piping, plumbing fixtures, and plumbing piping extending out to 5 ft from the building where a break is made between plumbing and exterior sewage, drainage, and water piping materials.

The work shall include, but shall not be limited to the following:

#### 6.1.1 System

Furnishing and installing a complete plumbing system consisting of soil, waste and vent lines and hot and cold water distribution.

#### 6.1.2 Fixtures, Trim, and Accessories

Furnishing and installing plumbing fixtures, trim and accessories.

#### 6.1.3 Sewer and Water Lines

Furnishing and installing sewer and water lines from building to 5 ft-0 in. outside of building.

#### 6.1.4 Flashing

Furnishing and installing flashing and counterflashing for items of this system.

### 6.2 MATERIALS OF CONSTRUCTION

#### 6.2.1 Waste and Vent

Above ground 1-1/2 in. and smaller shall be Schedule 40 galvanized steel pipe with coated cast iron drainage type screwed fittings. 2 in. and larger shall be service weight cast iron soil pipe and fittings (Bell and Spigot Type or No-Hub).

6.2.2 Sewer

Below grade or slab shall be Bell and Spigot service weight cast iron soil pipe with neoprene compression gaskets to ASTM C 564. Above grade shall be standard weight cast iron Bell & Spigot or No-Hub.

6.2.3 Domestic Hot and Cold Water Piping

Materials shall be Schedule 40 galvanized carbon steel pipe and fittings to ASTM A 120 with 300 lb rating.

6.2.4 Steel Pipe Unions

Galvanized 300 lb malleable iron, railroad ground joint type.

6.2.5 Valves

Valves shall be gate valves 150 lb. Screwed bronze ISRS, Crane No. 431 or Approved Equal, or ball valves 300 lb. Screwed brass with TFE seals, Pacific No. 1-B or Approved Equal.

6.2.6 Partition Stops

Repcal B98 or Approved Equal, loose key type, hose bibb, with flange.

6.2.7 Strainer

Sporlan or Approved Equal.

6.2.8 Sleeves

Sleeves shall be of 24 gauge galvanized iron or steel, for use wherever pipes pass through concrete floors and foundations.

6.3 PLUMBING FIXTURES

6.3.1 Water Closet. American Standard No. 2502.011 white vitreous china, siphon jet wall hung, Sloan Royal No. 110 flush valve, white open front seat less cover. J. R. Smith No. 100 carrier.

6.3.2 Urinal (Mark - UR). American Standard No. 6500.011 white vitreous china, wall hung, Sloan Royal NO. 186-11 flush valve with 1-1/4 in. top spud, wall and spud flanges, vacuum breaker, with adjustable floor support.

6.3.3 Lavatory (Mark - L-1). American Standard No. 0350.132 20 by 18, wall hung, white vitreous china, No. 2248.284 faucet with pop-up drain, No. 2303.063 loose key angle stop supply pipes, No. 4401.014 adjustable P-Trap. Adjustable type concealed lavatory, floor support carrier, with four point locking.

6.3.4 Shower (SH). Sloan Royal No. AC-10 Ac-to-matic with 3 gpm flow control. Stainless steel, built-in mixing valve with 1/2 in. inlet ports.

6.3.5 Floor drain (FD-1). Josam 30000A cast iron body, nickel bronze strainer.

6.3.6 Roof Drain (RD). Josam 21000 Series, large dome, bottom outlet with standard clamp ring and gravel stop, gasket, dome, and body and to include deck clamp, drain receiver, and stationary extension collar.

6.3.7 Overflow Drain (OD). Josam 21000-16 Series, large dome, bottom outlet with standard clamp ring and gravel stop, gasket, dome, and body and to include deck clamp, drain receiver, and stationary extension collar.

6.3.8 Cleanouts (types)

(1) Ordinary: Zurn A-1305

(2) Floor Type: Zurn Z-1326-1 or Z-1326-10, for setting with top flush and square with floor.

(3) Wall Type: Zurn with Z-1310 chrome plated cover plate.

6.3.9 Water Hammer Arresters (WHA). Water hammer arresters shall be Zurn Shocktrol 1700 Series, Smith 5000 Series, or Approved Equal.

6.3.10 Roof Drainage. Piping for the roof drainage system will be carbon steel, hot-dipped galvanized, ASTM A53, Gr "B", Std. Wt. threaded ends. Fittings will be 125# cast iron, ASTM A126, Grade B, hot-dipped galvanized, threaded ends.

6.4 EQUIPMENT

6.4.1 Electric Water Coolers

The cooler capacity shall be in accordance with Sunroc Model NSF-8-D or Approved Equal. The cabinet shall be constructed of 19-20 gauge welded stainless steel, with a removable front panel, a stainless steel base, and a Type 300 series stainless steel top. A chrome plated brass hand operated bubbler on a raised mount shall have a built-in pressure regulator. The Contractor shall furnish a reciprocating type hermetically sealed motor compressor with an air cooled condenser and a tube type cooling unit for Type 12 refrigerant, an insulated power cable, and an enclosed, adjustable thermostat. Electrical specifications are 1/4 hp, 115 V, 60 Hz, single phase. The cooler shall bear the Underwriters Laboratory (UL) label.

### 6.4.2 Electrical Water Heaters

The heater shall bear the Underwriters Laboratory (UL) label. Each heater shall have a steel glass lined tank with a magnesium anode, 4 bolt flange, inconel sheathed, rod-type heating element with pre-wired terminal leads, and immersion type thermostat switching a magnetic contactor(s). The heater shall have a minimum 3 inch glass fiber insulation with a round steel shell. Each heater shall be provided with an ASME rated temperature and pressure relief valve.

## 7.0 ELECTRICAL

This section applies to all electrical equipment and components, which will be used on the Ion Implantation/Sputtering Facility. All items are commercially available and shall comply with applicable codes and standards. The power and services required are available from the existing Site utilities. Conduit only will be stubbed out 5 ft from the building for 13.8 kV normal and 480 volt standby power connections.

### 7.1 CONDUIT

All conduit systems shall be UL approved, rigid steel, zinc-coated or 304L seamless stainless steel, Schedule 40 pipe. The minimum conduit size shall be 3/4 in. for power, unless otherwise noted, and 1/2 in. for exposed communication, control and instrumentation. Insulated bushings shall be provided at all terminals, where hubs are not used. Flexible metallic conduit shall be liquid tight. Expansion type conduit fittings shall be used across building expansion joints.

### 7.2 WIREWAYS AND AUXILIARY GUTTERS

Wireways and auxiliary gutters used in dry locations shall be preformed with screw type covers.

### 7.3 BUILDING WIRE, 600 VOLT

Single conductors for power, lighting, and miscellaneous control shall be 600 volt, code type, 90$^{o}$C, RHH-RHW,USE,FP1 with chlorosulfonated, polyethylene jacket for No. 2 AWG and larger, Okonite Okolon, or equal. Type THHN-THWN shall be used for conductors smaller than No. 2 AWG. The minimum control wire size shall be No. 14 AWG, and No. 12 AWG for all other wiring. All conductors shall be stranded copper except that lighting and branch circuits with wiring No. 10 AWG and smaller may be solid. Aluminum wire is not acceptable.

7.4 HIGH RADIATION WIRE

All wiring, single or multi-conductor, within high radiation areas and through shielding walls shall be No. 12 AWG minimum, Class IE, 600 volt wire rated for $10^7$ R minimum total integrated dosage, as manufactured by American Insulated Wire Corp., Boston Insulated Wire and Cable Co., PSC, Div. M.W. Riedel, or The Rockbestos Co. Wiring inside the high radiation areas shall be multi-conductor with a special chlorosulfonated, polyethylene overall jacket suitable for decontamination with water, nitric acid, oxalic acid, and Turco No. 4502.

7.5 UNIT SUBSTATION, 13.8 KV TO 480 VOLT

The indoor unit substation shall consist of a three-position, manually operated, 600 amp, 15 kV primary fused interrupter switch, a silicone insulating fluid transformer, a secondary main and feeder draw-out air circuit breakers. The rating and the equipment quantity shall be as shown on the Single Line Diagrams. The 480 volt breakers shall have static long time (L), short time (S), and ground (G) tripping characteristics. The buses shall be copper with silver plated joints and connections. A manually operated overhead hoist shall be provided to remove the 480 volt air circuit breakers.

7.6 DISTRIBUTION TRANSFORMERS

The quiet type distribution, three-phase transformers, rated 480-208Y/120 volt, shall be general purpose dry type in an indoor enclosure and shall have 220°C insulation temperature classification and 150°C winding temperature rise for 30 kVA and larger, and 185°C insulation temperature and 115°C winding temperature rise for 25 kVA and smaller. Full capacity NEMA standard taps shall be provided on the high voltage winding.

7.7 MOTORS

Motors shall be of sufficient size for the duty to be performed. All motors shall have full nameplate horsepower available with a service factor of 1.0 at 3000 ft elevation and 1.15 at sea level. Unless otherwise specified, all motors shall be totally enclosed, and shall have a continuous duty classification based on a 40°C, ambient temperature of reference. Crane and monorail motors shall be rated for 30 minute intermittant duty. Motors shall be the premium efficiency type. The motors shall have the following factory guaranteed minimum efficiencies in accordance with IEEE 112 Test Procedures and shall have the efficiency index letter stamped on the motor nameplate:

| HP | % Efficiency | HP | % Efficiency | HP | % Efficiency |
|---|---|---|---|---|---|
| 1 | 78.5 | 10 | 88.9 | 50 | 92.0 |
| 1 1/2 | 81.5 | 15 | 89.8 | 60 | 92.0 |
| 2 | 81.5 | 20 | 90.6 | 75 | 93.3 |
| 3 | 84.0 | 25 | 90.6 | 100 | 93.3 |
| 5 | 84.0 | 30 | 91.4 | 125 | 93.3 |
| 7 1/2 | 88.9 | 40 | 92.0 | 150 | 94.3 |

The motor insulation shall be Class F minimum. Motors in high radiation areas shall have Class H insulation and shall be rated for $2 \times 10^7$ R total minimum gamma radiation dosage. The high radiation area motors shall be suitably coated in the field with Crouse-Hinds "Corro-Free S-602" Cat. No. ETU2, or equal. The motor voltage rating shall be selected as follows:

1/2 hp through 150 hp: 460 volt, 3 phase, 60 hertz

1/3 hp and smaller: 115 volt, single phase, 60 hertz

Motors 1/4 hp and 1/3 hp in a batch process shall be rated 460 volts, 3 phase, 60 hertz. Polyphase motors shall be NEMA Design B minimum, squirrel cage type, having normal starting torque and low starting current; single-phase motors shall be capacitor start type, except that motors rated 1/6 hp and less may be split phase type. Gear motors shall be Class II or III, in accordance with the gear loading requirements. Motors 5 hp and larger shall have full load power factor of 0.85 minimum. Motors 5 hp and larger with a full load power factor less than 0.85 shall be corrected to at least 0.90, utilizing a power factor corrective device located at the motor. Two-speed motors shall be the two-winding type. Motors connected to the site standby power shall be capable of starting on a voltage reduction of 20 to 30 percent. A copper grounding lug shall be provided in terminal connection box of all 460 volt, 3 phase motors.

## 7.8 STARTERS

Combination magnetic starters with 120 volt transformer and control shall be provided for 460 volt, 3 phase motors that are 1/2 hp through 150 hp, and manual starters shall be provided for all 115 volt, single phase motors smaller than 1/2 hp.

## 7.9 MOTOR CONTROL CENTERS

The motor control center (MCC1) and split bus motor control center MCC2 shall be 277/480 V, 3 phase, 4 wire, 60 hertz, free-standing, dead-front, dead-rear, copper bus only, NEMA Class II, Type B wiring consisting of vertical sections containing phase busing, terminals, copper ground bus, wireways, and housing modular plug-in type equipment drawers behind interlocked hinged doors Westinghouse Type Five Star, or equal. The enclosures shall be NEMA 1. All operating handles and controls shall be externally operable. An individual, 480-120 volt control transformer with secondary fuse shall be provided for each motor starter. Each starter shall have a HAND-OFF-AUTO selector switch in the cover. The motor control center shall be braced for a minimum of 22,000 ampere symmetrical short circuit. The automatic transfer switch, with solid state control and located in the standby section of the motor control center MCC2, shall be rated 260 amp, 480 volt, 3 phase, 3 pole, 60 Hz, and suitable to withstand a 22,000 amp short-circuit fault. Upon power failure, the transfer switch shall automatically start the Site diesel generator system. The return to normal power shall be manual. In the event the standby power fails and normal power is available, the transfer switch shall have an override to transfer automatically to normal power. Two each tandem pilot lights shall be provided to indicate the contact position. The transfer switch shall be ASCO Model 940326099 with accessories 6C, 9A, 9B and 28, or equal.

7.10 PANELBOARDS

The panelboards shall be dead front, copper bus, 4 wire, circuit breaker type. Circuit breakers shall be E Frame minimum and rated for ac or dc operation. The circuit breakers shall have a minimum interrupting rating of 10,000 rms symmetrical amperes for 208 volt panelboards and 14,000 rms symmetrical amperes for 277/480 volt lighting panelboards. A ground bus with screw terminals shall be provided. Neutral buses shall be isolated. Enclosures shall be NEMA 1, surface mounted. Panelboards of sizes and ratings, as shown on the drawings, shall be provided to serve the ventilating, lighting, and miscellaneous power loads. Ground fault interrupter (GFI) breakers rated 120 Vac only shall be provided, as required by National Electrical Code.

7.11 RECEPTACLES

Convenience outlets shall conform with NEMA Standard configuration 5-15R and shall be 3 wire, duplex, grounding type, 120 Vac, 15 amp, Hubbell Cat. 5262, or equal.

Receptacles for 480 volt, 3 phase service shall be 60 amp, 4 pole, 3 wire type, with spring door and combined with a non-fused, heavy-duty, horsepower rated disconnect switch, Crouse-Hinds WSRD 63542 or equal. The mating male plugs shall be Crouse-Hinds APJ 6485, or equal, for 60 amp service.

7.12 HIGH RADIATION AREA CONNECTORS

The remote electromechanical manipulator operated, 304 stainless steel, connectors shall be rated for $10^7$ R total integrated dosage minimum and 600 volts. The connector shall be suitably sealed for decontamination with nitric acid, oxalic acid and Turco No. 4502. The receptacle and plug assembly shall be Gulton Lormec Series 9588 and 9405 respectively, or equal.

7.13 SAFETY SWITCHES

Safety switches shall be the heavy-duty type, horsepower rated, 600 volt, 3 pole, with current rating and fusing, as shown on the drawings. The enclosure shall be NEMA 1.

7.14 TOGGLE SWITCHES

Toggle switches installed for the control of incandescent, high pressure sodium, and fluorescent lighting luminaires shall be heavy-duty, general purpose, UL approved devices. Toggle switches shall be specification grade, single-pole, Hubbell Cat No. 1221 or 1221-I, or equal.

7.15 LIMIT SWITCHES

The non-plug-in limit switches shall be heavy-duty type, 600 volts, 10 amp continuous rating contacts, single pole, double throw (SPDT) or electrically independent double pole, double throw (DPDT). The limit switches shall be Micro Switch Type HDLS Series, or equal.

7.16 BOXES AND FITTINGS

Outlet boxes shall be rust-resistant, cast-iron alloy boxes with threaded hubs or bosses for conduit connection. Pullboxes and their covers shall be constructed of galvanized steel.

7.17 RELAYS

Control relays shall be magnetically operated relays with 120 Vac coils, and contacts rated for 10 amp inductive at 120 volt continuous duty. Timing relays shall be magnetic relays with an adjustable pneumatic timing mechanism and a minimum 5 amp continuous contact rating.

7.18 GENERAL LIGHTING

Commercial type recessed fluorescent luminaires with acrylic lenses and high power factor and energy saving ETL, Class P ballasts and 4 ft, cool white, rapid start fluorescent lamps with wattage not to exceed 35 watts shall be used in offices, control room, toilet and similar areas. Ballasts shall not contain PCB capacitors. Industrial type fluorescent luminaires with upward component and porcelain enamel reflectors shall be utilized in other low bay areas. Lighting in the high bay areas shall utilize high pressure sodium (HPS) luminaires. Exterior HPS wall mounted luminaires shall be provided. Special cell HPS luminaires, suitable for remote removal, shall be provided, as required.

The emergency lighting shall be provided by fully automatic 120/277 V supply, lead calcium rechargeable batteries, Holophane Cat. No. M-12-2A-X, or equal.

7.19 LIGHTNING PROTECTION

Lightning protection, complete with UL Master "C" label, shall be provided.

7.20 GROUNDING

A No. 4/0 AWG soft drawn bare copper ground loop with 3/4 in. by 10 ft. copper-clad steel ground rods, shall be provided and connected to the Site duct bank ground system. One insulated instrumentation ground bus plate and cable shall be furnished in the control room. The cable shall be connected to the facility ground system at only one point. The maximum facility ground resistance shall be five ohms. The lowest level of building reinforcing bar shall be grounded. The shielding window liners shall be grounded.

7.21 CATHODIC PROTECTION

Cathodic protection shall be provided for all direct buried metallic lines and underground tanks.

7.22 TERMINAL BOXES

Control terminal box enclosures shall be NEMA 1 sheet steel construction with hinged door, lock and steel equipment mounting panel(s). Barriers shall be steel, full depth and height, finished the same as the enclosures. The interior of the enclosure shall be finished with white enamel. The exterior shall be painted with color, as directed.

7.23 TERMINAL BLOCKS

All power and control wiring shall be terminated on accessible terminal blocks. The 600 volt, melamine, rail mounted, terminal blocks shall be Weidmuller Type SAK, or equal. A snap-in preprinted unique wire number marker shall be provided. Hand lettered terminal identification is not acceptable. Terminal connectors shall be the vibration proof, pressure clamp type.

7.24 TELEPHONE SYSTEM

Telephone cabinets shall be provided, as required. Conduit only shall be installed in the building, as required. The telephone system wiring will be by Others.

7.25 CELL SPEAKER SYSTEM

A cell speaker system shall be provided for monitoring audio sounds inside the cell. The system shall consist of a microphone with box mounted on a remotely removable Gulton plug in the cell and connected to a speaker in the control room.

7.26 FIRE ALARM DETECTION SYSTEM

The fire detection system shall include control panels, annunciators, initiating devices, signal conduits, and wire necessary for a complete and operational system. The final connection to the Site fire alarm system will be by Others. The system shall be Pyr-A-Larm System 3, or equal. The system shall consist of a multiplexer and enclosed terminal board, thermal detectors, manual stations, public address speakers, control panel audible devices, remote annunciator and control panels. The detection devices shall be capable of being interchanged without any changes required to the wiring, control panel or to the mounting base. The supervision shall not require additional wires other than the pair used for detection or alarm. The system shall be capable of being expanded at any time up to the maximum capacity of the system. The system shall be capable of having ionization, thermal, and photoelectric detecting devices, control relays, and manual stations connected across the same pair of wires. The system shall be electrically supervised against both short and open wire faults in the detection circuit, the manual station alarm circuit, and an open in the system alarm and trouble relay coils. An open wiring fault occurring in these circuits shall cause an audible and visual trouble indication at the control panel. A fire alarm signal shall override trouble signals. In the event of a trouble signal resulting from trouble on an initiating zone, a fire signal from another zone shall appear on the panel and remain until the panel is reset, at which time the trouble signal will reappear. Alarm initiating zones shall be as shown on the drawings. A separate switch monitor shall be provided to control waterflow alarms separately from other alarm signals.

7.26.1 Alarm System

The system shall function as follows when any sprinkler flow switch operates, or thermal detector in the HVAC fire protection system operates:

A. The main and remote annunciator panel alarm devices shall annunciate audible and visual indicators of a fire alarm.

B. The visible indicator shall indicate the zone location and the device initiating the fire alarm. The audible indicator shall produce the same sound for all fire alarms.

C. An alarm indicating lamp shall light in the base of the HVAC detector initiating the alarm.

D. Panel locks into alarm until manually reset.

E. Exhaust duct detector circuits shall be provided to energize the HVAC fire protection chamber fire water system for HEPA filters.

F. Supply duct detector circuits shall be provided to shut down the supply fan(s).

G. The alarm shall be manually transmitted as a voice alarm throughout the building over the fire alarm PA speakers.

7.26.2 Fire Supervisory Signals.

The supervisory alarm initiating devices shall include post indicator valve (PIV) switches, OS and Y valve switches, dry pipe system low air pressure switches, trouble signals from each of the Halon and $CO_2$ systems, and the Pyr-A-Larm Panel system trouble indicators. The supervisory alarm system shall function when any of these devices operate, as follows:

A. The main control panel shall annunciate audible and visual indicators of a supervisory alarm. The audible indicator shall provide a different sound than the fire alarm audible indicator.

B. The main panel locks the visual alarm indicator on, until manually reset. The audible indicator can be silenced by operating the alarm normal switch.

C. The main panel relays the supervisory alarm signal via a separate transmitter to the Site fire supervisory alarm system.

7.27 EVACUATION ALARM SYSTEM

The evacuation system shall be completely independent of any other system. Speaker wiring may be installed in same conduit as fire alarm. No voice communication is required. The evacuation alarm system shall include an evacuation alarm panel, supervised public address speakers, initiating devices, a tone generator, signal conduits, and wire necessary for a complete and operational system. The system shall be Pyr-A-Larm System 3, or equal. No voice communication is required.

The system shall be electrically supervised against both short and open wire faults in the initiating circuit, the audible alarm circuit, and an open wire fault in the system alarm and trouble relay coils. An open wiring fault occurring in these circuits shall cause an audible and visual trouble indication at the control panel. A short in the initiating circuit and the audible alarm circuit shall cause an audible and visual trouble indicator at the control panel. The evacuation alarm signal shall override the trouble signals. In the event of a trouble signal resulting from trouble on an initiating zone, an evacuation signal from another zone shall appear on the panel and remain until the circuit is reset, at which time the trouble signal will reappear. If a second evacuation alarm signal is initiated after a prior signal has been silenced, the selected evacuation signal shall sound even if the control circuit has not been reset. The evacuation alarm system shall shut off automatically after 5 minutes.

The System 3 evacuation shall also provide the following functions:

A. Receive "ALERT" and "EVACUATION" signals from the Site evacuation system.

B. Provide local building status on "EVACUATION" mode only to the Site evacuation system.

C. Provide alarm signal over two No. 14 AWG wires to the Health Physic office.

D. Provide for remote monitoring of the building trouble status.

7.27.1 Local Alarm

This system shall provide an "ALERT" signal, with the panel mounted front cover switch in the "DOWN" position, consisting of continuous, non-varying audible siren tone or an "EVACUATION" signal, with the switch in the "UP" position, consisting of continuous cyclic audible siren tone the cycle to be "ON" for 5 seconds and "off" for 5 seconds. Each signal shall be initiated by operating any remote and one control room manual alarm switch. Any switch shall initiate the signal, but if more than one is operated at the same time, the switch turned to "EVACUATE" will take precedence over all other switches. Initiation of an "ALERT" or "EVACUATION" signal from any control point within the building shall be shown by an indicating light on the evacuation alarm panel. In addition, an audible panel alarm buzzer shall be actuated. The audible alarm can be silenced by operating the "ALARM-NORMAL" switch to the opposite position but the light shall remain on until all switches or contacts are returned to normal position.

7.27.2 Site Wide Alarm.

A separately maintained toggle switch with "Lock-out" pin in the "DOWN" position, located in the control room, shall provide the Site wide alarm system an "ALERT" signal with the switch in the "DOWN" position or an "EVACUATION" signal with the switch in the "UP" position over two No. 14 AWG wires to connection in the Security Building.

# 8.0 PIPING MATERIALS

## 8.1 SCOPE OF WORK

The Contractor shall provide labor, materials, equipment, and tools necessary to fabricate, test, inspect, document, deliver to the site, field fabricate and/or install, and field inspect and test all piping materials in the quantities defined and as located by the drawings, and in accordance with this specification.

## 8.2 OUTLINE SPECIFICATIONS

The Piping Service Classes to be used are

| Class | Service |
|---|---|
| D | Process Equipment Waste |
| N | High Pressure Steam, Low Pressure Steam, Condensate, High Pressure Air, Vacuum |
| P | Low Pressure Air |
| Q | Cooling Water Supply And Return |
| U | High Pressure Gas |
| V | Pressurized Feed Gas |

## SERVICE INDEX
(FOR GENERAL REFERENCE ONLY; SEE LINE CLASS FOR SPECIFIC DETAILS)

| LATEST REV PAGE 1 | 2 | 3 | 4 | 5 | CLASS | FLANGE RATING | MAX PRESS | TEMP RANGE | SERVICE | PIPE MATL / CRSN ALLOW | BOLTS / GASKETS | SMALL FITTINGS | VALVES BODY | VALVES TRIM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | D | 150# ANSI RF | Per B16.5 | 100°F | Process Equipment Waste | 304L SS | B7 / Spiral Wound | 304L SS BW | 304L SS | 304 SS |
| | | | | | N | 150# ANSI RF | Per B16.5 | 365°F | High Pressure Steam, Low Pressure Steam, Condensate High Pressure Air, Vacuum | Carbon Steel | Alloy A193-B7 / Grafoil | 3000# C.S. Scrd | Carb Stl | 12 Cr. |
| | | | | | P | 125# FF | Per B16.5 | 200°F | Low Pressure Air | Carbon Steel | Steel 307-B / Grafoil | 150# MI | Bronze & C.I. | Bronze |
| | | | | | Q | 125# FF | Per B16.5 | 200°F | Cooling Water Supply and Return | Carbon Stl. Galv. | Steel A307-B | 300# M.I. | Bronze & C.I. | Bronze |
| | | | | | U | 15,000 | | 300°F | High Pressure Gas | 316L S.S. | -- / -- | 15,000 Cone & THD | 316L S.S. | 316L S.S. |
| | | | | | V | 300# RF | Per B16.5 | 200°F | Pressurized Feed Gas | 316L SS | B7 / Spiral Wound | 316L SS BW | 316 SS | 316 SS |

| SERVICE: Process Equipment Waste | CLASS D PAGE 1 OF 5 |
|---|---|

| | | | |
|---|---|---|---|
| RATING: | 150# | CORROSION ALLOWANCE — | |
| FACING: | Raised Face | PRESSURE LIMIT — | Per B16.5 |
| MATERIAL: | 304L Stainless Steel | TEMPERATURE LIMIT — | 100°F |

| CODE NUMBER | EN-CODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | --------------------PIPE------------------ | | |
| | | 2" and smaller | Stainless Steel, ASTM A312, Grade TP304L, Schedule 80S Threaded Ends | | |
| | | 3" and larger | Stainless Steel, ASTM A312, Grade TP304L, Schedule 40S, Buttweld Ends | | |
| | | | ----------------FITTINGS----------------- | | |
| | | 2" and smaller | 3000# 304L Stainless Steel, Threaded Ends, ASTM A182, Grade F304L, Schedule 80S | | |
| | | | ----------------FITTINGS----------------- | | |
| | | 3" and larger | Seamless Stainless Steel, ASTM A403, Grade WP304L or ASTM A182 Grade F304L Buttweld Ends, Schedule 40S Bore | | |
| | | | ---------------THREADOLET---------------- | | |
| | | 2" and smaller | 3000# 304L Stainless Steel, Threaded, ASTM A182, Grade | | |
| | | | -----------------WELDOLETS--------------- | | |
| | | 3" and larger | Forged 304L Stainless Steel, ASTM A182, Grade F304L, Schedule 40 Bore | | |
| | | | --------------SWAGE NIPPLES-------------- | | |
| | | 2" and smaller | 304L Stainless Steel, ASTM A403, Grade WP304L Schedule 80 Bore, Threaded Ends | | |
| | | | ------------------UNIONS------------------ | | |
| | | 2" and smaller | 3000# 304L, Stainless Steel, ASTM A182, Grade F304L, Schedule 80 Bore, Ground Joint Type, Integral Seats, Threaded Ends | | |
| | | | ------------------PLUGS------------------ | | |
| | | 2" and smaller | 304L Stainless Steel, ASTM A182, Grade F304L, Round Head Type Threaded End | | |
| | | | -------------------CAPS------------------ | | |
| | | 2" and smaller | 3000# 304L Stainless Steel, ASTM A182, Grade F304L, Threaded End | | |
| | | | -----------------FLANGES----------------- | | |
| | | 2" and smaller | 150# ANSI, Raised Face, Threaded Type, 304L Stainless Steel, ASTM A182, Grade F304L Schedule 80S Bore | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ----------------FLANGES CONT'D-------------- | | |
| | | 3" and larger | 150# ANSI, Raised Face, Weld Neck Type 304L Stainless Steel ASTM A182 Grade F304L Schedule 40S Bore | | |
| | | | -----------------ORIFICE FLANGES------------ | | |
| | | 1" and larger | 300# ANSI Raised Face Weld Neck Type, Forged Stainless Steel, ASTM A182 Grade F304L Schedule 40S Bore, with 1/2" Scrd Taps | | |
| | | | ---------------BRANCH CONNECTIONS---------- | | |
| | | <u>Header</u> | <u>Branch</u> — <u>Use</u> | | |
| | | 2" and smaller | Full or Reducing — Full or Reducing Tee | | |
| | | 3" and larger | Full Size — Full Size Tee or Weldolet | | |
| | | | 2" and smaller — Threadolet | | |
| | | | ---------PIPING INSTRUMENT CONNECTIONS----- | | |
| | | | Temperature Conn's — 1-1/2" Flgd. | | |
| | | | Pressure Conn's — 1/2" Threaded | | |
| | | | Orifice Tap Conn's — 1/2" Threaded | | |
| | | | ---------------GASKETS-------------------- | | |
| | | | Spiral-Wound Metallic Type, T304L Stainless Steel Spiral Windings with Grafold Filler 1/8" Thick 304 Stainless Steel Centering Ring | | |
| | | | ------------------BOLTING------------------ | | |
| | | | Stud Bolt, 304 Stainless Steel, ASTM A193 Grade B7 with 2 Heavy Hex Nuts, ASTM A194 Grade 2H | | |
| | | | -----------------PIPE BENDS---------------- | | |
| | | | Bends (Minimum) 5 Times the Normal Diameter may be used in place of Threaded Fittings | | |
| | | | -----------------Y-STRAINERS--------------- | | |
| | | 2" and smaller | 316 Stainless Steel Body, ASTM A351, Grade CF8M, Threaded Ends, 316 or 304 Stainless Steel Screen with .045 Diameter Perforations, Threaded Blowoff Connection<br>Acceptable Model<br>Armstrong Fig. No. E7CS-1/2 thru 1 1/4<br>Armstrong Fig. No. E7SC 1 1/2" thru 2" | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ------------------Y-STRAINERS-------------- | | |
| | | 3" and larger | 316 Stainless Steel Body, ASTM A351, Grade CF8M, Flanged Ends, 316 or 304 Stainless Steel Screen with .045 Diameter Performations, Threaded Blow-Off Connection<br>Acceptable Model<br>Armstrong Fig. No. E7FL-3" thru 10" | | |
| | | | ----------------STEAM TRAPS---------------- | | |
| | | 1/2" - 3/4" | Steam Trap, Threaded Ends, Impulse Type, 1-1/4 CR - 1/2 Moly Body, Stainless Steel Bonnet, Seat, and Disc, Integral Strainer and Blow-Off<br>Acceptable Model<br>Yarway Fig. No. 720 | | |
| | | | ---------------THREAD COMPOUND------------- | | |
| | | | Use "Liquid O Ring" for Pipe Threads | | |
| | | | ------------------GATE VALVES------------- | | |
| | | 2" and smaller | 150# ANSI Threaded Ends OS&Y, Bolted Bonnet, Body & Bonnet - 316L Stainless Steel, Casting - ASTM A351, Grade CF3M, Forging ASTM 182, Grade F316L, Trim 316 Stainless Steel, Packing - Reinforced TFE, Bonnet Gasket - Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Aloyco Fig. No. 110 | | |
| | | | ------------------GATE VALVES------------- | | |
| | | 3" and larger | 150# ANSI, Flanged Ends, OS&Y, Bolted Bonnet, Body and Bonnet 316 Stainless Steel, Casting - ASTM A351, Grade CF8M, Forging - ASTM A182, Grade F316, Packing Reinforced TFE, Bonnet Gasket, Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Aloyco Fig. No. 117 | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ------------------GLOBE VALVE--------------- | | |
| | | 2" and smaller | 150# ANSI, Threaded Ends, OS&Y, Bolted Bonnet, Body and Bonnet 316L Stainless Steel, Casting ASTM A351, Grade CF3M, Forging ASTM A182, Grade F316L, Packing Reinforced TFE, Bonnet Gasket - Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Aloyco Fig. No. 314 | | |
| | | | ------------------GLOBE VALVES------------- | | |
| | | 3" and larger | 150# ANSI - Flanged Ends, RF, OS&Y, Bolted Bonnet, Body and Bonnet 316 Stainless Steel Casting ASTM A351, Grade CF8M, Forging ASTM A182, Grade F316 Packing Reinforced TFE, Bonnet Gasket - Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Aloyco Fig. No. 317 | | |
| | | | ------------------BALL VALVES-------------- | | |
| | | 2" and | 150# ANSI, Threaded Ends, Handle Operated, Body and Ends, 316L Stainless Steel, Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316, Seats and Seals Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Worchester Controls<br>Fig. No. W5966TSES7 | | |
| | | | ------------------BALL VALVES-------------- | | |
| | | 3" and 4" | 150# ANSI Flanged Ends, Handle Operated, Body and Ends, 316 Stainless Steel, Castings - ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316, Seats and Seals - Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Hills-McCanna Fig. No. S15156RS6 | | |
| | | | ----------------CHECK VALVES--------------- | | |
| | | 2" and smaller | 150# ANSI, Threaded Ends, Swing Type, Bolted Bonnet, Body and Bonnet 316L Stainless Steel Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316L, Bonnet Gasket Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Powell Fig. No. 2341 | | |

| CODE NUMBER | ENCODER | SIZE FROM | TO | DESCRIPTION | NOTES | REV |
| --- | --- | --- | --- | --- | --- | --- |
| | | | | -----------------CHECK VALVES-------------- | | |
| | 1 | 3" and larger | | 150# ANSI - Flanged Ends - RF Swing Type, Bolted Bonnet, Body and Bonnet 316 Stainless Steel, Castings ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316, Bonnet Gasket - Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Aloyco Fig. No. 377 | | |

| SERVICE: | High Pressure Steam, Low Pressure Steam, Condensate, High Pressure Air, Vacuum | CLASS N PAGE 1 OF 4 |
|---|---|---|

| | | | |
|---|---|---|---|
| RATING: | 150# | CORROSION ALLOWANCE — | Per B16.5 |
| FACING: | Raised Face | PRESSURE LIMIT — | 365°F |
| MATERIAL: | Carbon Steel | TEMPERATURE LIMIT — | |

| CODE NUMBER | EN-CODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | --------------------PIPE-------------------- | | |
| | | 2" and smaller | Carbon Steel, ASTM A53 Grade B, Extra Strong Threaded Ends | | |
| | | 3" and larger | Carbon Steel, ASTM A53 Grade B, Standard Weight Beveled Ends | | |
| | | | -----------------FITTINGS----------------- | | |
| | | 2" and smaller | 3000# Carbon Steel, Threaded Ends ASTM A105 | | |
| | | | ------------------FITTINGS---------------- | | |
| | | 3" and larger | Seamless or Welded Carbon Steel, Buttweld Ends, Standard Weight, ASTM A234 Grade WPB | | |
| | | | -----------------THREADOLETS--------------- | | |
| | | 2" and smaller | 3000# Forged Carbon Steel, ASTM A105, Schedule 80 Bore, Conforming to Bonney Forge | | |
| | | | ------------------WELDOLETS---------------- | | |
| | | 3" and larger | Forged Carbon Steel, Standard Weight, ASTM A105, Schedule 40 Bore, Conforming to Bonney Forge | | |
| | | | ----------------SWAGE NIPPLES-------------- | | |
| | | 2" and smaller | Carbon Steel, Threaded Ends, ASTM A234, Grade WPB, Extra Strong | | |
| | | | -------------------UNIONS------------------ | | |
| | | 2" and smaller | 3000# Forged Carbon Steel, ASTM A105, Schedule 80 Bore, Ground Joint Type with Integral Seats, Threaded Ends | | |
| | | | --------------------PLUGS------------------ | | |
| | | 2" and smaller | Forged Carbon Steel, Round Head Type, Threaded End | | |
| | | | --------------------CAPS------------------- | | |
| | | 2" and smaller | 3000# Forged Carbon Steel, ASTM A105, Schedule 80 Bore, Threaded | | |
| | | | ------------------FLANGES----------------- | | |
| | | 2" and smaller | 150# ANSI, Raised Face Ends, Carbon Steel, ASTM A105, Threaded XS Bore | | |

| CODE NUMBER | ENCODER | SIZE FROM | TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|---|
| | | 3" and larger | | 150# ANSI, Raised Face Slip-On Type, Carbon Steel, ASTM A105 | | |
| | | 1" and larger | | 150# ANSI, Raised Face Blind Flange, Carbon Steel ASTM A105 | | |
| | | | | ------------------ORIFICE FLANGES---------- | | |
| | | 1" and larger | | 300# ANSI, Raised Face Weld-Neck Type, Forged Carbon Steel, ASTM A105 Bore to Match Pipe, with 1/2" Scrd Taps | | |
| | | | | -------------BRANCH CONNECTIONS------------ | | |

| Header | Branch | Use |
|---|---|---|
| 2" and smaller | Full or Reduced Size | Full or Reducing Tee |
| 3" and larger | Full Size | Full Size Tee |
| | 2" and smaller | Threadolet |

--------PIPING INSTRUMENT CONNECTIONS------

Primary Instrument Conn's to Piping

| | |
|---|---|
| Temperature Conn's | 1-1/2" Fldg |
| Pressure Conn's | 1/2" Threaded |
| Orifice Tap Conn's | 1/2" Threaded |

-------------------GASKETS-----------------

Grafoil Flange Gasket, Flat Ring, 1/16" thick, John Crane or Approved Equal

------------------BOLTING------------------

Alloy Stud Bolt, ASTM A193 Grade B7 with 2 Heavy Hex Nuts, ASTM A194 Grade 2H

-----------------Y-STRAINER----------------

| SIZE | DESCRIPTION |
|---|---|
| 2" and smaller | 600#, Carbon Steel Body, ASTM A216, Grade WCB, Threaded Ends, 304 Stainless Steam Screen with 0.45 Diameter Perforations Acceptable Model Armstrong Fig. No. B15C |

------------------Y-STRAINER---------------

| SIZE | DESCRIPTION |
|---|---|
| 3" and larger | 150# ANSI, Raised Face Flanged Ends, Carbon Steel Body, ASTM A216 Grade WCB, 304 Stainless Steel Screen with 0.045" Diameter Perforations Acceptable Model: Armstrong Fig. No. BIFL |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ---------------STEAM TRAPS---------------- | | |
| | | 1/2" - 3/4" | Steam Trap, Screwed Ends, Impulse Type, 1-1/4 Cr-1/2 Moly Body, Stainless Steel Bonnet, Seat and Disc, Integral Strainer and Blow-off<br>Acceptable Model:<br>Yarway Fig. No. 720 | | |
| | | | ---------------THREAD COMPOUND------------ | | |
| | | | Use "Liquid O Ring" for Pipe Threads | | |
| | | | ---------------GATE VALVES---------------- | | |
| | | 2" and smaller | 800# Threaded Ends, OS&Y Seal Welded Bonnet, Body and Bonnet, Carbon Steel, Forgings - ASTM A105, Trim F6<br>Acceptable Model<br>Vogt Fig. No. 2801 thru 2808 | | |
| | | | ---------------GATE VALVES---------------- | | |
| | | 3" and larger | 150# ANSI Flanged Ends, Raised Face OS&Y Bolted Bonnet, Body and Bonnet Carbon Steel, Castings - ASTM A216, Grade WCB, Forgings ASTM A105, Trim No. 4<br>Acceptable Model<br>Pacific Fig. No. 150-4 | | |
| | | | ---------------GLOBE VALVES--------------- | | |
| | | 2" and smaller | 800# Threaded Ends, OS&Y Seal Welded Bonnet, Body and Bonnet, Carbon Steel, Forgings - ASTM A105, Trim F6<br>Acceptable Model<br>Vogt Fig. No. 2821 thru 2828 | | |
| | | | ---------------GLOBE VALVES--------------- | | |
| | | 3" and larger | 150# ANSI Flanged Ends, Raised Face OS&Y Bolted Bonnet, Body and Bonnet Carbon Steel, Castings - ASTM A216, Grade WCB, Forgings ASTM A105, Trim No. 4<br>Acceptable Model<br>Pacific Fig. No. 160-4 | | |
| | | | ---------------CHECK VALVES--------------- | | |
| | | 2" and smaller | 800# Threaded Ends, Bolted Bonnet Horizontal Piston Type, Body and Bonnet, Carbon Steel, Forgings - ASTM A105, Trim F6<br>Acceptable Model<br>Vogt Fig. No. 701 thru 708 | | |

| SERVICE | | | | CLASS N PAGE 4 OF 4 | | |
|---|---|---|---|---|---|---|
| CODE NUMBER | ENCODER | SIZE FROM | TO | DESCRIPTION | NOTES | REV |
| | | 3" and larger | | -----------CHECK VALVES CONT'D------------<br>150# ANSI Flanged Ends, Raised Face<br>Bolted Bonnet, Swing Type, Body and Bonnet<br>Carbon Steel, Castings - ASTM A216,<br>Grade WCB, Forgings ASTM A105, Trim No. 4<br>Acceptable Model<br>Pacific Fig. No. 180-4 | | |
| | | 2" and smaller | | ----------------BALL VALVES----------------<br>150# ANSI, Threaded Ends, Handle Operated,<br>Body and Ends, Carbon Steel, Castings,<br>ASTM A216, Grade WCB, SEats and Seals,<br>Reinforced TFE, Trim 316 Stainless Steel<br>Acceptable Model<br>Worcester Controls<br>Fig. No. W5944RSE | | |
| | | 2" and smaller | | --------------PLUG VALVES-----------------<br>300# Threaded Ends Carbon Steel Body,<br>Cover, Plug, and Cover Bolts, Castings<br>ASTM A216, Grade WCB, Teflon or Approved<br>Equal Sleeve and Diaphragm, Wrench Operated,<br>Extra Strong Bore<br>Acceptable Model<br>Tufline Fig. No. 0366SE Nom.<br>Lubricated | | |

| SERVICE: Low Pressure Air | CLASS P PAGE 1 OF 3 |
|---|---|

| | |
|---|---|
| RATING: 125# | CORROSION ALLOWANCE — |
| FACING: Flat Face | PRESSURE LIMIT — Per B16.1 |
| MATERIAL: Carbon Steel | TEMPERATURE LIMIT — 200$^{o}$F |

| CODE NUMBER | EN-CODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ------------------PIPE--------------------- | | |
| | | 2" and smaller | Carbon Steel, ASTM A53, Grade B, Schedule 40 Bore, Threaded Ends | | |
| | | 3" and larger | Carbon Steel, ASTM A53, Grade B, Standard Weight, Beveled Ends | | |
| | | | -----------------FITTINGS----------------- | | |
| | | 2" and smaller | 150# Malleable Iron, ASTM A47, Threaded Ends | | |
| | | 3" and larger | Seamless Carbon Steel ASTM A234, Grade WPB Standard Weight, Beveled Ends | | |
| | | | ----------------THREADOLET---------------- | | |
| | | 2" and smaller | 3000# Carbon Steel, ASTM A105, Conforming to Bonnet Forge | | |
| | | | --------------SWAGE NIPPLES--------------- | | |
| | | 2" and smaller | Carbon Steel, Thread Both Ends, ASTM A53, Grade B, Schedule 40 Bore | | |
| | | | -----------------UNIONS------------------ | | |
| | | 2" and smaller | 150# Malleable Iron, ASTM A197, Ground Joint Type with Integral Seats, Threaded Ends | | |
| | | | ------------------PLUGS------------------- | | |
| | | 2" and smaller | Carbon Steel, ATM A105 Round Head Type, Threaded | | |
| | | | ------------------CAPS-------------------- | | |
| | | 2" and smaller | 3000# Forged Carbon Steel, ASTM A105, Schedule 40 Bore, Threaded | | |
| | | | -------------THREAD COMPOUND-------------- | | |
| | | | Use "Liquid O Ring" for Pipe Threads | | |
| | | | -----------PIPE BENDS--------------------- | | |
| | | | Bend (Minimum 5 times the normal diameter) may be used in place of Threaded Fittings | | |
| | | | -----------------FLANGES------------------ | | |
| | | 2" and smaller | 150# ANSI, Flat Face, Threaded Ends, Carbon Steel, ASTM A105 Schedule 40 Bore | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
| --- | --- | --- | --- | --- | --- |
| | | 3" and larger | 150# ANSI, Flat Face, Slip-On Type, Carbon Steel, ASTM A105, Schedule 40 Bore | | |
| | | 1/2" and larger | 150# ANSI, Flat Face Blind Flange Carbon Steel ASTM A105 | | |
| | | | ---------------ORIFICE FLANGES------------- | | |
| | | 1" and larger | 300# ANSI, Raised Face, Weld-Neck Type, Carbon Steel, ASTM A105, Schedule 40 Bore with 1/2 Scrd Taps | | |
| | | | ------------BRANCH CONNECTIONS------------- | | |
| | | | <u>Branch</u> — <u>Use</u> | | |
| | | 2" and smaller | Full or Reduced Size — Full or Reducing Tee | | |
| | | 3" and larger | Full Size — Full size tee | | |
| | | | 2" and smaller — Threadolet | | |
| | | | -----------PIPING INSTRUMENT CONNECTIONS--- | | |
| | | | Primary Instr. Conn's to Piping | | |
| | | | Temperature Conn's — 1" Scrd | | |
| | | | Pressure Conn's — 1/2" Scrd | | |
| | | | -----------------GASKETS------------------ | | |
| | | | Grafoil Flange Gasket, Flat Ring, 1/16" thick, John Crane or Approved Equal | | |
| | | | ------------------BOLTING----------------- | | |
| | | | Hex Head Machine Bolt with Hex Nut, ASTM A307 Grade B | | |
| | | | -----------------Y-STRAINER---------------- | | |
| | | 2" and smaller | 300" - Bronze Body ASTM B-62 Threaded Ends, 304 or 55 Screen with 0.045 Perforations<br>Acceptable Model<br>Armstrong Fig. No. F7SC-300 | | |
| | | 3" and larger | 150# ANSI, Flanged, Raised Face, Carbon Steel Body, ASTM A216, Grade WCB, 304 S.S. Screen with 0.045 Diameter Perforations<br>Acceptable Model<br>Armstrong Fig. No. BIFL | | |
| | | | -------------THREAD COMPOUND-------------- | | |
| | | | Thread Compound use "Liquid O Ring" for Pipe Threads | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ---------------GATE VALVES------------------ | | |
| | | 2" and smaller | 150# Threaded Ends, Rising Stem, Integral Seat, Body and Bonnet - Bronze ASTM B62, Trim Manufacturer's Standard<br>Acceptable Model<br>Crane Fig. No. 431 | | |
| | | | ----------------GATE VALVES----------------- | | |
| | | 3" and larger | 125# ANSI Flanged Ends, Flat Face, OS&Y, Bolted Bonnet Body and Bonnet Cast Iron, ASTM A126, Class B, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 465 1/2 | | |
| | | | ------------------GLOBE VALVES-------------- | | |
| | | 2" and smaller | 200# Threaded Ends, Rising Stem, Union Bonnet, Integral Seat, Body and Bonnet - Bronze ASTM B61 - Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 70 | | |
| | | | ------------------GLOBE VALVES-------------- | | |
| | | 3" and larger | 125# ANSI Flanged Ends, Flat Face, OS&Y, Bolted Bonnet Body and Bonnet Cast Iron, ASTM A126, Class B, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 351 | | |
| | | | ------------------CHECK VALVES-------------- | | |
| | | 2" and smaller | 200# Threaded Ends, Swing Type, Screwed Bonnet, Body and Bonnet Bronze ASTM B61, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 36 | | |
| | | | -------------------CHECK VALVES------------- | | |
| | | 3" and larger | 125# ANSI, Flanged, Flat Face, Swing Type, Bolted Bonnet, Body and Bonnet Cast Iron - ASTM A126, Class B, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 373 | | |
| | | | ----------------BALL VALVES---------------- | | |
| | | 2" and smaller | 300# - Threaded Ends, Handle Operated Body Bronze ASTM B61, Ball Stem and External Parts - Bronze, Seat and Body Seal TFE<br>Acceptable Model<br>Jamesbury Fig. No. A11TT | | |

| SERVICE: Cooling Water Supply and Return | | | | | CLASS 0 PAGE 1 OF 3 |
|---|---|---|---|---|---|
| RATING: 125# FACING: Flat Face MATERIAL: Carbon Steel | | | CORROSION ALLOWANCE — PRESSURE LIMIT — Per B16.1 TEMPERATURE LIMIT — 200°F | | |

| CODE NUMBER | EN-CODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | -------------------PIPE------------------- | | |
| | | 2" and smaller | Carbon Steel, Galvanized, ASTM A120, Extra Strong, Threaded and Coupled Ends | | |
| | | 3" and larger | Carbon Steel, ASTM A53, Grade B, Standard Weight, Beveled Ends | | |
| | | | ----------------FITTINGS------------------ | | |
| | | 2" and smaller | 300# Galvanized Malleable Iron, Threaded Ends, ASTM A197 | | |
| | | 3" and larger | Black, Seamless or Welded Carbon Steel, Buttweld Ends, Standard Weight, ASTM A284, Grade WPB | | |
| | | | ----------------SWAGE NIPPLES-------------- | | |
| | | 2" and smaller | 300# Galvanized Malleable Iron ASTM A197, Threaded Ends | | |
| | | | -------------------UNIONS----------------- | | |
| | | 2" and smaller | 300# Galvanized Malleable Iron ASTM A197, Ground Joint Type with Bronze to Iron Seat, Threaded Ends | | |
| | | | -------------------PLUGS------------------ | | |
| | | 2" and smaller | 300# Galvanized Malleable Iron ASTM A197, Solid Square Head Type, Threaded End | | |
| | | | ----------------------FLANGES-------------- | | |
| | | 2" and smaller | 150# ANSI, Flat Face Screwed Flange, Galvanized Steel, ASTM A105 | | |
| | | | 150# ANSI, Flat Face Blind Flange, Galvanized Steel, ASTM A105 | | |
| | | 3" and larger | 150# ANSI, Flat Face Slip-on Type, Carbon Steel, ASTM A105 | | |
| | | | 150# ANSI, Flat Face Blind Flanges, Carbon Steel ASTM A105 | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | --------------------ORIFICE FLANGES--------- | | |
| | | | 300# ANSI, Raised Face Weld-Neck Type, Forged Carbon Steel, ASTM A105, with 1/2" Scrd Taps | | |
| | | 2" and smaller | Extra Strong Bore | | |
| | | 3" and larger | Standard Weight Bore | | |
| | | | ----------------BRANCH CONNECTIONS--------- | | |
| | | | Branch — Use | | |
| | | 2" and smaller | Full or Reduced Size — Full or Reducing Tee | | |
| | | 3" and larger | Full Size — Full size tee | | |
| | | | 2" and smaller — Threadolet | | |
| | | | -----------PIPING INSTRUMENT CONNECTIONS--- | | |
| | | | Primary Instr. Conn's to Piping | | |
| | | | Temperature Conn's — 1" Scrd | | |
| | | | Pressure Conn's — 1/2" Scrd | | |
| | | | Secondary Piping — Use this class | | |
| | | | ------------------GASKETS------------------ | | |
| | | | Grafoil Flange Gasket, Flat Ring, 1/16" thick, John Crane or Approved Equal. | | |
| | | | -----------------BOLTING------------------ | | |
| | | | Hex Head Machine Bolt with Hex Nut, ASTM A307 Grade B | | |
| | | | --------------THREAD COMPOUND------------- | | |
| | | | Use "Liquid O Ring" for Pipe Threads | | |
| | | | ----------------GATE VALVES---------------- | | |
| | | 2" and smaller | 150# Threaded Ends, Rising Stem, Integral Seat, Body and Bonnet - Bronze ASTM B62, Trim Manufactures Standard<br>Acceptable Model<br>Crane Fig. No. 431 | | |
| | | | ----------------GATE VALVES---------------- | | |
| | | 3" and larger | 125# ANSI - Flanged Ends, Flat Face, OS&Y Bolted Bonnet, Body and Bonnet Cast Iron ASTM A126, Class B, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 465 1/2 | | |

| SERVICE | | | | CLASS Q<br>PAGE 3 OF 3 | |
|---|---|---|---|---|---|
| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
| | | | ----------------GLOBE VALVE---------------- | | |
| | | 2" and smaller | 200# Threaded Ends, Rising Stem, Union Bonnet, Integral Seat, Body and Bonnet - Bronze ASTM B61 - Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 70 | | |
| | | 3" and larger | 125# ANSI - Flanged Ends, Flat Face, OS&Y Bolted Bonnet, Body and Bonnet Cast Iron ASTM A126, Class B, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 351 | | |
| | | | ----------------CHECK VALVES--------------- | | |
| | | 2" and smaller | 200# Threaded Ends, Swing Type, Screwed Bonnet, Body and Bonnet Bronze, ASTM B61, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 36 | | |
| | | | ----------------CHECK VALVES--------------- | | |
| | | 3" and larger | 125# ANSI, Flanged, Flat Face, Swing Type, Bolted Bonnet, Body and Bonnet Cast Iron, ASTM A126, Class B, Trim Bronze<br>Acceptable Model<br>Crane Fig. No. 373 | | |
| | | | ----------------BALL VALVES---------------- | | |
| | | 2" and smaller | 300# Threaded Ends, Handle Operated, Body Bronze, ASTM B61, Ball, Stem and External Parts - Bronze, Seat and Body Seal TFE<br>Acceptable Model<br>Jamesbury Fig. No. A11TT | | |

| SERVICE: High Pressure Gas | CLASS PAGE 1 OF 2 |
|---|---|

| | | | |
|---|---|---|---|
| RATING: | 15,000# | CORROSION ALLOWANCE | — |
| FACING: | Coned and Threaded | PRESSURE LIMIT | — |
| MATERIAL: | 316L Stainless Steel | TEMPERATURE LIMIT | — 300°F |

| CODE NUMBER | EN-CODER | SIZE FROM | SIZE TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|---|
| | | | | --------------------TUBING------------------- | | |
| | | 9/16" | | Stainless Steel, ASTM A312 Grade TP 316L .125 Wall | | |
| | | | | ----------------FITTINGS------------------- | | |
| | | 9/16" | | Stainless Steel, ASTM A312 Grade TP316L | | |
| | | | | --------------UNION TEES------------------- | | |
| | | 9/16" | | Acceptable Part No. SNO-TRIK SS-940-3 | | |
| | | | | --------------UNIONS---------------------- | | |
| | | 9/16" | | Acceptable Part No. SNO-TRIK SS-940-6 | | |
| | | | | ---------------BULKHEAD UNIONS------------- | | |
| | | 9/16" | | Acceptable Part No. SNO-TRIK SS-940-61 | | |
| | | | | --------------UNION ELBOWS----------------- | | |
| | | 9/16" | | Acceptable Part No. SNO-TRIK SS-940-9 | | |
| | | | | -----------CONED TUBE STUB ADAPTER--------- | | |
| | | 9/16" | | Acceptable Part No. SNO-TRIK SS-94M-A-941 | | |
| | | | | -------------------CAPS-------------------- | | |
| | | 9/16" | | Acceptable Part No. SNO-TRIK SS-940-C | | |
| | | | | -------------------PLUG-------------------- | | |
| | | 9/16" | | Acceptable Part No. SNO-TRIK SS-940-P | | |
| | | | | ----------FEMALE THREAD CONNECTOR---------- | | |
| | | 9/16" | | Acceptable Part No. SNO-TRIK SS-940-7-94F | | |
| | | | | ----------CONED TUBE STUB REDUCER---------- | | |
| | | 9/16" | | Acceptable Part No. SNO-TRIK SS-940-R-641 | | |

| CODE NUMBER | ENCODER | SIZE FROM | SIZE TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|---|
| | | | | ------------PRE-CONED TUBING--------------- | | |
| | | 9/16" | | Stainless Steel, ASTM A312 Grade TP316L .125 Wall Acceptable Part No. SNO-TRIK SS-912-4, "SS-912-8, & SS-912-12" | | |
| | | | | -----------------VALVES------------------ | | |
| | | 9/16" | | FP Series (Straight Pattern) 45,000#, Threaded Body 316 Stainless Steel, Stem 400 Series Stainless Steel, Packing, TFE Acceptable Part No. SNO-TRIK SS-945-FP | | |
| | | 9/16" | | FPAR Series (Angle Pattern) Acceptable Part No. SNOP-TRIK SS-945-FPAR | | |

| SERVICE: | Pressurized Feed Gas | CLASS V PAGE 1 OF 2 |
|---|---|---|

| | | | |
|---|---|---|---|
| RATING: | 300# | CORROSION ALLOWANCE — | |
| FACING: | Raised Face | PRESSURE LIMIT — | Per B16.5 |
| MATERIAL: | Stainless Steel | TEMPERATURE LIMIT — | 200 °F |

| CODE NUMBER | EN-CODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ------------------PIPE--------------------- | | |
| | | 1/2" - 10" | Stainless Steel, ASTM A312 Grade TP316L, Schedule 40S, Beveled Ends | | |
| | | | ----------------FITTINGS------------------ | | |
| | | 1/2" - 10" | Seamless Stainless Steel, ASTM A403 Grade WP316L, Buttwelding Ends Schedule 40S | | |
| | | | -------------------FLANGES----------------- | | |
| | | 1/2" - 10" | 300# ANSI, Raised Face Weld-Neck Type, Forged Stainless Steel ASTM A182 Grade F316, Schedule 40S Bore | | |
| | | | ----------------ORIFICE FLANGES------------ | | |
| | | 2" - 10" | 300# ANSI, Raised Face Weld-Neck Type, Forged Stainless Steel ASTM A182 Grade F316, Schedule 40S Bore, with 1/2" Socketweld Taps | | |
| | | | --------------BRANCH CONNECTIONS----------- | | |
| | | Header | Branch — Use | | |
| | | 1/2" - 10" | Full or Reducing — Full or Reducing Tees | | |
| | | | ---------PIPING INSTRUMENT CONNECTIONS----- | | |
| | | | Primary Instrument Connections to Piping | | |
| | | | Temperature Conn's — 1-1/2" Flgd | | |
| | | | Pressure Conn's — 1/2" BW | | |
| | | | Orifice Tap Connections — 1/2" SW | | |
| | | | -----------------GASKETS------------------ | | |
| | | 1/2" - 10" | Grafoil Flange Gasket, Flat Ring, 1/16" Thick, John Crane or Approved Equal | | |
| | | | ------------------BOLTS------------------- | | |
| | | | Alloy Stud Bolts, ASTM A193 Grade B7, with 2 Heavy Hex Nuts, ASTM A194, Grade 2H | | |

| CODE NUMBER | ENCODER | SIZE FROM TO | DESCRIPTION | NOTES | REV |
|---|---|---|---|---|---|
| | | | ----------------GLOBE VALVES--------------- | | |
| | | 1/2" - 6" | 300# ANSI, Buttweld Ends, OS&Y, Bolted Bonnet, 316 Stainless Steel Body, 316 Stainless Steel Trim, Grafoil Packing, Sch 40S Bore<br>Acceptable Model:<br>Aloyco Fig. No. 2316A or 2316 | | |
| | | 1/2" - 6" | 300# ANSI, Raised Face Flanged Ends, OS&Y Bolted Bonnet, 316 Stainless Steel Body and Trim, Grafoil Packing<br>Acceptable Model<br>Aloyco Fig. No. 2317A or 2317 | | |
| | | | ------------------BALL VALVES------------- | | |
| | | | 300 ANSI, Buttweld Ends, 316 S.S. Body, Ball, Stem, and External Parts, Polyfill or Approved Equal Seat, Metal "S" Gasket or Approved Equal Body Seal, Lever Operated | | |
| | | 1/2" - 4" | Schedule 40S Bore | | |
| | | 6" only | Schedule 40S Bore<br>Acceptable Model: Worcester Controls<br>Fig. No. W5966PMBWS7 (1/2" - 4")<br>Fig. No. W4566PMBWS7 (6" only) | | |
| | | | --------------PLUG VALVE----------------- | | |
| | | 1/2" - 3" | 300# ANSI, Butt-Weld Ends, 316 Stainless Steel Body, Cover, and Plug, Stainless Steel Cover Bolts, UHMW Polyethylene or Approved Equal Sleeve and Diaphragm, Wrench Operated, Sch 40S Bore | | |
| | | 4" - 10" | Ditto, except Enclosed Gear Operated<br>Acceptable Model:<br>Tufline Fig. No. 1366BW, Non-lubricated | | |
| | | | ----------------CHECK VALVES------------- | | |
| | | 1/2" - 10" | 300# ANSI, Buttweld Ends, Swing Type, Bolted Cover, 316 Stainless Steel Body, 316 Stainless Steel Trim, Sch 40S Bore<br>Acceptable Model:<br>Aloyco Fig. No. 2376 | | |

## 9.0 COATING AND WRAPPING

### 9.1 SCOPE OF WORK

The Contractor shall provide all material, labor, equipment, and tools necessary for the preparation and application of corrosion resistant coatings for exterior surfaces of carbon and stainless steel pipe, flanges, valves, and fittings in direct buried service.

### 9.2 MATERIALS OF CONSTRUCTION

The following materials or Approved Equal are acceptable:

| MATERIALS | MANUFACTURER | MFR's CODE | SERVICE TEMPERATURE |
|---|---|---|---|
| Tape Primer | Polyken Div | No. 927 | -30°F to 200°F |
| Primary Tape | of the | No. 980 | -30°F to 200°F |
| Filler Tap | Kendall Co., | No. 931 | -30°F to 200°F |
| Joint Tape | Boston, Mass. | No. 930 | -30°F to 200°F |

### 9.3 EQUIPMENT

The pipe wrapping shall be electrically inspected with a Tinker & Rasor Model AP or APW or Approved Equal holiday detector set at a minimum dc voltage of 150 times the mil thickness of the coating to detect any wrapping flaws.

## 10.0 FIRE PROTECTION

### 10.1 SCOPE OF WORK

This Specification establishes the requirements for the design, fabrication, and installation including furnishing labor, materials, tools, and equipment, and performing operations necessary for engineering, detailing, inspection, testing, documentation, delivery to jobsite and installing Underwriters Laboratories (UL) and/or Factory Mutual (FM) approved automatic fire sprinkler systems, fire hose cabinets, and fire hose racks.

### 10.2 MATERIALS OF CONSTRUCTION

Sprinkler heads for offices and other finished areas shall be UL and/or FM approved, pendant type with ceiling plate, a temperature rating of 212 deg F, and a standard 1/2-inch orifice size. Sprinkler heads for all other areas shall be UL and/or FM approved brass upright type, with a standard 1/2-inch orifice size and a temperature rating of 212 deg F except near heat sources where the temperature rating shall be in accordance with NFPA Standard No. 13, Table 3-16.6.4.

Water flow detectors shall be provided and installed according to NFPA Standard No. 72A. Wiring and conduits shall be provided and installed by the Contractor.

Piping shall comply with the ANSI and ASTM standards. Pipe hangers shall be in accordance with requirements of the Underwriters' Laboratories, Inc., for use in sprinkler systems.

| | |
|---|---|
| Pipe: | Carbon Steel, ASTM A 53, Grade B, Standard Weight |
| Screwed Fittings: | Cast Iron ASTM A 126 conforming to ANSI B16.4 & B16.1 or Malleable Iron, ASTM A 197 conforming to ANSI B16.3 |
| Flanges: | Cast Iron ASTM A 126 conforming to ANSI B16.1 |
| Couplings and Unions: | As per NFPA Standard No. 13 |
| Valves: | (1) Class 175 WWP Iron Body, Bronze Mounted, OS&Y Gate Valves for all sizes larger than 2 inches<br>(2) Class 175 WWP Iron Body Swing Alarm Check Valve<br>(3) Class 175 WWP Iron Body Dry Pipe Valve |

## 10.3 EQUIPMENT

### 10.3.1 Alarm Check Valves

The alarm check valves shall be Viking Model F-1 Alarm Check Valve with retarding chambers and complete trim packages, or Approved Equal. A water motor gong local alarm shall be included with each wet pipe system.

### 10.3.2 Fire Hose Racks, Fire Hose and Extinguisher Cabinets

Fire hose racks and fire hose cabinets shall be of the surface mounted type and shall be provided and installed at the approximate locations shown on the drawings. All fire hose racks and cabinets shall be installed in compliance with NFPA Standard No. 14 for Class II service and NFPA Standard No. 13 for combined systems. All fire hose cabinets shall be sized to house a 2-1/2 gallon water-type fire extinguisher in addition to the hose and appurtenances.

# APPENDIX D

# CALCULATIONS

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 1 OF 4

JOB NO. 6154-3 DEPARTMENT AUTHOR [signature] DATE 4/15/81

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
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# RADIOLYTIC HEAT GENERATION

85 Kr (Z=36) $\beta^-$ decays to 85 Rb (Z=37)

Reference: NCRP Report No. 44, Krypton-85 In The Atmosphere — Accumulation, Biological Significance, and Control Technology July 1, 1975 pg 3

mean energy $\beta_1^-$ 0.0475 MeV
$\gamma_1$ 0.514 MeV } 0.0043 fraction decays

mean energy $\bar{\beta}_2$ 0.251 MeV 0.9957 fraction decays

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 2 OF 4

JOB NO. 6154-3 DEPARTMENT AUTHOR [signature] DATE 4/15/81

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$$\frac{(0.0043)\left(0.0475\frac{MeV}{dis}\right)\left(1.6021\times10^{-19}\frac{J}{eV}\right)\left(10^{6}\frac{eV}{MeV}\right)}{\left(3.70\times10^{10}\frac{dis/s}{Ci}\right)\left(1\frac{w\,s}{J}\right)} = 0.0012\times10^{-3}\frac{w}{Ci\ 85Kr}$$

$$\frac{(0.0043)\left(0.514\frac{MeV}{dis}\right)\left(1.6021\times10^{-19}\frac{J}{eV}\right)\left(10^{6}\frac{eV}{MeV}\right)}{\left(3.70\times10^{10}\frac{dis/s}{Ci}\right)\left(1\frac{w\,s}{J}\right)} = 0.0131\times10^{-3}\frac{w}{Ci\ 85Kr}$$

$$\frac{(0.9957)\left(0.251\frac{MeV}{dis}\right)\left(1.6021\times10^{-19}\frac{J}{eV}\right)\left(10^{6}\frac{eV}{MeV}\right)}{\left(3.70\times10^{10}\frac{dis/s}{Ci}\right)\left(1\frac{w\,s}{J}\right)} = 1.481^{5}\times10^{-3}\frac{w}{Ci\ 85Kr}$$

$$1.496\times10^{-3}\frac{w}{Ci\ 85Kr}$$

$$\left(1.496\times10^{-3}\frac{w}{Ci\ 85Kr}\right)\left(392\frac{Ci}{g\ 85Kr}\right) = 0.586\frac{w}{g\ 85Kr}$$

Reference: Merril Eisenbud, Environmental Radioactivity 2nd Ed 1973 pg. 485

Effective Energy (MeV): 0.24

$$\frac{\left(0.24\frac{MeV}{dis}\right)\left(1.6021\times10^{-19}\frac{J}{eV}\right)\left(10^{6}\frac{eV}{MeV}\right)}{\left(3.70\times10^{10}\frac{dis/s}{Ci}\right)\left(1\frac{w\,s}{J}\right)} = 1.423\times10^{-3}\frac{w}{Ci\ 85Kr}$$

$$\left(1.423\times10^{-3}\frac{w}{Ci\ 85Kr}\right)\left(392\frac{Ci}{g\ 85Kr}\right) = 0.558\frac{w}{g\ 85Kr}$$

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Reference: A.B. Christensen, Physical Properties and Heat Transfer Characteristics of Materials for Krypton-85 Storage, ICP-1128, Sept 1977, pg 3

average decay energy 0.24⁶ MeV

$$\left(0.246\,\frac{MeV}{dis}\right)\left(1.6021\times10^{-19}\,\frac{J}{eV}\right)\left(10^{6}\,\frac{eV}{MeV}\right)\left(3.70\times10^{10}\,\frac{dis/s}{Ci}\right)\left(1\,\frac{w\,s}{J}\right) = 1.458\times10^{-3}\,\frac{w}{Ci\ 85Kr}$$

$$\left(1.458\times10^{-3}\,\frac{w}{Ci\,85Kr}\right)\left(392\,\frac{Ci}{g\,85Kr}\right) = 0.572\,\frac{w}{g\,85Kr}$$

---

Reference: SE Nunn & WA Reardon, The Formation and Decay of Selected Isotopes, BNWL-487 ADPG, January 1967.

$$\sim 0.53\,\frac{w}{g\,85Kr}$$

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO 4 OF 4

JOB NO 6154-3 DEPARTMENT AUTHOR [signature] DATE 4/15/81

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FOR THESE CALCULATIONS WILL USE:

$$1.458 \times 10^{-3} \frac{W}{Ci\ 85Kr}$$

$$\frac{\left(1.458 \times 10^{-3} \frac{W}{Ci\ 85Kr}\right)\left(18.7 \frac{MCi}{y}\right)\left(10^{6} \frac{Ci}{MCi}\right)}{\left(232.5 \frac{m^3}{y}\right)}$$

$$= 117.3 \ \frac{W}{m^3} \leftarrow$$

($m^3$ @ 0°C, 1 atm) THIS IS RADIOLYTIC DECAY HEAT PER CUBIC METER FEED GAS

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TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 1 OF 1

JOB NO. 6154-3 DEPARTMENT ______ AUTHOR [signature] DATE 5/5/81

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# RUBIDIUM OXIDATION

$$Rb + \frac{1}{4}O_2 \rightarrow \frac{1}{2}Rb_2O$$

85.47 8.00

$$\left(617 \frac{g\ Rb}{y}\right) \frac{8.00 \frac{g\ O_2}{gmole}}{85.47 \frac{g\ Rb}{gmole}} = 57.8 \frac{g\ O_2}{y}$$

for oxidation of Rb accumulation in 60 day lag storage

$$\frac{\left(232.5 \frac{m^3}{y}\right)\left(\frac{200}{10^6}\right)\left(10^3 \frac{l}{m^3}\right)\left(32.0 \frac{g\ O_2}{gmole\ O_2}\right)}{22.4 \frac{l}{gmole\ O_2}} = 66.4 \frac{g\ O_2}{y}$$

200 ppm $O_2$ in feed gas would provide enough $O_2$ to oxidize Rb accumulation in lag storage

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| TITLE KRYPTON 85 ENCAPSULATION | | SHEET NO. 1 OF 5 |
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Calculations for Lag Feed Storage.

Basis: provide 60 days of storage (out of a 300 day/year operation or) 1/5th of the annual production.

Previous calculations gave a rate of 232.5 $m^3/yr$ with a heat generation of 117.3 $W/m^3$.

$$\frac{60\ d}{300\ d/yr} \times 232.5 \frac{m^3}{yr} \div .028317\ m^3/ft^3 = 1642.\ ft^3\ (1\ atm, 0°C)$$

$$\frac{60}{300} \times 232.5 \times 117.3 \frac{W}{m^3} = 5454.\ \text{WATTS}$$

$$5454\ W \times 3.413 \frac{BTU/HR}{W} = 18615.\ BTU/HR\ \text{HEAT RELEASE}$$

Preliminary considerations suggested use of 12" Sch 80 O.S. pipe with allowable working pressure (A.W.P) of 720 psig up to 650°F for use as storage vessels. We use a design pressure of 500 psig, 2/3 of A.W.P. The wall thickness is 0.688 in. and the contained volume is 0.7056 $ft^3/ft$.

At 0°C and 514.7 psia the contained gas volume is:

RMP THE RALPH M. PARSONS COMPANY D-3 CALCULATION SHEET

TITLE Krypton 85 Encapsulation SHEET NO. 2 OF 5

JOB NO. 6154-3 DEPARTMENT Process AUTHOR Perrot DATE 4/29/.

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$$0.7056 \times \frac{514.7}{14.7} = 24.7\ ft^3/ft \text{ of gas @ } 0°C$$

for $\frac{1642\ ft^3 \text{ of gas to be contained}}{24.7\ ft^3/ft \text{ of gas } (0°C)} = 66.48$ ft of pipe

Assuming 80 feet of pipe as 8-10 ft. sections stacked 2 wide and 4 high, have a space envelope of ~30" wide × 60" high × 12' long.

Since 80 ft. of pipe = 1976. $ft^3$, we can calculate what the temperature could be before exceeding 500 psig.

$$\underset{(1atm,\ T)}{1976\ ft^3} = \left(\frac{T + 460}{492}\right) \times \underset{(1atm,\ 0°C)}{1642\ ft^3}$$

$$T°F = 492\left(\frac{1976}{1642}\right) - 460 = 132°F \quad \text{(1st est., see below)}$$

But have to remove 18615 BTU/hr through a natural convection surface film on

$$80\ ft \times 3.338\ ft^2/ft = 267.04\ ft^2$$

$$\therefore h_c \Delta T = \frac{\dot{Q}}{A} = 18615/267.04 = 69.71\ \frac{BTU}{ft^2\ hr.}$$

since, $h_c \simeq 0.8$ need a $\Delta T \simeq 87°F$. If air conv...
(actually calculated later. this is an est. to get 1st est of $\Delta T$)

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in @ 90°F (max) and exits @ 110°F max. (20°F ΔT rise)

$\bar{T}(air) = 100°F \quad T_s = 187°F \quad T_{gas} \simeq 200°F.$

We increase the design pressure to

$$514.7\,psia \times \frac{(200+460)}{(132+460)} = 573.8\,psia$$

or $573.8 - 14.7 = 560\,psig.$

For $T_s = 187°F$, $\bar{T}_\infty = 100°F$ $\quad Pr < 10^9 \therefore$ LAMINAR

$$Nu = 0.47\,(Pr\,Gr)^{1/4}$$

$Pr(air) = 0.7$

$$Gr = \frac{g\,\frac{(T_s - T_\infty)}{T_\infty}\,L^3}{\nu^2}$$

$\nu = \mu/\rho$

$$Gr = \frac{g\left(\frac{T_s - T_\infty}{T_\infty}\right) L^3 \rho^2}{\mu^2}$$

$g = 32.2\,ft/sec^2$

$\mu = \left(\frac{.0183\,cp}{1488}\right) \frac{lb}{ft\cdot sec}$

$$Gr = \frac{(32.2)\left(\frac{87°R}{560°R}\right)\left(\frac{12.75}{12.00}\right)^3 (.0808)^2}{(.0183/1488)^2}$$

$\rho = .0808\,lb/ft^3$

$$Gr = 0.259 \times 10^9$$

$k = .019\,\frac{BTU}{hr\,ft\,°F}$

$$Nu = \frac{hD}{k} = 0.47\left(0.7\,(.259\times10^9)\right)^{1/4} = 54.54$$

$$h_c = \frac{(.019)(54.54)}{\frac{12.75}{12}} = 0.975\ BTU/hr\,ft^2\,°F$$

$\therefore\ \Delta T(2) = 69.71/.975 = 71.48 \quad vs\ \Delta T(1) \simeq 87$

assume $\Delta T(3) = 75$; $h_c(2)\left(\frac{75}{87}\right)^{1/4} \times 0.975 = 0.94 \quad \Delta T(3) = 74.2°F$ ✓✓

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Then $T_{s_{kiln}} = 100 + 75 = 175°F$ $\quad T_{gas} \simeq 250°F$

based on $h_c(i) \simeq h_c(o)$

and design pressure is then:

$$\left[514.7 \times \left(\frac{250+460}{132+460}\right)\right] - 14.7 \simeq 600 \text{ psig}$$

Increasing length from 10' to 12' gives 500psig design.

Air Flow:

For 20°F rise $\quad \dot{W} = \frac{\dot{Q}}{c_p \Delta T}$

$c_p = 0.25$ BTU/lb
$\rho = .0808$ lb/ft³

$$\dot{W} = \frac{18615}{(0.25)(20)} = 3723 \text{ lb/hr}$$
$$= 62.05 \text{ lb/min}$$

REQUIRED < or 768 cfm.

considering a "frontal" area of 30" × 10' up the stack = 25 ft² $\quad \vec{v} = 30.7$ ft/min $= 0.5$ ft/sec

∴ some assist to natural convection, but not much

$$\frac{DV\rho}{\mu} = \frac{12.75}{12.0} \times \frac{0.5 \times .0808}{.0183/1488} = 3490$$

$$Nu = \frac{hD}{k} = 0.023\, Re^{.8}\, Pr^{1/3} = 13.94$$

$$h = \frac{k}{D} \times 13.94 = \frac{(.019)(13.94)}{12.75/12.0} = 0.25$$

Also $h$(natural conv.) + $h$(forced conv.) are not simply

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additive, $h(\text{Total}) < h(\text{n.c.}) + h(\text{fc})$ and the inside $h$, $h_c(i)$ does not change, so use 250°F as $T_{gas}$ and 175°F as $T_{wall}$.

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TITLE ION IMPLANTATION SHEET NO. 1 OF 3

JOB NO. 6154-3 DEPARTMENT AUTHOR R. WILKINSON DATE 6-13-81

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ION IMPLANTATION/SPUTTERING EQUIPMENT SIZING

DESIGN PARAMETERS

1. USE 10-INCH PIPE, COMPATIBLE WITH SURF STORAGE
2. 3000 $cm^2$ INITIAL SUBSTRATE AREA
3. 1 cm THICK DEPOSIT
4. 79 % Ni, 21 % La BY WEIGHT
5. 12.7 % KRYPTON IN DEPOSIT BY WEIGHT
6. SPUTTERING RATE : 7.95 g/A-HR. × 0.009 A/$cm^2$ = 0.07155 g/$cm^2$-HR BASED ON INITIAL TARGET SURFACE AREA.
7. DESIGN THROUGHPUT : 232.5 $m^3$ GAS AT STP
8. DEPOSIT DENSITY : 8.0 g/$cm^3$

A. SUBSTRATE SIZE

10-INCH STD. WT. PIPE (10.02 IN. I.D.) W/ CAP

CAP SURFACE AREA = $1.084 D^2 = 1.084 (10.02 \times 2.54)^2 = 702.15\ cm^2$

STRAIGHT LENGTH

$$L = \frac{(3000 - 702.15}{\pi \times 10.02 \times 2.54} = 28.74\ cm = 11.315'', \text{ USE } 12''$$

ACTUAL SUBSTRATE AREA = 3139 $cm^2$

B. DEPOSIT VOLUME

DEPOSIT O.D. = 10.02 × 2.54 = 25.45 cm
DEPOSIT I.D. = 23.45 cm

$$V = \frac{\pi (25.45^2 - 23.45^2)}{4} \times 12 \times 2.54 + \frac{\pi (25.45^3 - 23.45^3)}{24} = 2811\ cm^3$$

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RMP THE RALPH M. PARSONS COMPANY **CALCULATION SHEET**

TITLE: ION IMPLANTATION SHEET NO. 2 OF 3

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C. DEPOSIT CONSTITUENTS

DEPOSIT WEIGHT = 2811 × 8.0 = 22488 g (10.22 LB)
ENTRAPPED GAS = 22488 × 0.127 = 2856 g
NICKEL (22488 − 2856) 0.79 = 15509 g
LANTHANUM (22488 − 2856) 0.21 = 4123 g

D. TARGET VOLUME

NICKEL DENSITY = 8.9 g/cm³
LANTHANUM DENSITY = 6.15 g/cm³

$$\text{VOLUME} = \frac{15509}{8.9} + \frac{4123}{6.15} = 2413 \text{ cm}^3$$

E. TARGET SIZE

6 INCH STD. WT. PIPE (6.625" O.D.) W/ CAP
USE L = 11.125" TO MAINTAIN TARGET TO SUBSTRATE GAP

$$2413 = \frac{\pi(D_o^2 - 16.8275^2)}{4} 28.2575 + \frac{\pi(D_o^3 - 16.8275^3)}{24}$$

BY TRIAL AND ERROR, USE $D_o$ = 19.4275 cm, OR A TARGET THICKNESS OF 1.30 cm.

ACTUAL TARGET VOLUME = 2428 cm³

F. PROCESSING TIME: INITIAL TARGET AREA = 2134 cm²

$$T = \frac{22488 - 2856}{0.07155 \times 2134} \cong 129 \text{ HRS}$$

TITLE ION IMPLANTATION SHEET NO. 3 OF 3

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G. ENTRAPPED GAS

$$\frac{2856\ g}{83.8\ g/\text{mole-Kr}} \times 22.4\ \ell/\text{mole} = 763\ \ell/\text{deposit}$$

H. UNITS REQUIRED

$$\frac{232{,}500\ \ell/\text{YEAR}}{763\ \ell/\text{deposit}} = 305\ \text{DEPOSITS/YEAR}$$

$$\frac{305 \times 129}{300 \times 24} = 5.57$$ UNITS MINIMUM, 24 HRS./DAY, 300 DAYS/YEAR

USE 8 UNITS

AVE. UTILIZATION = $\frac{5.57}{8} \cong 70\%$

RMP THE RALPH M. PARSONS COMPANY **D-5** CALCULATION SHEET

TITLE Krypton 85 Ion Implantation SHEET NO. 1 OF 2

JOB NO. 61543 DEPARTMENT Process AUTHOR Perret DATE 5/1/81

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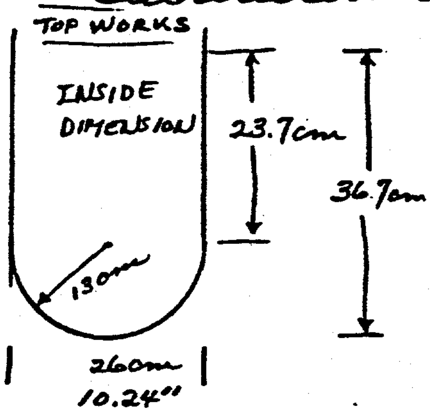
## Calculations for 1-year Product Storage

Information used is per G.L. Tingey, sketchpad 3/19/81 pages 56, 57, 58 undated.

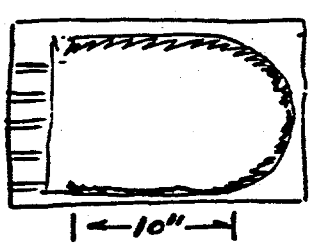
Substrate wall given as 3000 cm², dimensions as shown.




It is estimated that the outside of the water jacket will be 11½" O.D. × 18" long.

435 of these units used to hold the annual production, which has a heat release of 5 × 18615 = 93075 $\frac{BTU}{HR}$. (See prior calcs. for lag storage.)

Heat release per unit is 93075/435 = 214 $\frac{BTU}{HR}$




Because of the deposit geometry, assume only 10" of length are used for heat transfer. A(heat trf.) = 10" × 11½" × π = 2.5 ft²

$$\frac{\dot{Q}}{A} = \frac{214}{2.5}\frac{BTU/HR}{FT^2} = 85.6\ \frac{BTU/HR}{FT^2} = h_c \Delta T_f$$

Again from calcs. for lag storage, know $h_c \approx 0.98$

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so 1st est. of $\Delta T_f(1) \simeq 87°F$. Rationing prior results (for same $\Delta T$)

$$h_c \simeq 0.975\left\{\frac{11.5''}{12.75''}\right\}^{1/4} = 0.950 \ \frac{BTU/hr}{ft^2\ °F}$$

$$\Delta T_f(2) = \frac{85.6 \ \frac{BTU/HR}{FT^2}}{h_c} = 90.1°F$$

$$h_c(2) = 0.975\left\{\frac{11.5}{12.75} \times \frac{90.1}{87}\right\}^{1/4} = .9585$$

$$\Delta T_f(3) = 89.3°F \simeq \Delta T_f(2) \ ✓✓$$

Surface $\Delta T$ less than 90°F rise.

Assume the units can be stacked 15" on centers and spaced 24" face to face. A 6×6×13 array will require 90"×90" on the face × 26' deep. Alternate arrangements can be used and the best fit to overall bldg. geometry will be determined. Same air loading is required as determined for zeolite encapsulation, 1920 scfm.

Floor space for standing these units singly on 15" centers is about 30'×30' vs. about 12'×26' for above.

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 1 OF 4

JOB NO 6154-3 DEPARTMENT AUTHOR [signature] DATE 5/18/81

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## ION/IMPLANTATION ELECTRIC POWER COST

DEMAND — During each 156 hour deposit batch run:

| | | | | | |
|---|---|---|---|---|---|
| TARGET | (2500v)(20a) = | 50,000 va = | 50.0 Kw | DC |
| ANODE | (60v)(50a) = | 3000 va = | 3.0 Kw | DC |
| FILAMENT | $(10v)(56a)\frac{1}{\sqrt{2}}$ = | 400 va = | 0.4 Kw | AC |
| SUBSTRATE | (250v)(30a) = | 7500 va = | 7.5 Kw | DC |
| | | | 60.9 Kw | |

Power demand from E.D. McClanahan, personal communication 4/6/81 (included in MINUTES OF APRIL 6, 1981 MEETING E.E. Fisher to R.J. Secondo 4/17/81.)

$$(60.9\ Kw)\left(156\frac{hr}{batch}\right)\left(435\frac{batch}{y}\right) = 4.13\times10^{6}\ Kwh/yr$$

<u>ASSUMING</u> demand at sputtering chamber is 50% of power supplied to electrical equipment

RMP-307 (2/78)

PAGE NUMBER

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION (ION/IMP'N) SHEET NO. 2 OF 4

JOB NO 654-3 DEPARTMENT AUTHOR David F. Davis DATE 5/18/81

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$$\frac{4.13 \times 10^6 \text{ Kwh/y}}{0.50} = \underline{8.2 \times 10^6 \text{ Kwh/y}}$$

Load Factor ≥ 85%

$$\frac{60.9 \text{ Kw}}{0.50} = 121 \text{ Kw peak demand}$$

$$(121 \text{ Kw})(730 \tfrac{hr}{mo}) = 88{,}300 \text{ Kwh/mo useage}$$

} For Encapsulation Facility

(TVA uses 730 $\frac{hr}{mo}$ for rate schedules)

Cost of electricity will depend upon demand & useage for conceptual Nuclear Fuels Reprocessing Plant site

ASSUME 0.035 $\frac{\$}{Kwh}$ conceptual NFRP site Oak Ridge, TN industrial

(BACKUP DATA FOLLOWS)

$$(8.2 \times 10^6 \tfrac{Kwh}{y})(0.035 \tfrac{\$}{Kwh}) = \underline{\$287{,}000}$$ ◄

ELECTRIC POWER COST ION/IMPLANTATION

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 3 OF 4

JOB NO. 6154-3 DEPARTMENT ______ AUTHOR [signature] Davis DATE 5/20/81

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# ELECTRIC POWER COST

Oak Ridge, Tennesse industrial
from TVA, Chattanooga, TN
Charlie Henry (615) 755 6781

TVA uses monthly peak demand Kw and useage Kwh/mo for determining rate of this type — 730 hr/mo used.

1000 Kw peak demand } for conceptual
730,000 Kwh/mo useage } NFRP site

| load factor | |
|---|---|
| 100% | $3.274 \times 10^{-2}$ \$/Kwh |
| 90% | $3.374 \times 10^{-2}$ \$/Kwh |
| 80% | $3.500 \times 10^{-2}$ \$/Kwh |
| 40% | $4.60 \times 10^{-2}$ \$/Kwh |

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 4 OF 4

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| | | | | | | | | |

(E POWER CONT.)

400 Kw peak demand } site
292,000 Kwh/mo useage }

| low cost in Chattanooga District, TVA | Oak Ridge TVA | high cost in Chattanooga District, TVA |
|---|---|---|
| $3.253 \times 10^{-2} \frac{\$}{Kwh}$ | $3.271 \times 10^{-2} \frac{\$}{Kwh}$ | $3.458 \times 10^{-2} \frac{\$}{Kwh}$ |

all at 100% load factor

RMP THE RALPH M. PARSONS COMPANY D-7 CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 1 OF 14

JOB NO. 6154-3 DEPARTMENT AUTHOR [signature] DATE 4/20/81

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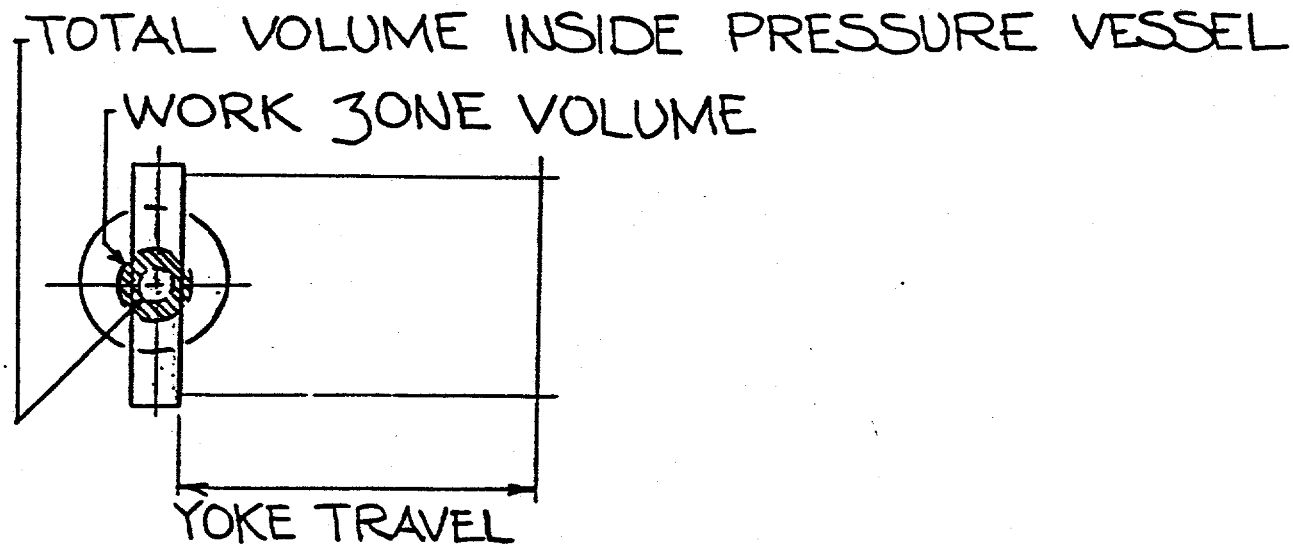
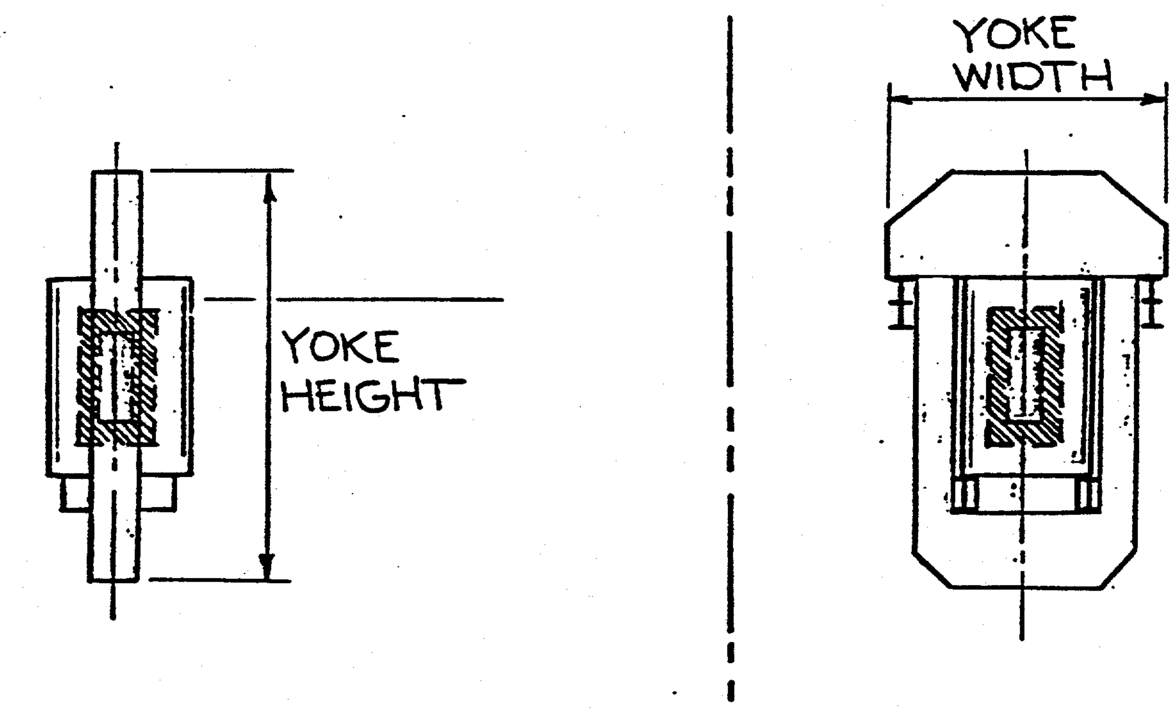
# HOT ISOSTATIC PRESS

# PHYSICAL DIMENSIONS

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RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 2 OF 14

JOB NO. 6154-3 DEPARTMENT AUTHOR [signature] DATE 4/24/8

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## HIGH PRESSURE - Ci 85KR/BATCH

$$\frac{(18.7\ MCi/y)(10^6\ Ci/MCi)}{600\ \frac{batches}{y}} = 3.12 \times 10^4\ \frac{Ci\ 85Kr}{batch}$$

$$\frac{(18.7\ MCi/y)(10^6\ Ci/MCi)}{300\ \frac{batches}{y}} = 6.23 \times 10^4\ \frac{Ci\ 85Kr}{batch}$$

## HEAT GENERATION PER BATCH

$$1.458 \times 10^{-3}\ \frac{w}{Ci\ 85Kr}$$

$$\frac{(18.7\ MCi/y)(10^6\ Ci/MCi)(1.458 \times 10^{-3}\ \frac{w}{Ci})}{600\ \frac{batches}{y}} = 45.4\ \frac{w}{batch}$$

$$\frac{(18.7\ MCi/y)(10^6\ Ci/MCi)(1.458 \times 10^{-3}\ \frac{w}{Ci})}{300\ \frac{batches}{y}} = 90.9\ \frac{w}{batch}$$

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 3 OF 14

JOB NO. 6154-3 DEPARTMENT AUTHOR [signature] DATE 4/24/81

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## HIGH PRESSURE

VOLUME ENCAPSULATED PER BATCH

$$\frac{232.5 \frac{m^3}{y}}{600 \frac{batches}{y}} \left(10^3 \frac{l}{m^3}\right) = 387.5 \frac{l}{batch} \quad (0°C, 1 \text{ atm condition})$$

$$\frac{232.5 \frac{m^3}{y}}{300 \frac{batches}{y}} \left(10^3 \frac{l}{m^3}\right) = 775 \frac{l}{batch} \quad (0°C, 1 \text{ atm condition})$$

VOLUME GAS SUPPLIED PER ENCAPSULATION BATCH

600 cycles/y 1000 atm, 700°C

0.30 fraction supplied is encapsulated

ATTACHMENT 4, MINUTES OF MEETING KRYPTON 85 ENCAPSULATION PRECONCEPTUAL DESIGN JOB NO 6154-3, APRIL 6, 1981

$$0.30S = 387.5 \frac{l}{batch}$$

$$S = 1291.7 \frac{l}{batch}$$

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 4 OF 14

JOB NO 6154-3 DEPARTMENT AUTHOR DATE 4/24/8

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| | | | | | | | | |

300 cycles/y 500 atm, 900°C

0.55 fraction supplied is encapsulated

(APRIL 6, 1981 MEETING MINUTES)

$0.55\,S = 775\ \frac{l}{batch}$

$S = 1409.1\ \frac{l}{batch}$

VOLUME GAS PUMPED BACK PER BATCH

600 cycles

$1291.7\ \frac{l}{batch}$
$-\ 387.5$ "
$904.2\ \frac{l}{batch}$ (0°C, 1 atm condition)

300 cycles

$1409.1\ \frac{l}{batch}$
$-775$ "
$634.1\ \frac{l}{batch}$

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 5 OF 14
JOB NO 6154-3 DEPARTMENT AUTHOR [signature] DATE 5/6/8

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## HIGH PRESSURE - VOLUME GAS IN WORK ZONE

600 cycles/y — 1292 l gas in work zone (0°C, 1 atm condition) which could under incredible occurrence release into building

300 cycles/y — 1410 l gas in work zone (0°C, 1 atm) which could under incredible occurrence release into building

GAS VOLUMES PROVIDED BY
AB CHRISTENSEN 5/5/81

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 6 OF 14

JOB NO. 6154-3 DEPARTMENT AUTHOR [signature] DATE 5/6/8

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## HIGH PRESSURE - VOLUME GAS IN VOID VOLUME

This is gas which provides isostatic pressure

600 cycles/y 5848 l gas in void volume (0°C, 1 atm condition) which could under incredible occurrence release into building

300 cycles/y 7700 l gas in void volume (0°C, 1 atm condition) which could under incredible occurrence release into building

GAS VOLUMES PROVIDED BY AB CHRISTENSEN 5/5/81

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 7 OF 14

JOB NO. 6154-3 DEPARTMENT AUTHOR [signature] DATE 5/6/8

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HIGH PRESSURE - VOLUME GAS

TOTAL POTENTIAL RELEASE

600 cycles/y

1292 l
\+ 5848 l
7140 l

300 cycles/y

1410 l
\+ 7700 l
9110 l

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
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## HIGH PRESSURE

BUILDING OVERPRESSURE WHICH WOULD RESULT FROM INCREDIBLE OCCURRENCE OF GAS RELEASE FROM HIP

ASSUMING IDEAL GAS BEHAVIOR

$$PV = nRT$$

$$P = \frac{nRT}{V}$$ before pressure increase

$$P + \Delta P = \frac{(n + \Delta n)RT}{V}$$ after release of $\Delta n$ moles gas

$$n = \frac{PV}{RT}$$

$$P + \Delta P = \frac{\left(\frac{PV}{RT} + \Delta n\right)RT}{V} = P + \frac{\Delta n RT}{V}$$

$$\Delta P = \frac{\Delta n RT}{V}$$

$$V = \frac{\Delta n RT}{\Delta P}$$

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE: KRYPTON 85 ENCAPSULATION SHEET NO. 9 OF 14

JOB NO. 6154-3 DEPARTMENT AUTHOR [signature] DATE 5/6/8

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600 cycles/y   7140 l (0°C, 1 atm) gas which could release

$$\Delta n = \frac{7140\, l}{22.41 \frac{l}{g\,mole}} = 319 \text{ g moles}$$

$$R = 0.08205 \frac{atm\ l}{g\,mole\ K^\circ}$$

<u>ASSUME</u> before pressure increase

$T_n$ n moles at 298°K (25°C)

$T_{\Delta n}$ Δn moles at 973°K (700°C)

$C_p$ = constant

NOTE: THIS ASSUMES GAS I WORK ZONE EXPANDED FROM 1000 ATM TO 15.7 PSIA AT 700°C

$$n C_p (T - 298) = \Delta n C_p (973 - T)$$

$$T = \frac{298 n + 973 \Delta n}{n + \Delta n}$$

$$n = \frac{PV}{RT_n} = \frac{(1)V}{(0.08205)(298)} = 0.0409V \quad (V \text{ in liters})$$

$$T = \frac{12.19V + 973\Delta n}{0.0409V + \Delta n}$$

FOR $\Delta P = 1 \text{ psi} = \frac{1}{14.7}$ atm

RMP 307 (2/78)

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 10 OF 14

JOB NO. 6154-3 DEPARTMENT AUTHOR [signature] DATE 5/6/8

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$$V = \frac{(319)(0.08205)}{\frac{1}{14.7}} \left\{ \frac{12.19V + 973(319)}{0.0409V + (319)} \right\}$$

$$V = \frac{4690V + 1.194 \times 10^8}{0.0409V + 319}$$

$$0.0409V^2 + 319V = 4690V + 1.194 \times 10^8$$

$$0.0409V^2 - 4371V - 1.194 \times 10^8 = 0$$

$$V = \frac{4371 \pm \sqrt{1.911 \times 10^7 + 1.953 \times 10^7}}{0.0818}$$

$$V = \frac{4371 \pm 6216}{0.0818}$$

$$V = 129{,}000\ \ell$$

$129\ m^3$ round to $\underline{130\ m^3}$

$$(130\ m^3)\left(35.31\frac{ft^3}{m^3}\right) = 4590\ ft^3$$

round to $4600\ ft^3$

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300 cycles/y 9110 ℓ (0°C, 1 atm) gas which could release

$$\Delta n = \frac{9110\ \ell}{22.41\ \frac{\ell}{\text{gmole}}} = 407\ \text{gmole}$$

$$V = \frac{(407)(0.08205)}{\frac{1}{14.7}} \left\{ \frac{12.19V + 973(407)}{0.0409V + 407} \right\}$$

$$V = \frac{5984V + 7.22 \times 10^7}{0.0409V + 407}$$

$$0.0409V^2 + 407V = 5984V + 1.944 \times 10^8$$

$$0.0409V^2 - 5577V - 1.944 \times 10^8 = 0$$

$$V = \frac{5577 \pm \sqrt{3.11 \times 10^7 + 3.18 \times 10^7}}{0.0818}$$

$$V = \frac{5577 \pm 7930}{0.0818}$$

$$V = 166{,}000\ \ell$$

$$166\ m^3$$

$$(166\ m^3)\left(35.31\ \frac{ft^3}{m^3}\right) = 5900\ ft^3$$

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 12 OF 14

JOB NO. 6154-3 DEPARTMENT AUTHOR [signature] DATE 4/28/81

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# MASS SUBSTRATE REQUIRED PER BATCH LOADING

600 cycles/y $\quad 0.050\ cm^3/g\text{-}atm$

$$(0.050\ cm^3/g\text{-}atm)(1000\ atm)\left(10^{-3}\frac{l}{cm^3}\right) = 0.050\frac{l\ \text{gas mix}}{g\ \text{zeolite}}$$

$$\frac{387.5\ l\ \text{gas mix/batch}}{0.050\ \frac{l\ \text{gas mix}}{g\ \text{zeolite}}} = 7{,}750\ \frac{g\ \text{zeolite}}{\text{batch}}$$

300 cycles/y $\quad 0.027\ cm^3/g\text{-}atm$

$$(0.027\ cm^3/g\text{-}atm)(500\ atm)\left(10^{-3}\frac{l}{cm^3}\right) = 0.0135\frac{l\ \text{gas mix}}{g\ \text{Vycor}}$$

$$\frac{775\ l\ \text{gas mix/batch}}{0.0135\ \frac{l\ \text{gas mix}}{g\ \text{Vycor}}} = 57{,}407\ \frac{g\ \text{Vycor}}{\text{batch}}$$

RMP-307 (2/78) PAGE NUMBER

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 13 OF 14

JOB NO. 6154-3 DEPARTMENT AUTHOR [illegible] DATE 4/28/81

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VOLUME SUBSTRATE REQUIRED PER BATCH LOADING

600 cycles/y

$$\frac{7{,}750 \frac{\text{g zeolite}}{\text{batch}}}{1.0 \frac{\text{g zeolite}}{\text{cm}^3 \text{ zeolite}}} = 7{,}750 \frac{\text{cm}^3 \text{ zeolite}}{\text{batch}}$$

$$\frac{7{,}750 \frac{\text{g zeolite}}{\text{batch}}}{0.95 \frac{\text{g zeolite}}{\text{cm}^3 \text{ zeolite}}} = 8{,}158 \frac{\text{cm}^3 \text{ zeolite}}{\text{batch}}$$

free poured

300 cycles/y

$$\frac{57{,}407 \frac{\text{g Vycor}}{\text{batch}}}{1.3 \frac{\text{g Vycor}}{\text{cm}^3}} = 44{,}160 \frac{\text{cm}^3 \text{ Vycor}}{\text{batch}}$$

| SUBSTRATE | NOMINAL WORK ZONE (SUBSTRATE CONTAINER) VOLUME | ENCAP-SULATION PRESSURE | ENCAP-SULATION SOAK TEMPER-ATURE | NUMBER CYCLES PER YEAR | YOKE HEIGHT | YOKE WIDTH |
|---|---|---|---|---|---|---|
| ZEOLITE 5A | 8 l | 1000 ATM | 700°C | 600 | 12 FT (3658) | 5 FT (1524) |
| "THIRSTY" VYCOR | 45 l | 500 ATM | 900°C | 300 | 14 FT (4267) | 5.8 FT (1778) |

[2] PRESSURE VESSEL INSIDE DIMENS
CAPSULE, FURNACE, HEAT SHIELD
SUCH THAT NOMINAL TOTAL VOLUM
FILLED WITH GAS

| YOKE WIDTH | YOKE TRAVEL | WORK ZONE DIMENSIONS | VOLUME ENCAPSULATED PER BATCH (0°C, 1 ATM CONDITION) | FRACTION SUPPLIED ENCAPSULATED | VOLUME PUMPED-BACK PER BATCH (0°C, 1 ATM CONDITION) | VOLUME GAS IN WORK ZONE [1] (0°C, 1 ATM CONDITION) | PRESSURE VESSEL INSIDE DIMENSIONS [2] | VOLUME GAS MAX IMUM F ISOSTATI PRESSU (0°C, 1 AT CONDITIO |
|---|---|---|---|---|---|---|---|---|
| 5 FT (1524) | 8.3 FT (2540) | 7 IN DIA × 14 IN HI (178 DIA × 356 HI) 8.8 l | 387.5 l | 0.30 | 904.2 l | 1292 l | 11.5 IN DIA × 17.5 IN HI (295 DIA × 439 HI) 30 l | 5848 l |
| 5.8 FT (1778) | 10 FT (3048) | 12 IN DIA 24 IN HI (305 DIA × 610 HI) 44.5 l | 775 l | 0.55 | 634.1 l | 1410 l | 16.5 IN DIA × 28.5 IN HI (420 DIA × 722 HI) 100 l | 7700 l |

DIMENSIONS ARE OCCUPIED BY
SHIELD & INTERNAL FEATURES
VOLUME IS ONLY PARTIALLY

[1] VOLUME GAS WITHIN HIP WHICH POT
[3] VOLUME GAS WITHIN HIP WHICH IS
[4] WORK ZONE PLUS VOID VOLUME GAS
[5] VOLUME OF BUILDING WHICH WOULD
14.7 PSIA TO 15.7 PSIA IN EVE
[6] $CM^3$ FEED EXPRESSED AT 0°C, I

| ...ESSURE ...SSEL ...SIDE ...MEN- ...ONS[2] | VOLUME GAS MAXIMUM FOR ISOSTATIC PRESSURE[3] (0°C, 1 ATM CONDITION) | VOLUME GAS TOTAL POTENTIAL RELEASE[4] (0°C, 1 ATM CONDITION) | BUILDING VOLUME 1 PSI ΔP OVER PRESSURE[5] | SUBSTRATE BULK DENSITY | SUBSTRATE VOID FRACTION | SUBSTRATE FEED GAS LOADING[6] | CI 85KR PER BATCH | HEAT GENERATION PER BATCH |
|---|---|---|---|---|---|---|---|---|
| ...5 IN DIA ...5 IN HI ...5 DIA× ...9 HI) ...0 ℓ | 5848 ℓ | 7140 ℓ | $130 M^3$ ($4600 FT^3$) | $1.0 G/CM^3$ VIBRATIONAL COMPACTED ($0.95 G/CM^3$ FREE POURED) | 0.5 | 0.050 $CM^3$/G-ATM @ 700°C | $3.12\times10^4$ CI/BATCH | 45.4 W/BATCH |
| ...5 IN DIA ...5 IN HI ...20 DIA× ...22 HI) ...0 ℓ | 7700 ℓ | 9110 ℓ | $166 M^3$ ($5900 FT^3$) | $1.3 G/CM^3$ | 0.13 | 0.027 $CM^3$/G-ATM @ 900°C | $6.23\times10^4$ CI/BATCH | 90.9 W/BATCH |

...HIP WHICH POTENTIALLY COULD RELEASE FROM WORK ZONE
...HIP WHICH IS PROVIDING ISOSTATIC PRESSURE
...ID VOLUME GAS WHICH POTENTIALLY COULD RELEASE
...WHICH WOULD INCREASE IN STATIC PRESSURE FROM
...7 PSIA IN EVENT OF HIP TOTAL POTENTIAL RELEASE
...SSED AT 0°C, 1 ATM CONDITION

DESIGN PARAMETERS...
PRECONCEPTUAL DESIGN...
85 KRYPTON ENCAPSULAT...
HIGH PRESSURE

6154-3 5/6/8...

| …R …H | HEAT GENERATION PER BATCH | VOLUME SUBSTRATE REQ'D PER BATCH | MASS SUBSTRATE REQ'D PER BATCH | SOAK TIME | MAXIMUM TOTAL GAS COMPRESSIVE ENERGY | | |
|---|---|---|---|---|---|---|---|
| …4 …H | 45.4 W/BATCH | 7,750 $CM^3$ | 7,750 G | 2 HR | 1.55 MJ | | |
| | | (8,158 $CM^3$ FOR FREE POURED) | | | | | |
| …4 …H | 90.9 W/BATCH | 44,160 $CM^3$ | 57,407 G | 2 HR | 2.48 MJ | | |

…AMETERS
DESIGN
…APSULATION
…SSURE

5/6/81

RMP THE RALPH M. PARSONS COMPANY **D-8** CALCULATION SHEET

TITLE Krypton 85 Encapsulation SHEET NO. 1 OF 7

JOB NO. 6154-3 DEPARTMENT Process AUTHOR Parrot DATE 4/30/8

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
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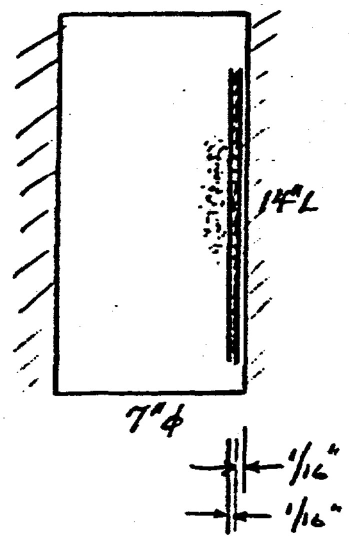
## Calculations for 1 year Product Storage




For 600 units per year case of HP (high pressure) encapsulation in zeolite, the working volume is given as 7"φ × 14" high. Assume a 1/16" gap between canned substrate and vol. walls, and 1/16" walls for can.

$\therefore$ O.D. of can = 7.000 − 2(.0625) = 6.875"
I.D. of can = 6.875 − 2(.0625) = 6.750"

$$\text{contained Vol.} = \frac{6.75^2 \pi}{4} \times 13.75'' = 492\ in^3 = 8.063\ L$$

to contain 7.750 L of zeolite.

For a 1/16" wall of 304ss., 6.875" O.D. @ 400°F, A.W.P = 173 psi

Choose a standard pipe size and a minimum gap for an "overpack". Std pipe minimizes cost, minimum gap minimized ΔT across the gas gap.

Using an 8" sch 120 overpack 8.625" O.D. × 7.187" I.D, 60.7 lbs/ft of length, have

$$\frac{\underset{I.D.}{7.187} - \underset{O.D}{6.875}}{2} = 0.156'' \text{ gap}$$

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE Krypton 85 Encapsulation SHEET NO. 2 OF 7

JOB NO. 6154-3 DEPARTMENT Process AUTHOR Garret DATE 4/30/81

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| | | | | | | | | |

For pure conduction: $\frac{k}{L}\Delta T = \frac{\dot{Q}}{A}$

air @ 300°F $k = 0.019$ BTU/hr-ft-°F

then $\frac{k}{L} = 0.019 \times \frac{12}{0.156} = 1.46 \frac{BTU/hr}{ft^2\text{-}°F}$

For 600 cans per year:

$$\frac{232.5 \frac{m^3}{yr} \times 117.3 \frac{W}{m^3} \times 3.413 \frac{BTU/hr}{W}}{600\ cans/yr} = 155.1 \frac{BTU/hr}{can}$$

Using the curved surface only:

$$\bar{A} = \pi \bar{D} L = \frac{\pi \times 6.93'' \times 13.375''}{144} = 2.10\ ft^2$$

$$\Delta T_{gap} = \frac{155.1\ BTU/hr}{2.10\ ft^2 \times 1.46 \frac{BTU/hr}{ft^2\text{-}°F}} = 50.64\ °F$$

$\bar{D} = 7.884$

$t = 0.72''$

$$\Delta T_{wall} = \frac{155.1\ BTU/hr}{2.387\ ft^2 \times \frac{10 \times 12}{.72} \frac{BTU/hr}{ft^2\text{-}°F}} = 0.4°F$$

$$\Delta T_o = \frac{\dot{Q}}{A h_c} \simeq \frac{155.1}{2.61 \times 0.9} = 66.0\ °F$$

for given Tmax center line of 300°C = 572°F and air @ 120°F, total max ΔT = 452°F; the total from above = 117°F = 26% of allowable which appears reasonable for conceptual design pending

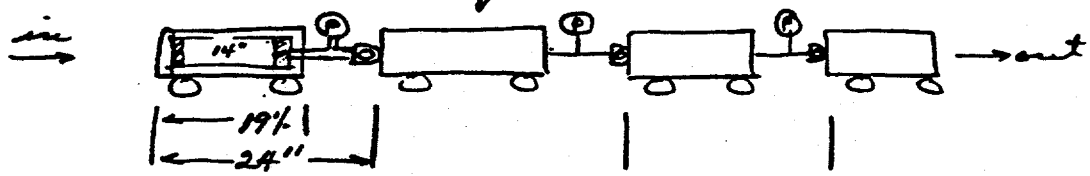
RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEE[T]

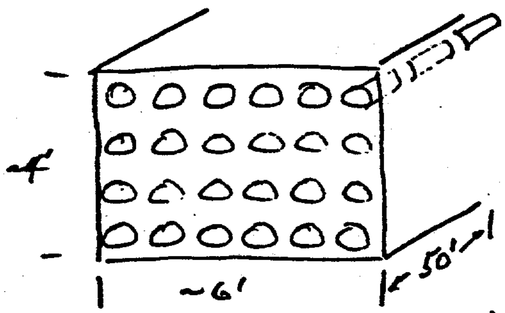
TITLE Krypton 85 Encapsulation SHEET NO. 3 OF 7
JOB NO. 6954-3 DEPARTMENT Process AUTHOR Perret DATE 4/30/8[1]

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

further definition of ΔT through zeolite matrix.

To minimize storage space consider an array



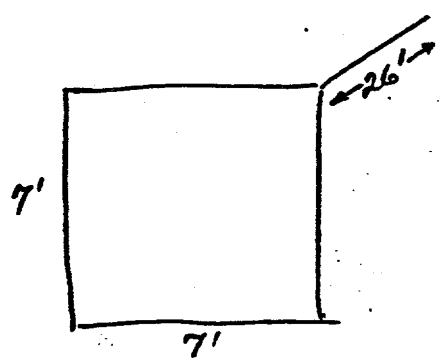




$4 \times 6 \times 25 = 600$

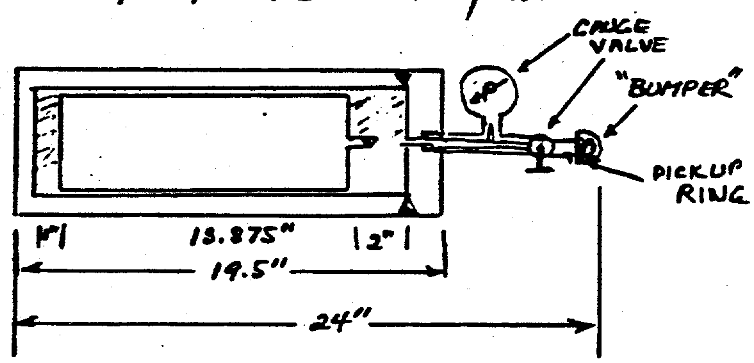
where the overpacks are pushed into the face and discharged from the rear much as the old "X"-pile.

Alternately for more compact volume:

$7 \times 7 \times 13 = 637$ units




~RACK DIMENSIONS




a sch 120 - 8" pipe of 304 ss @ 200°F has A.W.P. = 3700 psi

Check on assumption $h_c \approx 0.9$:

From calcs. for log storage $Gr = \dfrac{g\left(\frac{T_s - T_\infty}{T_\infty}\right) L^3 \rho^2}{\mu^2}$

TITLE Krypton 85 Encapsulation SHEET NO. 4 OF 7

JOB NO. 6154-3 DEPARTMENT Process AUTHOR Perret DATE 4/30/

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

only $T_s$ and $T_\infty$ and $L = D$ change.

Because of large total heat load assume 40°F rise in air, 100°F to 140°F for $\bar{T}_\infty = 120°F$

$$Gr = \frac{32.2\left(\frac{66}{560}\right)\left(\frac{8.625}{12.0}\right)^3(.0808)^2}{(.0183/1488)^2} = .061 \times 10^9$$

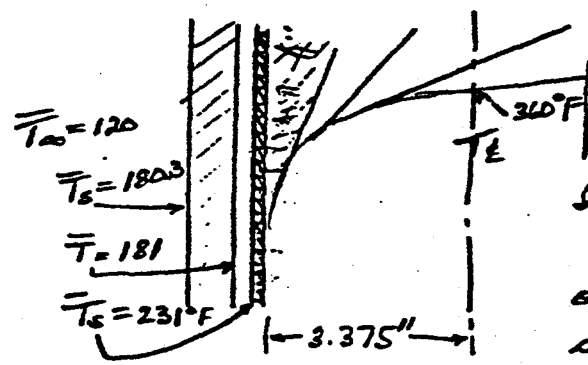
$$Nu = 0.47\,(80.78) = 37.96$$

$$h_c = \frac{.019 \times 37.96}{8.625/12} = 1.0036$$

Since $h > h$(assumed), correct $T_s - T_\infty = 66$, $h \propto \Delta T^{1/4}$

$h_c \cong 0.97$ $\Delta T \simeq 61$ $\left(\frac{61}{66}\right)^{1/4} \times 1.0036 = 0.985$

$\Delta T = 60.3$ ✓




DON'T SEE HOW $T_℄$ could be > 572°F

In any event the overpack add only 51°F ΔT to the bare can so the surface ΔT exists in any case.

from data provided $k$ with He $\simeq 1.5 \times 10^{-3}$ W/cm °K

$\simeq$ .087 $\frac{BTU/hr}{ft \cdot °F}$ = 1.04 $\frac{BTU/hr}{in \cdot °F}$

$\frac{Q}{A}$ @ 3.375 = 155.1/2.025 = 76.6 BTU/hr-ft²

| | | ΔT | |
|---|---|---|---|
| @ 3.375 | 76.6 | | |
| | | 61° | |
| @ 2.375 | = 55.3 | | |
| | | 42.7 | |
| @ 1.375 | = 31.2 | | 128°F |
| | | 19.9 | |
| @ 0.375 | = 8.51 | | |
| | | 4.2 | |

128°F ΔT estimated based on He back fill.

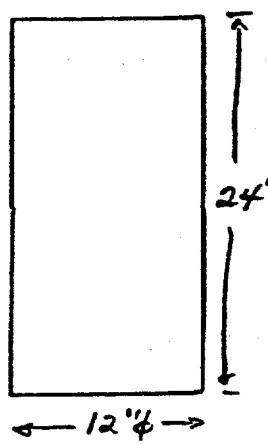
D-8

RMP — THE RALPH M. PARSONS COMPANY — CALCULATION SHEE[T]

TITLE Krypton 85 Encapsulation SHEET NO. 5 OF 7

JOB NO. 6154-3 DEPARTMENT Process AUTHOR Perret DATE 4/30/[illegible]

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |




For ~300 Units per year of "thirsty" vycor encapsulation under 500 atm. of pressure, the working volume is given as 12"ϕ x 24" deep.

If we assume a 1/16" gap for easy fit and a 1/8" wall for 100 psi differential, the interior volume is $12.00 - 2/16" - 2/8" = 11\,5/8"\phi$

$24.00 - 2/16 - 2/8 = 23\,5/8"$ Long.

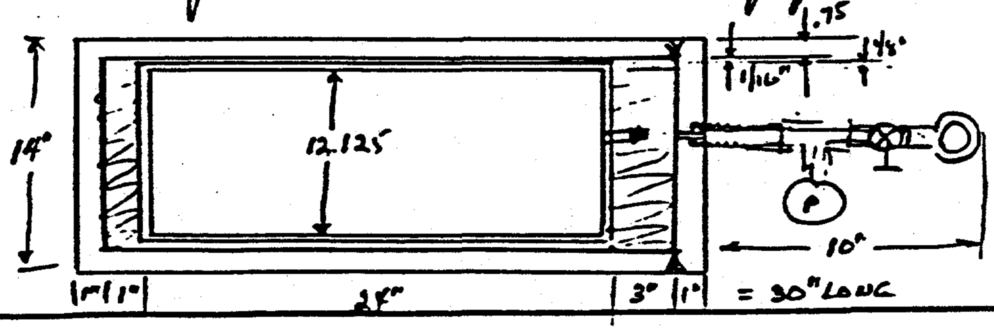
$$Vol = \frac{(11\,5/8)^2 \pi}{4} \times 23\,5/8" = 2507.5\ in^3 = 41.091\ L$$

since need 300 X 44.16 L of vycor substrate, would need about 330 vessels.

Use 12.5"ϕ as work vol. interior = 12.50 − 3/8 = 12.125"

$Vol = 2727.9\ in^3 = 44.701\ L.$ just about big enough for 44.16 L vycor & 300 units.

For over pack use 14" sch 80 pipe (12.50" I.D.) for



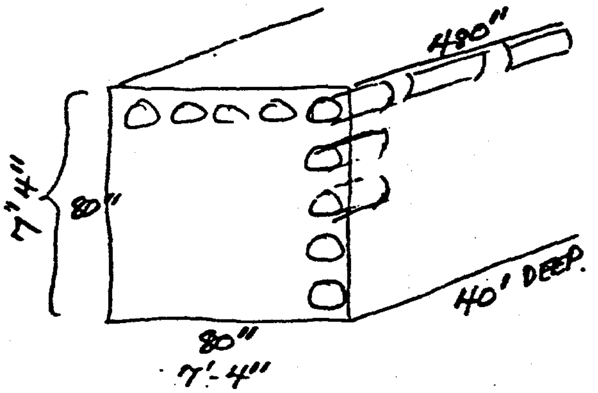
RMP THE RALPH M. PARSONS COMPANY D-8 CALCULATION SHEET

TITLE Krypton 85 Encapsulation SHEET NO. 6 OF 7

JOB NO. 61543 DEPARTMENT Process AUTHOR Perret DATE 4/30/81

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

assume 18" on centers, 5×5 array × 12 deep




For 300 units have $2(155.1) = 310.2$ BTU/hr

$A_S = \pi DL = \pi(12.375)(13.875)/144 = 6.446\ ft^2$ ; $\dot{Q}/A = 48.1 \frac{BTU}{hr\ ft^2}$

This compares to $155.1/2.10 = 73.8 \frac{BTU/hr}{ft^2}$ of case 1

∴ all ΔT's are proportionately reduced for the internal gas gap and the surface film.

For the temp. rise in the matrix:

| | | Q flow | A | Q/A | $\overline{\dot{Q}/A}$ | ~ΔT rise |
|---|---|---|---|---|---|---|
| $\dot{Q}/A$ @ | 6.0625 | 310.2 | 6.446 | 48.1 | 44.14 | $\frac{x}{2}$ ~10 |
| | 5.0625 | | | 40.185 | 36.22 | |
| | 4.0625 | | | 32.25 | 28.28 | |
| | 3.0625 | | | 24.31 | 20.34 | |
| | 2.0625 | | | 16.37 | 12.40 | |
| | 1.0625 | | | 8.43 | 4.465 | |
| | .0625 | | | 0.496 | | |

$\Sigma = 156°F$

∴ Both alternatives look feasible from thermal point of view and little difference in required storage volumes; thus the only difference

RMP-307 (2/78)

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE Krypton 85 Encapsulation SHEET NO. 7 OF 7

JOB NO. 6154-3 DEPARTMENT Process AUTHOR Perret DATE 4/30/8

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

appears to lie in the no. of units handled and the weights. Based on the preliminary design given above, the small unit weighs about 165 lbs while the larger is about 400 lbs. The effect on required handling equipment needs to be evaluated.

In either case, for a 40°F temperature rise

$$\dot{W} = \frac{\dot{Q}}{C_p \Delta T} = \frac{5 \times 18615}{(0.25)(40)} = 2.5 \times 3723 \text{ lb/hr}$$

$$= 1920 \text{ cfm}$$

to be supplied to the storage area.

J.

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION SHEET NO. 1 OF 4

JOB NO. 6154-3 DEPARTMENT AUTHOR [signature] DATE 5/18/81

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

# HIGH PRESSURE SUBSTRATE COSTS

600 batches/y

$$\left(7{,}750\frac{cm^3}{batch}\right)\left(1.0\frac{g}{cm^3}\right)\left(10^{-3}\frac{Kg}{g}\right)\left(600\frac{batches}{y}\right) = 4650\frac{Kg}{y}$$

$$\left(3.35\frac{\$}{lb}\right)\left(2.2\frac{lb}{Kg}\right)\left(4650\frac{Kg}{y}\right) = \underline{34{,}300\frac{\$}{y}}$$

Zeolite 5A
SUBSTRATE 600¢/y

$$7.37\frac{\$}{Kg}$$

---

300 batches/y

$$\left(44{,}160\frac{cm^3}{batch}\right)\left(1.3\frac{g}{cm^3}\right)\left(10^{-3}\frac{Kg}{g}\right)\left(300\frac{batches}{y}\right) = 17{,}222\frac{Kg}{y}$$

$\frac{1}{4}$-inch dia × 36-inch long Vycor glass rod

$1.5\frac{g}{cm^3}$   $5.0\frac{\$}{rod}$

$$\frac{\frac{\pi}{4}\left(\frac{1}{4}in\right)^2(36in)\left(16.39\frac{cm^3}{in^3}\right)\left(1.5\frac{g}{cm^3}\right)}{1000\frac{g}{Kg}} = 0.0434\ Kg$$

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON 85 ENCAPSULATION (HIP) SHEET NO. 2 OF 4

JOB NO 6154-3 DEPARTMENT AUTHOR D. E. Davis DATE 5/18/81

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

$$\frac{5\ \frac{\$}{rod}}{0.0434\ Kg} = 115.2\ \frac{\$}{Kg}$$

$$\left(17{,}222\ \frac{Kg}{y}\right)\left(115.2\ \frac{\$}{Kg}\right) = \underline{1{,}984{,}000\ \frac{\$}{y}}$$

Vycor glass 300ϕ/y
(Dow-Corning)

---

$3.35\ \frac{\$}{lb}$ Zeolite 5A

$5\ \frac{\$}{rod}$ Vycor glass rod

Substrate costs provided by personal communication AB Christensen, 5/15/81

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON ENCAPSULATION (HIP) SHEET NO. 3 OF 4

JOB NO 6154-3 DEPARTMENT AUTHOR [signature] DATE 5/20/81

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

# COST OF OVERPACK CONTAINERS

600 batches/y

14-inch length sch 120 8-inch dia pipe

carbon steel 32 $/ft

316 sst 250 $/ft

Figure 17 units cut from 20 ft pipe length.

$$(20\,ft)(32\,\tfrac{\$}{ft})\frac{600\ units}{17\ units} = \$22{,}600\ \text{PIPE}$$

2,400 ENDCAPS

\$25,000 C.S. 600φ/y

$$(20\,ft)(250\,\tfrac{\$}{ft})\frac{600\ units}{17\ units} = \$176{,}000\ \text{PIPE}$$

9,000 ENDCAPS

\$185,000 316SST 600φ/y

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE KRYPTON ENDCAPSULATION (HI P) SHEET NO. 4 OF 4

JOB NO. 6154-3 DEPARTMENT AUTHOR [signature] DATE 5/20/81

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

300 batches/y

24-inch length sch 80 14-inch dia pipe

carbon steel 55 $/ft

stainless steel 316 300 $/ft

Figure 10 units cut from 20 ft pipe length.

$$(20\,ft)(55\,\tfrac{\$}{ft})\frac{300\text{ units}}{10\text{ units}} = \$33{,}000 \text{ PIPE}$$

5,000 ENDCAPS

$38,000 C.S.

300¢/y

$$(20\,ft)(300\,\tfrac{\$}{ft})\frac{300\text{ units}}{10\text{ units}} = \$180{,}000 \text{ PIPE}$$

10,000 ENDCAPS

$190,000 316 SST

300¢/y

PIPE COSTS FROM DICK DORSCH, RMPCo PIPING ESTIMATOR, COST ENGINEERING & SCHEDULING

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE VESSEL RUPTURE SHEET NO. 1 OF

JOB NO. 6154-3 DEPARTMENT AUTHOR R. WILKINSON DATE 6-30-81

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

BASED ON PRELIMINARY ASSESSMENTS, AND ON THE CONFIGURATION USED FOR THE PRECONCEPTUAL DESIGN, THE MOST SERIOUS CREDIBLE ACCIDENT FOR THE HOT ISOSTATIC PRESS WOULD BE BRITTLE FAILURE OF THE YOKE UNDER PRESSURE, AND LAUNCHING OF THE TOP PLUG AS A MISSILE. THIS CALCULATION WILL DETERMINE THE MAXIMUM VELOCITY OF THE TOP PLUG, AND THE REQUIRED THICKNESS OF CONCRETE TO CONTAIN THE MISSILE.

CALCULATIONS ARE BASED ON THE PROCEDURES USED IN ENICO 1055, "PRELIMINARY SAFETY EVALUATION OF A COMMERCIAL-SCALE KRYPTON-85 ENCAPSULATION FACILITY", SEPTEMBER, 1980. FOR WORST CASE CALCULATION, ENERGY VALUES ARE BASED ON ARGON GAS PROPERTIES.

$P_1$ = PRESSURE PRIOR TO RUPTURE = 1000 ATM.

$T_1$ = TEMPERATURE PRIOR TO RUPTURE = 700 °C = 973 °K

V = GAS VOLUME = 7140 ℓ (0°C, 1 ATM)

$v_1$ = SPECIFIC INITIAL VOLUME (PER REDLICH-KWONG EQUATION)

= 103 cm³/MOLE

$V_2$ = 162.5 m³

$P_2$ (ESTIMATED) = 1.055 ATM.

$T_2$ (ESTIMATED) = 80°K

$v_2$ = 6250 cm³/MOLE

RMP-307 (2/78) PAGE NUMBER

RMP THE RALPH M. PARSONS COMPANY CALCULATION SHEET

TITLE VESSEL RUPTURE SHEET NO. 2 OF 2

JOB NO. 6154-3 DEPARTMENT AUTHOR R. WILKINSON DATE 6-30-81

| REV | CHECKER | DATE | REV | CHECKER | DATE | REV | CHECKER | DATE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

$\Delta U = 121.92\ J/L$

TOTAL ENERGY = 870,540 J

THE ESTIMATED PLUG DIMENSIONS ARE 11.5 IN. DIAMETER BY 10 IN. THK., ESTIMATED WEIGHT = 300 LB = 136 Kg

$K.E = 0.6\,\Delta U = 0.6 \times 870{,}540 = 522{,}300\ J$

$V_p = (2K.E / W_p)^{1/2} = 87.64\ m/s$

THE THICKNESS OF CONCRETE REQUIRED TO STOP THE PLUG IS

$$t = \frac{6 \times 10^{-4}\, W_p}{A_p} \log_{10}\left(1 + 5 \times 10^{-5}\, V_p^2\right)$$

$W_p = 136\ Kg$

$A_p = 0.067\ m^2$

$t = 0.172\ m = 6.8\ IN.$

THEREFORE, THE 18 IN. THICK CONCRETE CELL CEILING IS MORE THAN ADEQUATE.

THE EQUIVALENT EXPLOSIVE ENERGY IS

0.193 Kg TNT

0.426 LB TNT

RMP-307 (2/78)

# APPENDIX E

# COST ESTIMATES

E-1 ION IMPLANTATION/SPUTTERING

E-2 ZEOLITE ENCAPSULATION

RMP

THE RALPH M. PARSONS COMPANY



PROJECT NAME: KRYPTON ENCAPSULATION PRECONCEPTUAL DESIGN ION IMPLANTATION / SPUTTERING FACILITY DATE JULY, 1981

ESTIMATE OF COST PAGE ___ OF ___

PROJECT NO. 6154-3 SUMMARY BY ___

| ACCT. NO. | DESCRIPTION | LABOR COST $ | MATERIAL COST $ | TOTAL COST $ |
|---|---|---|---|---|
| | DIRECT COST | | | |
| 400 | IMPROVEMENTS TO LAND | 23,000 | 2,000 | 25,000 |
| 500 | BUILDING & OTHER STRUCTURES | 1,620,000 | 1,525,000 | 3,145,000 |
| 600 | UTILITIES (NOT INCLUDED) | — | — | — |
| 700 | EQUIPMENT | 215,000 | 1,480,000 | 1,695,000 |
| 800 | DEMOLITION & REMOVALS (NONE) | — | — | — |
| | TOTAL DIRECT COST | 1,858,000 | 3,007,000 | 4,865,000 |
| | | | | |
| | CONTRACTOR INDIRECTS @ 10% | | | 487,000 |
| | | | | |
| | | | | |
| | | | | |
| | TOTAL CONSTRUCTION COST | | | 5,352,000 |
| | | | | |
| | | | | |
| | TITLE I @ 6% | | | 321,000 |
| | TITLE II @ 14% | | | 750,000 |
| | TITLE III @ 8% | | | 428,000 |
| | A - FIELD INSPECTION | | | |
| | B - SHOP INSPECTION | | | |
| | | | | |
| | PROJECT ADMINISTRATION @ 10% | | | 535,000 |
| | | | | |
| | SUB-TOTAL ENGINEERING | | | 2,034,000 |
| | | | | |
| | SUB-TOTAL | | | 7,386,000 |
| | | | | |
| | ESCALATION (NOT INCLUDED) | — | — | — |
| | | | | |
| | SUB-TOTAL | | | 7,386,000 |
| | | | | |
| | CONTINGENCY @ 40% | | | 2,954,000 |
| | TOTAL JOB COST | | | 10,340,000 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW  PRICED BY RW  DATE JULY, 1981  SHEET ____ OF ____

JOB NO.: 6154-3  CLIENT: U.S. DOE  TYPE OF ESTIMATE:  CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ION IMPLANTATION / SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT | | | MATERIAL EXPENSE | SUBCONTRACT | | LABOR | | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MATL | M/H | LAB $ | | M/HRS | DOLLARS | M/HRS | DOLLARS | |
| 400 | IMPROVEMENTS TO LAND | | | | | | | | | | | |
| | SITE CLEARING | 6000 | SY | - | .014 | | | | | 84 | | |
| | EXCAVATION | 640 | CY | - | .15 | | | | | 96 | | |
| | COMPACTED BACKFILL | 200 | CY | 2.00 | .16 | | 400 | | | 32 | | |
| | GRADING | 5200 | SF | - | .012 | | | | | 62 | | |
| | DISPOSAL | 440 | CY | - | .10 | | | | | 44 | | |
| | CONCRETE WALKS (EST) 6" THK. | 400 | SF | 1.60 | .10 | | 640 | | | 40 | | |
| | SUB-TOTAL | | | | | | 1040 | | | 358 | | |
| | PRODUCTIVITY (1.80 × 358) | 644 | MH | | | 19.50 | | | | 644 | 12560 | |
| | SUB-TOTAL | | | | | | 1040 | | | | 12560 | 13600 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 360 | | | | 10040 | 10400 |
| | TOTAL 400 | | | | | | 1400 | | | | 22600 | 24000 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW  PRICED BY RW  DATE JULY, 1981  SHEET ____ OF ____

JOB NO.: 6154-3  CLIENT: U.S. DOE  TYPE OF ESTIMATE:  CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ION IMPLANTATION / SPUTTERING

CAPACITY:

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS & STRUCTURES | | | | | | | | | | | |
| | CONCRETE | | | | | | 307730 | | | 10185 | 339160 | 646890 |
| | MASONRY | | | | | | 2890 | | | 524 | 18310 | 21200 |
| | STRUCTURAL STEEL & MISC. METALS | | | | | | 48340 | | | 752 | 28160 | 76500 |
| | FINISHES | | | | | | 50150 | | | 4001 | 138950 | 189100 |
| | PAINTING & SPECIAL COATING | | | | | | 5000 | | | 2005 | 70400 | 75400 |
| | DOORS & WINDOWS | | | | | | 14400 | | | 302 | 10600 | 30000 |
| | SPECIALTIES | | | | | | 7210 | | | 166 | 5890 | 13100 |
| | PIPING | | | | | | 66890 | | | 3744 | 146210 | 213100 |
| | INSTRUMENTATION | | | | | | 99710 | | | 1550 | 58290 | 158000 |
| | ELECTRICAL | | | | | | 284120 | | | 9158 | 343880 | 628000 |
| | HVAC | | | | | | 289350 | | | 3578 | 124950 | 414300 |
| | FIRE PROTECTION | | | | | | 35100 | | | 936 | 32700 | 67800 |
| | PLUMBING | | | | | | 31050 | | | 1890 | 73850 | 104900 |
| | SPECIAL BLDG. COMPONENTS | | | | | | 275120 | | | 6165 | 225280 | 500400 |
| | TOTAL 500 | | | | | | 1522060 | | | | 1616630 | 3138690 |
| | USE | | | | | | 1525000 | | | | 1620000 | 3145000 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY SV PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION/SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | CONCRETE | | | | | | | | | | | |
| | FOUNDATION | 230 | CY | | | | 55410 | | | 1254 | | |
| | WALLS | 338 | CY | | | | 112250 | | | 2893 | | |
| | SUSPENDED SLABS | 263 | CY | | | | 60290 | | | 1511 | | |
| | SUB-TOTAL | | | | | | 227950 | | | 5658 | | |
| | PRODUCTIVITY (1.80 x 5658) | 10185 | | | | 18.50 | | | | 10185 | 188420 | |
| | SUB-TOTAL | | | | | | 227950 | | | | 188420 | |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 79780 | | | | 150740 | |
| | | | | | | | 307730 | | | | 339160 | 646890 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY SV    PRICED BY RW    DATE JULY, 1981    SHEET ____ OF ____

JOB NO.: 6154-3    CLIENT: US DOE    TYPE OF ESTIMATE:    CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION / SPUTTERING

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | COST OR M/HRS PER UNIT: M/H | COST OR M/HRS PER UNIT: LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | SUBCONTRACT: DOLLARS | LABOR: M/HRS | LABOR: DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | CONCRETE | | | | | | | | | | | |
| | FOUNDATION | | | | | | | | | | | |
| | VAPOR BARRIER | 4800 | SF | .20 | .005 | | 960 | | | 24 | | |
| | CONCRETE FOOTINGS | 170 | CY | 60 | .40 | | 10200 | | | 68 | | |
| | SLAB ON GRADE (4800 SF) | 60 | CY | 60 | .30 | | 3600 | | | 18 | | |
| | FORMWORK | 3600 | SF | .71 | .01 | | 2560 | | | 360 | | |
| | REBAR (190#/CY) | 22 | TON | 700 | 16 | | 15400 | | | 352 | | |
| | EMBEDS (C.S., 75#/CY) | 9 | TON | 2500 | 40 | | 22500 | | | 360 | | |
| | FINISH | 4800 | SF | .04 | .015 | | 190 | | | 72 | | |
| | SUB-TOTAL | | | | | | 55410 | | | 1254 | | |
| | WALLS | | | | | | | | | | | |
| | CONCRETE WALLS (12" THK) | 320 | CY | 60 | .70 | | 19200 | | | 224 | | |
| | PARAPET (8" THK) | 16 | CY | 60 | .70 | | 960 | | | 11 | | |
| | COLUMNS (12" x 12") | 1.5 | CY | 60 | .70 | | 90 | | | 1 | | |
| | FORMWORK | 18,200 | SF | .71 | .02 | | 12920 | | | 364 | | |
| | REBAR (240#/CY) | 40.5 | TON | 700 | 18 | | 28350 | | | 729 | | |
| | EMBEDS (120#/CY) | 20 | TON | 2500 | 60 | | 50000 | | | 1200 | | |
| | FINISH | 18,200 | SF | .04 | .02 | | 730 | | | 364 | | |
| | SUB-TOTAL | | | | | | 112250 | | | 2893 | | |
| | SUSPENDED SLAB | | | | | | | | | | | |
| | CONCRETE (12" THK) | 263 | CY | 60 | .40 | | 15780 | | | 105 | | |
| | FORMWORK | 7100 | SF | 1.30 | .04 | | 9230 | | | 284 | | |
| | REBAR (190#/CY) | 25 | TON | 700 | 20 | | 17500 | | | 500 | | |
| | EMBEDS (60#/CY) | 8 | TON | 2500 | 60 | | 17500 | | | 480 | | |
| | FINISH | 7100 | SF | .04 | .02 | | 280 | | | 142 | | |
| | SUB-TOTAL | | | | | | 60290 | | | 1511 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: TYPE OF ESTIMATE: CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ION IMPLANTATION/SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | MASONRY | | | | | | | | | | | |
| | 8" CONCRETE BLOCK | 1860 | SF | 1.1 | 0.15 | | 2050 | | | 279 | | |
| | 12" CONCRETE BLOCK | 60 | SF | 1.5 | 0.20 | | 90 | | | 12 | | |
| | SUB-TOTAL | | | | | | 2140 | | | 291 | | |
| | PRODUCTIVITY (1.80 × 291) | 524 | MH | | | 19.40 | | | | 524 | 10170 | |
| | SUB-TOTAL | | | | | | 2140 | | | | 10170 | 12310 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 750 | | | | 8140 | 8890 |
| | TOTAL | | | | | | 2890 | | | | 18310 | 21200 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY SV　PRICED BY EW　DATE JULY, 1981　SHEET ____ OF ____

JOB NO.: 6154-3　CLIENT: US DOE　TYPE OF ESTIMATE:　CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ION IMPLANTATION/SPUTTERING

CAPACITY:

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | STRUCTURAL STEEL & MISC. METALS | | | | | | | | | | | |
| | OPEN WEB STEEL JOISTS (13@1200) | 7.8 | TON | 600 | 8 | | 4680 | | | 62 | | |
| | METAL DECKING | 1790 | SF | 3.20 | .02 | | 5730 | | | 36 | | |
| | PIPES, PLATES, & RODS (EST) | 2 | TON | 1360 | 10 | | 2720 | | | 20 | | |
| | MISCELLANEOUS SUPPORTS (EST | 12 | TON | 1390 | 20 | | 16680 | | | 240 | | |
| | MISC. (EST) | 5 | TON | 1200 | 12 | | 6000 | | | 60 | | |
| | SUB-TOTAL | | | | | | 35810 | | | 418 | | |
| | PRODUCTIVITY (1.80 × 418) | 752 | MH | | | 20.80 | | | | 752 | 15640 | |
| | SUB-TOTAL | | | | | | 35810 | | | | 15640 | 51450 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 12530 | | | | 12520 | 25050 |
| | TOTAL | | | | | | 48340 | | | | 28160 | 76500 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW — PRICED BY RW — DATE July, 1981 — SHEET ___ OF ___

JOB NO.: 6154-3 — CLIENT: US DOE — TYPE OF ESTIMATE: — CKD BY:

UNIT/AREA: Krypton Encapsulation

DESCRIPTION: Ion Implantation / Sputtering

CAPACITY:

| ACCNT | Description | Quantity | Unit | Cost per Unit MATL | Cost per Unit M/H | Cost per Unit LAB $ | Material Expense | Subcontract M/HRS | Subcontract Dollars | Labor M/HRS | Labor Dollars | Total Dollars |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | Buildings | | | | | | | | | | | |
| | Finishes | | | | | | | | | | | |
| | Insulated Metal Siding | 8190 | SF | 2.80 | .08 | | 22930 | | | 655 | | |
| | Inverted Roofing System | 4930 | SF | 1.80 | .25 | | 8870 | | | 1233 | | |
| | Flashing & Sheet Metal | 750 | LF | 1.00 | .15 | | 750 | | | 113 | | |
| | 4" Metal Studs x 9'-6" (16" c/c) | 210 | LF | 5.80 | .19 | | 1220 | | | 40 | | |
| | 5/8" THK Gypsum Board (Type X) | 1650 | SF | 0.30 | .015 | | 500 | | | 25 | | |
| | 5/8" THK Gypsum Board | 2280 | SF | 0.20 | .015 | | 460 | | | 34 | | |
| | Suspended Plaster Ceiling | 600 | SF | 1.15 | .05 | | 690 | | | 30 | | |
| | Suspended Acoustical Ceiling | 860 | SF | 0.80 | .02 | | 700 | | | 17 | | |
| | Ceramic Tile Walls | 130 | SF | 1.45 | .10 | | 190 | | | 13 | | |
| | Ceramic Tile Flooring | 250 | SF | 1.45 | .10 | | 360 | | | 25 | | |
| | Vinyl Asbestos Tile Flooring | 950 | SF | 0.50 | .04 | | 480 | | | 38 | | |
| | Sub-Total | | | | | | 37150 | | | 2223 | | |
| | Productivity (1.80 x 2223) | 4001 | MH | | | 19.30 | | | | 4001 | 77220 | |
| | Sub-Total | | | | | | 37150 | | | | 77220 | |
| | Subcontractor Mark-Up | | % | 35 | 80 | | 13000 | | | | 61730 | |
| | Total | | | | | | 50150 | | | | 138950 | 189100 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION/SPUTTERING

CAPACITY

| ACCNT | DESCRIPTION | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | PAINTING & SPECIAL COATING | | | | | | | | | | | |
| | PAINTING | | | | | | | | | | | |
| | GYPSUM BOARD | 3930 | SF | .12 | .03 | | 470 | | | 118 | | |
| | MASONRY BLOCK | 1920 | SF | .12 | .05 | | 230 | | | 96 | | |
| | PIPING (EST) | 1000 | SF | .12 | .05 | | 120 | | | 50 | | |
| | DUCTWORK (EST) | 3000 | SF | .12 | .04 | | 360 | | | 120 | | |
| | SPECIAL COATING | | | | | | | | | | | |
| | PLASTER CEILING | 600 | SF | .20 | .05 | | 120 | | | 30 | | |
| | CONCRETE WALLS | 5100 | SF | .20 | .06 | | 1020 | | | 306 | | |
| | CONCRETE FLOORS | 3900 | SF | .20 | .06 | | 780 | | | 234 | | |
| | PIPING (EST) | 1000 | SF | .20 | .06 | | 200 | | | 60 | | |
| | DUCTWORK (EST) | 2000 | SF | .20 | .05 | | 400 | | | 100 | | |
| | SUB-TOTAL | | | | | | 3700 | | | 1114 | | |
| | PRODUCTIVITY (1.80 × 1114) | 2005 | MH | | | 19.50 | | | | 2005 | 39100 | |
| | SUB-TOTAL | | | | | | 3700 | | | | 39100 | |
| | SUB-CONTRACTOR MARK-UP | | % | 35 | 80 | | 1300 | | | | 31300 | |
| | TOTAL | | | | | | 5000 | | | | 70400 | 75400 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION / SPUTTERING

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | DOORS & WINDOWS | | | | | | | | | | | |
| | TORNADO PROOF DOORS | | | | | | | | | | | |
| | 8'x8' METAL OVERHEAD | 1 | EA | 4200.00 | 16 | | 4200 | | | 16 | | |
| | 3'-0"x7'-0" METAL CLAD | 4 | EA | 1200.00 | 12 | | 4800 | | | 48 | | |
| | HOLLOW METAL DOORS 3'-0"x7'-0" | 7 | EA | 300.00 | 6 | | 2100 | | | 42 | | |
| | HOLLOW CORE WOOD 3'-0"x7'-0" | 8 | EA | 80.00 | 4 | | 640 | | | 32 | | |
| | METAL DOOR, SHEILDING 3'-0"x7'-0" | 6 | EA | 480.00 | 3 | | 2880 | | | 18 | | |
| | OFFICE WINDOW 11'-0"x4'-0" | 1 | EA | 800.00 | 16 | | 800 | | | 16 | | |
| | WIRE GLASS 12"x24" | 2 | EA | 80.00 | 4 | | 160 | | | 8 | | |
| | SUB-TOTAL | | | | | | 14380 | | | 168 | | |
| | PRODUCTIVITY (1.80 x 168) | 302 | | | | 19.50 | | | | 302 | 5890 | |
| | SUB-TOTAL | | | | | | 14380 | | | | 5890 | 20270 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 5020 | | | | 4710 | 9730 |
| | TOTAL | | | | | | 19400 | | | | 10600 | 30000 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ION IMPLANTATION / SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | SPECIALTIES | | | | | | | | | | | |
| | BATH ACCESSORIES | | | | | | | | | | | |
| | TOILET PARTITION | 2 | EA | 250 | 6 | | 500 | | | 12 | | |
| | URINAL SCREEN | 1 | EA | 60 | 2 | | 60 | | | 2 | | |
| | MIRROR W/ SS FRAME & SHELF | 2 | EA | 30 | 2 | | 60 | | | 4 | | |
| | COMB. TOWEL DISP. & RECEPT. | 2 | EA | 200 | 4 | | 400 | | | 8 | | |
| | FEMININE NAPKIN DISP | 1 | EA | 170 | 2 | | 170 | | | 2 | | |
| | TOILET PAPER DISP | 2 | EA | 20 | 1 | | 40 | | | 2 | | |
| | SOAP DISPENSER | 2 | EA | 25 | 1 | | 50 | | | 2 | | |
| | TOILET SEAT DISP. | 2 | EA | 30 | 1 | | 60 | | | 2 | | |
| | CABINET WORK | | | | | | | | | | | |
| | 24"×72"×36" W/ LAM. TOP & SS SINK | 1 | EA | 1650 | 20 | | 1650 | | | 20 | | |
| | 12"×72"×24" WALL HUNG | 1 | EA | 300 | 4 | | 300 | | | 4 | | |
| | 36"×168"×36" W/ LAM. TOP | 1 | EA | 1450 | 24 | | 1450 | | | 24 | | |
| | 15"×18"×60" LOCKERS | 10 | EA | 60 | 1 | | 600 | | | 10 | | |
| | SUB-TOTAL | | | | | | 5340 | | | 92 | | |
| | PRODUCTIVITY (1.80×92) | 166 | MH | | | 19.50 | | | | 166 | 3240 | |
| | SUB-TOTAL | | | | | | 5340 | | | | 3240 | 8580 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 1870 | | | | 2650 | |
| | TOTAL | | | | | | 7210 | | | | 5890 | 13100 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS    PRICED BY RW    DATE JULY, 1981    SHEET 1 OF 12

JOB NO.: 6154-3    CLIENT: US DOE    TYPE OF ESTIMATE:    CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION / SPUTTERING

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | PIPING SUMMARY | | | | | | | | | | | |
| | FROM SHT. 2 | | | | | | 1830 | | | 28 | | |
| | " " 3 | | | | | | 11890 | | | 277 | | |
| | " " 4 | | | | | | 1427 | | | 114 | | |
| | " " 5 | | | | | | 2110 | | | 229 | | |
| | " " 6 | | | | | | 1215 | | | 91 | | |
| | " " 7 | | | | | | 2895 | | | 99 | | |
| | " " 8 | | | | | | 1214 | | | 65 | | |
| | " " 9 | | | | | | 2832 | | | 252 | | |
| | " " 10 | | | | | | 3118 | | | 256 | | |
| | " " 11 | | | | | | 5241 | | | 334 | | |
| | " " 12 | | | | | | 3975 | | | 75 | | |
| | SUB-TOTAL | | | | | | 37747 | | | 1820 | | |
| | FIELD WELD & TEST (ALLOW) | | | | | | 800 | | | 80 | | |
| | UTILITY SUPPORTS (ALLOW) | | | | | | 6000 | | | 60 | | |
| | CLEAN & TEST (ALLOW) | | | | | | 5000 | | | 120 | | |
| | SUB-TOTAL | | | | | | 49550 | | | 2080 | | |
| | PRODUCTIVITY (1.80 × 2080) | 3744 | MH | | | 21.70 | | | | 3744 | 81240 | |
| | SUB-TOTAL | | | | | | 49550 | | | | 81240 | |
| | SUBCONTRACTOR MARKUP | | % | 35 | 80 | | 17340 | | | | 64970 | |
| | | | | | | | 66890 | | | | 146210 | 213100 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS PRICED BY RW DATE JULY, 1981 SHEET 2 OF 12

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION/SPUTTERING

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HIGH PRESSURE STEAM | | | | | | | | | | | |
| | SPEC N, CARBON STEEL | | | | | | | | | | | |
| | PIPE 3", STD. WT., BEVELED ENDS | 25 | LF | 4.20 | .35 | | 105 | | | 9 | | |
| | FITTINGS | | | | | | | | | | | |
| | TEES 3" x 3" x 3" | 1 | | 12.50 | - | | 13 | | | | | |
| | ELBOWS 3" LR | 3 | | 5.30 | - | | 16 | | | | | |
| | VALVES | | | | | | | | | | | |
| | GATE 3", 150# ANSI | 2 | | 364 | 4.5 | | 730 | | | 9 | | |
| | PRESSURE CONTROL, 3" | 1 | | 850 | 6 | | 850 | | | 6 | | |
| | STRAINER, 3", 150# ANSI | 1 | | 120 | 4 | | 120 | | | 4 | | |
| | | | | | | | 1830 | | | 28 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. Brooks PRICED BY RW DATE July, 1981 SHEET 3 OF 12

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA Krypton Encapsulation

DESCRIPTION Ion Implantation/Sputtering

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -- | Low Pressure Steam | | | | | | | | | | | |
| | Spec N, Carbon Steel | | | | | | | | | | | |
| | Pipe | | | | | | | | | | | |
| | 2" XS Threaded Ends | 50 | LF | 2.90 | .35 | | 145 | | | 18 | | |
| | 1½" XS Threaded Ends | 100 | LF | 1.90 | .30 | | 190 | | | 30 | | |
| | 1" XS Threaded Ends | 100 | LF | 1.30 | .25 | | 130 | | | 25 | | |
| | Fittings Tees 2×2×2 | 3 | | 14.– | | | 42 | | | 7 | | |
| | 1×1×1 | 4 | | 8.20 | | | 33 | | | 6 | | |
| | Ells 2" LR | 10 | | 10.– | | | 100 | | | 23 | | |
| | 1½" LR | 10 | | 8.50 | | | 85 | | | 17 | | |
| | 1" LR | 20 | | 6.20 | | | 124 | | | 30 | | |
| | Valves | | | | | | | | | | | |
| | Gate 2" | 6 | | 280.– | 4 | | 1680 | | | 24 | | |
| | 1½" | 2 | | 220 | 3 | | 440 | | | 6 | | |
| | 1" | 8 | | 190 | 3 | | 1520 | | | 24 | | |
| | 3/4" | 5 | | 160 | 2 | | 800 | | | 10 | | |
| | Globe 1" | 8 | | 210 | 3 | | 1680 | | | 24 | | |
| | PCV 2" | 1 | | 620 | 4 | | 620 | | | 4 | | |
| | TCV 2" | 2 | | 620 | 4 | | 1240 | | | 8 | | |
| | 1½" | 1 | | 480 | 3 | | 480 | | | 3 | | |
| | 1" | 4 | | 370 | 2 | | 1480 | | | 8 | | |
| | Trap, 3/4" | 5 | | 220 | 2 | | 1100 | | | 10 | | |
| | | | | | | | 11890 | | | 277 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L BROOKS PRICED BY RW DATE JULY, 1981 SHEET 4 OF 12

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION/SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CONDENSATE | | | | | | | | | | | |
| | SPEC N, CARBON STEEL | | | | | | | | | | | |
| | PIPE 1½" XS, THREADED | 20 | LF | 1.90 | .30 | | 38 | | | 6 | | |
| | 1" XS, THREADED | 70 | LF | 1.30 | .25 | | 91 | | | 18 | | |
| | 3/4" XS, THREADED | 100 | LF | 0.95 | .20 | | 95 | | | 20 | | |
| | FITTINGS | | | | | | | | | | | |
| | TEES 1½×1½×1 | 1 | | 10.40 | 1.7 | | 10 | | | 2 | | |
| | 1×1×¾ | 5 | | 8.20 | 1.5 | | 41 | | | 8 | | |
| | ELBOWS 1½ LR | 4 | | 8.50 | 1.7 | | 34 | | | 7 | | |
| | 1 LR | 10 | | 6.20 | 1.5 | | 62 | | | 15 | | |
| | 3/4 LR | 20 | | 4.80 | 1.3 | | 96 | | | 26 | | |
| | VALVES GATE 3/4 | 6 | | 160 | 2 | | 960 | | | 12 | | |
| | | | | | | | 1427 | | | 114 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS PRICED BY RW DATE JULY, 1981 SHEET 5 OF 12

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION / SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PROCESS EQUIPMENT DRAINS | | | | | | | | | | | |
| | SPEC D, 304L SS | | | | | | | | | | | |
| | PIPE 2" SCH 80S THREADED | 200 | LF | 14.30 | .35 | | 286 | | | 70 | | |
| | FITTINGS 90° LR ELL | 2 | | 14.20 | 2.3 | | 28 | | | 5 | | |
| | 45° LR ELL | 10 | | 12.80 | 2.3 | | 128 | | | 23 | | |
| | 45° LATERALS | 10 | | 14.20 | 2.3 | | 142 | | | 23 | | |
| | FLOOR DRAINS, 2" | 18 | | 85.— | 6 | | 1530 | | | 108 | | |
| | | | | | | | 2110 | | | 229 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS PRICED BY BW DATE JULY, 1981 SHEET 6 OF 12

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION / SPUTTERING

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | SUBCONTRACT: DOLLARS | LABOR: M/HRS | LABOR: DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HIGH PRESSURE AIR | | | | | | | | | | | |
| | PIPE, 1½ XS, THREADED | 110 | LF | 1.90 | .30 | | 209 | | | 33 | | |
| | 1 XS, THREADED | 50 | LF | 1.30 | .25 | | 65 | | | 13 | | |
| | FITTINGS TEES 1½×1½×1 | 4 | | 10.40 | 1.7 | | 42 | | | 7 | | |
| | 1½×1½×½ | 10 | | 10.40 | 1.7 | | 104 | | | 17 | | |
| | 1½×1½×1½ | 1 | | 10.40 | 1.7 | | 10 | | | 2 | | |
| | ELBOWS 1½ LR | 3 | | 8.50 | 1.7 | | 25 | | | 5 | | |
| | VALVES GATE, 1" | 4 | | 190 | 3 | | 760 | | | 12 | | |
| | | | | | | | 1215 | | | 91 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L BROOKS PRICED BY RW DATE JULY, 1981 SHEET 7 OF 12

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION / SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT | | | MATERIAL EXPENSE | SUBCONTRACT | | LABOR | | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MATL | M/H | LAB $ | | M/HRS | DOLLARS | M/HRS | DOLLARS | |
| | COOLING WATER SUPPLY | | | | | | | | | | | |
| | SPEC Q, CARBON STEEL | | | | | | | | | | | |
| | PIPE 2" XS, THREADED | 100 | LF | 2.90 | .35 | | 290 | | | 35 | | |
| | FITTINGS ELBOWS 2" LR | 10 | | 10- | 2.3 | | 100 | | | 23 | | |
| | TEES 2×2×1½ | 1 | | 14- | 2.3 | | 14 | | | 2 | | |
| | 2×2×½ | 4 | | 14- | 2.3 | | 56 | | | 9 | | |
| | VALVES GATE 2" | 4 | | 280- | 4 | | 1120 | | | 16 | | |
| | CHECK 2" | 1 | | 95- | 3 | | 95 | | | 3 | | |
| | FCV 2" | 1 | | 620- | 4 | | 620 | | | 4 | | |
| | BELLOWS SEAL GLOBE 2" | 1 | | 480- | 4 | | 480 | | | 4 | | |
| | FLOW ELEMENT, 2" | 1 | | 120 | 3 | | 120 | | | 3 | | |
| | | | | | | | 2895 | | | 99 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS PRICED BY RW DATE JULY, 1981 SHEET 8 OF 12

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION/SPUTTERING

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | COOLING WATER RETURN | | | | | | | | | | | |
| | SPEC Q, CARBON STEEL | | | | | | | | | | | |
| | PIPE 2", XS THREADED | 100 | LF | 2.90 | .35 | | 290 | | | 35 | | |
| | FITTINGS ELBOWS, 90° LR | 7 | | 10.– | 2.3 | | 70 | | | 16 | | |
| | TEES 2×2×1/2 | 1 | | 14.– | 2.3 | | 14 | | | 2 | | |
| | VALVES, GATE 2" | 3 | | 280.– | 4 | | 840 | | | 12 | | |
| | | | | | | | 1214 | | | 65 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L.A. BROOKS — PRICED BY RW — DATE JULY, 1981 — SHEET 9 OF 12

JOB NO.: 6154-3 — CLIENT: — TYPE OF ESTIMATE: — CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ION IMPLANTATION/SPUTTERING

CAPACITY

| ACCT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CLOSED LOOP COOLING WATER RETURN | | | | | | | | | | | |
| | SPEC Q, CARBON STEEL | | | | | | | | | | | |
| | PIPE 2" SCH XS THREADED | 100 | LF | 2.90 | .35 | | 290 | | | 35 | | |
| | 1" SCH XS THREADED | 80 | LF | 1.30 | .25 | | 104 | | | 20 | | |
| | FITTINGS | | | | | | | | | | | |
| | ELBOWS | | | | | | | | | | | |
| | 90° 2" LR | | 8 | 10- | 2.3 | | 80 | | | 18 | | |
| | 90° 1" LR | | 44 | 6.20 | 1.5 | | 273 | | | 66 | | |
| | TEES 2"×2"×2" | | 4 | 14- | 2.3 | | 56 | | | 9 | | |
| | 2"×2"×1" | | 10 | 14- | 2.3 | | 140 | | | 23 | | |
| | 1"×1"×1" | | 6 | 8.20 | 1.5 | | 49 | | | 9 | | |
| | VALVES | | | | | | | | | | | |
| | GATE 2" | | 2 | 280- | 4 | | 560 | | | 8 | | |
| | SOLENOID VALVES 1" | | 8 | 140 | 6 | | 1120 | | | 48 | | |
| | FLEX HOSE W/ BUTT WELD END CONNECTIONS × 9" LG, 1" | | 8 | 20 | 2 | | 160 | | | 16 | | |
| | | | | | | | 2832 | | | 252 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L.A. BROOKS PRICED BY RW DATE JULY, 1981 SHEET 10 OF 12

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION/ SPUTTERING

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CLOSED LOOP COOLING WATER SUPPLY | | | | | | | | | | | |
| | SPEC Q, CARBON STEEL | | | | | | | | | | | |
| | PIPE 2" SCH XS THREADED | 100 | LF | 2.90 | .35 | | 290 | | | 35 | | |
| | 1" SCH XS THREADED | 40 | LF | 1.30 | .25 | | 52 | | | 10 | | |
| | FITTINGS | | | | | | | | | | | |
| | ELBOWS | | | | | | | | | | | |
| | 45° 2" | | 1 | 8.40 | 2.3 | | 8 | | | 2 | | |
| | 90° 2" LR | | 8 | 10.– | 2.3 | | 80 | | | 18 | | |
| | 90° 1" LR | | 44 | 6.20 | 1.5 | | 273 | | | 66 | | |
| | TEES 2"x2"x2" | | 4 | 14.– | 2.3 | | 56 | | | 9 | | |
| | 2"x2"x1" | | 10 | 14.– | 2.3 | | 140 | | | 23 | | |
| | 1"x1"x1" | | 6 | 8.20 | 1.5 | | 49 | | | 9 | | |
| | VALVES | | | | | | | | | | | |
| | GATE VALVES 2" | | 2 | 280.– | 4 | | 560 | | | 8 | | |
| | CHECK VALVES 2" | | 2 | 95.– | 3 | | 190 | | | 6 | | |
| | SOLENOID VALVES 1" | | 9 | 140.– | 6 | | 1260 | | | 54 | | |
| | FLEX HOSE w/ BUTT WELD END CONNECTIONS x 9" LG | | 8 | 20 | 2 | | 160 | | | 16 | | |
| | | | | | | | 3118 | | | 256 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L.A. BROOKS | PRICED BY | DATE | SHEET 11 OF 12

JOB NO.: 6154-3 | CLIENT: | TYPE OF ESTIMATE: | CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ION IMPLANTATION/SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT | | | MATERIAL EXPENSE | SUBCONTRACT | | LABOR | | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MATL | M/H | LAB $ | | M/HRS | DOLLARS | M/HRS | DOLLARS | |
| | PRESSURIZED FEEDGAS MIX SYSTEM | | | | | | | | | | | |
| | 300 PSIG | | | | | | | | | | | |
| | SPEC V, T316L SS | | | | | | | | | | | |
| | PIPE | | | | | | | | | | | |
| | 1" SCH XS PLAIN ENDS | 150 | LF | 1.36 | .25 | | 195 | | | 38 | | |
| | FITTINGS | | | | | | | | | | | |
| | FLANGES 1" 300# WN RF | | 20 | 85 | 1.5 | | 170 | | | 30 | | |
| | ELBOWS 1" 90° LR | | 45 | 6.20 | 1.5 | | 279 | | | 68 | | |
| | ELBOWS 1" 45° | | 5 | 6.20 | 1.5 | | 31 | | | 8 | | |
| | TEES 1"x1"x1" | | 22 | 8.20 | 1.5 | | 180 | | | 33 | | |
| | 1x1x½" | | 4 | 8.20 | 1.5 | | 33 | | | 6 | | |
| | 1½"x1½"x1½" | | 4 | 10.40 | 1.7 | | 42 | | | 7 | | |
| | REDUCERS | | | | | | | | | | | |
| | 1½"x1" | | 8 | 6.40 | 1.5 | | 51 | | | 12 | | |
| | VALVES 1" 300# GATE | | 5 | 240 | 4 | | 1200 | | | 20 | | |
| | VALVES 1" 300# SOLENOIDS | | 18 | 160 | 6 | | 2880 | | | 108 | | |
| | FLOW ELEMENTS | | 2 | 90 | 2 | | 180 | | | 4 | | |
| | | | | | | | 5241 | | | 334 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. A. Brooks PRICED BY DATE SHEET 12 OF 12

JOB NO.: 6154-3 CLIENT: TYPE OF ESTIMATE: CKD BY:

UNIT/AREA: Krypton Encapsulation

DESCRIPTION: Ion Implantation / Sputtering

CAPACITY

| Description | Quantity | Unit | Cost or M/Hrs per Unit: Matl | M/H | Lab $ | Material Expense | Subcontract: M/Hrs | Dollars | Labor: M/Hrs | Dollars | Total Dollars |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DECONTAMINATION SOLUTION | | | | | | | | | | | |
| SPEC D, 304 L SS | | | | | | | | | | | |
| PIPE 1", SCH 80S, THREADED | 100 | LF | 6.40 | .25 | | 640 | | | 25 | | |
| FITTINGS | | | | | | | | | | | |
| ELBOWS 1" LR 90° | | 15 | 8.80 | 1.5 | | 132 | | | 23 | | |
| TEES 1"x1"x1" | | 2 | 11.60 | 1.5 | | 23 | | | 3 | | |
| VALVES | | | | | | | | | | | |
| GATE 1" | | 3 | 420 | 4 | | 1260 | | | 12 | | |
| CHECK 1" | | 2 | 120 | 2 | | 240 | | | 4 | | |
| ISOLATION (BELLOWS SEAL) | | 2 | 840 | 4 | | 1680 | | | 8 | | |
| | | | | | | 3975 | | | 75 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION / SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT | | | MATERIAL EXPENSE | SUBCONTRACT | | LABOR | | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MATL | M/H | LAB $ | | M/HRS | DOLLARS | M/HRS | DOLLARS | |
| 500 | BUILDINGS | | | | | | | | | | | |
| | INSTRUMENTATION | | | | | | | | | | | |
| | CONTROL INSTRUMENTATION (15% OF PIPING) | | | | | | 7430 | | | 312 | | |
| | HVAC (10% OF HVAC | | | | | | 21430 | | | 199 | | |
| | RADIATION MONITORING (ALLOW) | | | | | | 10000 | | | 100 | | |
| | PROCESS CONTROLS (ALLOW) | | | | | | 15000 | | | 150 | | |
| | DATA PROCESSING (ALLOW) | | | | | | 20000 | | | 100 | | |
| | SUB-TOTAL | | | | | | 73860 | | | 861 | | |
| | PRODUCTIVITY (1.80 × 861 ) | 1550 | MH | | | 20.90 | | | | 1550 | 32400 | |
| | SUB-TOTAL | | | | | | 73860 | | | | 32400 | |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 25850 | | | | 25920 | |
| | TOTAL | | | | | | 99710 | | | | 58320 | 158000 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY SHR | PRICED BY RW | DATE JULY, 1981 | SHEET ____ OF ____

JOB NO.: 6154-3 | CLIENT: US DOE | TYPE OF ESTIMATE: | CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ION IMPLANTATION/SPUTTERING

CAPACITY:

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDING | | | | | | | | | | | |
| | ELECTRICAL SUMMARY | | | | | | 210460 | | | 5088 | | |
| | PRODUCTIVITY (1.80 × 5088) | 9158 | MH | | | 20.86 | | | | 9158 | 191040 | |
| | SUB-TOTAL | | | | | | 210460 | | | | 191040 | |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 73660 | | | | 152840 | |
| | TOTAL | | | | | | 284120 | | | | 343880 | 628000 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY S. H. Rowe PRICED BY DATE 6/12/81 SHEET 1 OF 2

JOB NO.: 6154-3 CLIENT: DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA
DESCRIPTION Ion/Implantation
CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1000 KVA Unit Substation USI | 1 | EA | | | | 50400 | | | 60 | | |
| | MCC1 480/277V Cl II Type B | 1 | EA | | | | 22000 | | | 80 | | |
| | MCC2 480/277V Cl II Type B | 1 | EA | | | | 14000 | | | 64 | | |
| | 45 KVA Xfmr 480-208Y/120V | 1 | EA | | | | | | | | | |
| | 9 KVA Xfmr 480-208Y/120V | 1 | EA | | | | 470 | | | 9 | | |
| | Panelboard ELA 8 CKT | 1 | EA | | | | 200 | | | 8 | | |
| | Panelboard ELB 4 CKT | 1 | EA | | | | 170 | | | 6 | | |
| | Panelboard LPA 42 CKT | 1 | EA | | | | 800 | | | 28 | | |
| | Panelboard ELPB 12 CKT | 1 | EA | | | | 244 | | | 10 | | |
| | 60A Welding Recp & Sw | 1 | EA | | | | 400 | | | 4 | | |
| | 30A Disc Sw | 1 | EA | | | | 35 | | | 2 | | |
| | 480V Motor & Load Conn <10HP | 13 | EA | 1.20 | 2 | | 16 | | | 26 | | |
| | 15 HP | 2 | EA | 1.30 | 2.1 | | 3 | | | 6 | | |
| | Area Ltg, Wire & Conduit | 7100 | SF | 2.40 | .08 | | 17040 | | | 568 | | |
| | Special Cell Lts | 8 | EA | 1000 | 5 | | 8000 | | | 40 | | |
| | Recp, Wire & Conduit | 7100 | SF | 1.80 | .06 | | 12780 | | | 426 | | |
| | Multiplexer & Terminal Bd. | 1 | EA | | | | 5000 | | | 60 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY: SH Rowe | PRICED BY: | DATE: 6/12/81 | SHEET 2 OF 2

JOB NO.: 6154-3 | CLIENT: DOE | TYPE OF ESTIMATE: Conceptual | CKD BY:

UNIT/AREA:
DESCRIPTION: Ion/Implantation
CAPACITY:

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grounding | | LS | | | | 3000 | | | 130 | | |
| | Lightning Protection | | LS | | | | 5400 | | | 125 | | |
| | Cathodic Protection | | LS | | | | 25000 | | | 750 | | |
| | Intercom | | LS | | | | 10000 | | | 400 | | |
| | Fire Alarm | | LS | | | | 9000 | | | 300 | | |
| | Evacuation Alarm | | LS | | | | 6000 | | | 180 | | |
| | Conduit Fittings | | LS | | | | 1500 | | | 150 | | |
| | Connect Instrumentation | | LS | | | | 4000 | | | 300 | | |
| | Motor & Load Wire & Conduits (GS) | | LS | | | | 12000 | | | 1156 | | |
| | Solenoid Valve Wire & Conduit | | LS | | | | 3000 | | | 200 | | |
| | TOTAL | | | | | | 210,458 | | | 5088 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY E. Hom | PRICED BY E. Hom / RW | DATE July, 1981 | SHEET 1 OF 5

JOB NO.: 6154-3 | CLIENT: US DOE | TYPE OF ESTIMATE: | CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ION IMPLANTATION/SPUTTERING

CAPACITY:

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | HVAC SUMMARY | | | | | | | | | | | |
| | FROM SHT. 2 | | | | | | 11950 | | | 198 | | |
| | " " 3 | | | | | | 161550 | | | 351 | | |
| | " " 4 | | | | | | 14220 | | | 189 | | |
| | " " 5 | | | | | | 26610 | | | 1250 | | |
| | " " | | | | | | | | | | | |
| | SUB-TOTAL | | | | | | 214330 | | | 1988 | | |
| | PRODUCTIVITY (1.80 × 1988) | 3578 | MH | | | 19.40 | | | | 3578 | 69410 | |
| | SUB-TOTAL | | | | | | 214330 | | | | 69410 | 283740 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 75020 | | | | 55540 | 130560 |
| | TOTAL | | | | | | 289350 | | | | 124950 | 414300 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY E. HOM PRICED BY DATE 6-9-81 SHEET 2 OF 5

JOB NO.: 6154-3 CLIENT: DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA

DESCRIPTION KRYPTON ENCAPSULATION

CAPACITY SPUTTERING CONCEPT

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HVAC | | | | | | | | | | | |
| | SUPPLY FAN | | | | | | | | | | | |
| | CAP. 5,000 CFM AT 3"SP, 5HP | 2 | EA | 2200 | 25 | | 4400 | | | 50 | | |
| | BUFFALO FORGE CO. | | | | | | | | | | | |
| | TYPE BL-AEROFOIL SIZE 400 | | | | | | | | | | | |
| | SWSI, ARRG. 3, INLET VANES | | | | | | | | | | | |
| | EXHAUST FAN | 2 | EA | 2600 | 40 | | 5200 | | | 80 | | |
| | CAP. 5000 CFM AT 10"SP, 15 HP | | | | | | | | | | | |
| | SEISMIC - OBE | | | | | | | | | | | |
| | BUFFALO FORGE CO. | | | | | | | | | | | |
| | TYPE BL-AEROFOIL SIZE 365 | | | | | | | | | | | |
| | SWSI, ARRG. 3, INLET VANES | | | | | | | | | | | |
| | STEAM PREHEAT COIL | 2 | EA | 800 | 26 | | 1600 | | | 52 | | |
| | 5,000 CFM & 315,000 BTU/HR | | | | | | | | | | | |
| | 10 FT² FACE AREA, 2-ROW | | | | | | | | | | | |
| | -20°F ENT. & +50°F LV. AIR | | | | | | | | | | | |
| | 15 PSIG STEAM | | | | | | | | | | | |
| | STEAM HEATING COIL | 1 | EA | 150 | 6 | | 150 | | | 6 | | |
| | 550 CFM & 25,000 BTU/HR | | | | | | | | | | | |
| | 1-FT² FACE AREA, 1-ROW | | | | | | | | | | | |
| | +40°F ENT & 90°F LV. AIR | | | | | | | | | | | |
| | 15 PSIG STEAM | | | | | | | | | | | |
| | STEAM HEATING COIL | 1 | EA | 600 | 10 | | 600 | | | 10 | | |
| | 3150 CFM & 85,000 BTU/HR | | | | | | | | | | | |
| | 5 FT² FACE AREA, 1-ROW | | | | | | | | | | | |
| | +40°F ENT. & 70°F LV. AIR | | | | | | | | | | | |
| | 15 PSIG STEAM | | | | | | | | | | | |
| | | | | | | | 11950 | | | 198 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY E. HOM PRICED BY DATE 6-9-81 SHEET 3 OF 5

JOB NO.: 6154-3 CLIENT: DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA

DESCRIPTION KRYPTON ENCAPSULATION

CAPACITY SPUTTERING CONCEPT

| ACCNT | DESCRIPTION | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HVAC | | | | | | | | | | | |
| | STEAM HEATING COIL | 1 | EA | 250 | 7 | | 250 | | | 7 | | |
| | 1170 CFM & 53,000 BTU/HR | | | | | | | | | | | |
| | 2-FT² FACE AREA, 1-ROW | | | | | | | | | | | |
| | +40°F ENT. & +90°F LV. AIR | | | | | | | | | | | |
| | 15 PSIG STEAM | | | | | | | | | | | |
| | SPRAY COOLING CHAMBER | 2 | EA | 5000 | 40 | | 10 000 | | | 80 | | |
| | FILTER FIRE PROTECTION | | | | | | | | | | | |
| | 5000 CFM & 10 FT² FACE AREA | | | | | | | | | | | |
| | 1-BANK SPRAY NOZZLES, | | | | | | | | | | | |
| | MOISTURE SEPARATOR, DRAIN PAN | | | | | | | | | | | |
| | EXHAUST AIR HEPA FILTER | 2 | EA | 75000 | 120 | | 150 000 | | | 240 | | |
| | PLENUM, 6000 CFM RATING | | | | | | | | | | | |
| | FLANDERS FILTERS CO. | | | | | | | | | | | |
| | 2-STAGES OF HEPA FILTERS | | | | | | | | | | | |
| | 24"x24"x11½" FLUID SEAL TYPE | | | | | | | | | | | |
| | ARRANGED 2-WIDE BY 3-HIGH | | | | | | | | | | | |
| | BAG-OUT TYPE E-4 FILTER | | | | | | | | | | | |
| | HOUSINGS WITH IN-PLACE | | | | | | | | | | | |
| | REMOTE DOP TEST SECTIONS | | | | | | | | | | | |
| | T-I, T-C, & T-O. | | | | | | | | | | | |
| | SUPPLY AIR FILTER BOX | 2 | EA | 650 | 12 | | 1 300 | | | 24 | | |
| | CAP. 5,000 CFM | | | | | | | | | | | |
| | FARR CO. SIDE LOADING | | | | | | | | | | | |
| | MODEL 3P UNIVERSAL GLIDEPACK | | | | | | | | | | | |
| | WITH 4-24"x24"x4" TYPE 30/30 | | | | | | | | | | | |
| | 30% EFF. PREFILTERS & | | | | | | | | | | | |
| | 4-24"x24"x12" - 90% EFF. | | | | | | | | | | | |
| | TYPE HP-200 HIGH EFF. FILTERS | | | | | | | | | | | |
| | | | | | | | 161 550 | | | 351 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY E. HOM PRICED BY DATE 6-9-81 SHEET 4 OF 5

JOB NO.: 6154-3 CLIENT: DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA

DESCRIPTION KRYPTON ENCAPSULATION

CAPACITY SPUTTERING CONCEPT

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HVAC | | | | | | | | | | | |
| | REFRIGERANT COOLING COIL | 1 | EA | 400 | 10 | | 400 | | | 10 | | |
| | CAP. 1170 CFM & 30,000 BTU/HR | | | | | | | | | | | |
| | 2.5 FT² FACE AREA, 6-ROW DX | | | | | | | | | | | |
| | VENT FAN | 3 | EA | 3000 | 22 | | 9000 | | | 66 | | |
| | CAP. 18,000 CFM AT 1.0" SP, 15 HP | | | | | | | | | | | |
| | NEW YORK BLOWER CO. | | | | | | | | | | | |
| | TUBULAR ACOUSTAFOIL TYPE | | | | | | | | | | | |
| | SIZE T-309, IN-LINE | | | | | | | | | | | |
| | CENTRIFUGAL TYPE | | | | | | | | | | | |
| | VENT FAN | 1 | EA | 3300 | 23 | | 3300 | | | 23 | | |
| | CAP. 18,000 CFM AT 1.0" SP, 15 HP | | | | | | | | | | | |
| | NEW YORK BLOWER CO. | | | | | | | | | | | |
| | TUBULAR ACOUSTAFOIL TYPE | | | | | | | | | | | |
| | SIZE T-309, IN-LINE | | | | | | | | | | | |
| | CENTRIFUGAL TYPE PROVIDED | | | | | | | | | | | |
| | WITH INLET VORTEX DAMPERS | | | | | | | | | | | |
| | STEAM UNIT HEATER | 4 | EA | 350 | 20 | | 1400 | | | 80 | | |
| | CAP. 50,000 BTU/HR, 15 PSIG | | | | | | | | | | | |
| | STEAM, HORIZ. SUSPENDED TYPE | | | | | | | | | | | |
| | TRANE CO. MODEL 60-S | | | | | | | | | | | |
| | POWER ROOF VENTILATOR | 1 | EA | 120 | 10 | | 120 | | | 10 | | |
| | 150 CFM AT 3/8" SP. | | | | | | | | | | | |
| | SPUN ALUMINUM LOW SILHOUETTE | | | | | | | | | | | |
| | TYPE | | | | | | | | | | | |
| | | | | | | | 14220 | | | 187 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY E. HOM  PRICED BY  DATE 6-9-81  SHEET 5 OF 5

JOB NO.: 6154-3  CLIENT: DOE  TYPE OF ESTIMATE:  CKD BY:

UNIT/AREA

DESCRIPTION KRYPTON ENCAPSULATION

CAPACITY SPUTTERING CONCEPT

| ACCNT | DESCRIPTION | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HVAC | | | | | | | | | | | |
| | AIR COOLED REFRIGERANT | 1 | EA | 400 | 40 | | 400 | | | 40 | | |
| | CONDENSING UNIT | | | | | | | | | | | |
| | CAP. 30,000 BTU/HR, 95°F ENT. AIR | | | | | | | | | | | |
| | CARRIER 38 GS 042, 4 KW | | | | | | | | | | | |
| | GRAVITY ROOF VENTILATOR | 4 | EA | 600 | 25 | | 2400 | | | 100 | | |
| | 36 FT² THROAT AREA | | | | | | | | | | | |
| | ALL ALUM. CONSTRUCTION | | | | | | | | | | | |
| | DUCTWORK, GALV. STEEL | 4000 | LB | 1.50 | 0.08 | | 6000 | | | 320 | | |
| | DUCTWORK, STAINLESS STEEL | 1600 | LB | 3.90 | 0.10 | | 6240 | | | 160 | | |
| | GRILLES & REGISTERS | 1 | LS | | | | 2000 | | | 60 | | |
| | MANUAL, BALANCING, BACKDRAFT | 1 | LS | | | | 2500 | | | 50 | | |
| | DAMPERS | | | | | | | | | | | |
| | REFRIG. TUBING, COPPER TYPE "L" | | | | | | | | | | | |
| | 20' - 1/2" OD | 1 | LS | | | | 120 | | | 20 | | |
| | 20' - 5/8" OD | 1 | LS | | | | 150 | | | 20 | | |
| | INSULATION | 1 | LS | | | | 600 | | | 40 | | |
| | AUTOMATIC CONTROLS - HONEYWELL | 1 | LS | | | | 2200 | | | 220 | | |
| | PRESS. DIFFERENTIAL CONTROL - | 1 | LS | | | | 3000 | | | 120 | | |
| | AIR MONITOR | | | | | | | | | | | |
| | TEST & BALANCE | 1 | LS | | | | 1000 | | | 100 | | |
| | | | | | | | 26610 | | | 1250 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION / SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT | | | MATERIAL EXPENSE | SUBCONTRACT | | LABOR | | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MATL | M/H | LAB $ | | M/HRS | DOLLARS | M/HRS | DOLLARS | |
| 500 | BUILDINGS | | | | | | | | | | | |
| | FIRE PROTECTION, EST | 5200 | SF | 5.00 | .10 | | 26000 | | | 520 | | |
| | PRODUCTIVITY (1.8 × 520) | 936 | MH | | | 19.40 | | | | 936 | 18160 | |
| | SUB-TOTAL | | | | | | 26000 | | | | 18160 | 44160 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 9100 | | | | 14540 | 23640 |
| | TOTAL | | | | | | 35100 | | | | 32700 | 67800 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION/SPUTTERING

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | PLUMBING | | | | | | | | | | | |
| | ROOF DRAINS, EST. | | | | | | 5000 | | | 250 | | |
| | LAVATORY FIXTURES, EST. | | | | | | 5000 | | | 100 | | |
| | DRAINS & VENTS, EST. | | | | | | 10000 | | | 500 | | |
| | WATER SERVICES, EST. | | | | | | 3000 | | | 200 | | |
| | SUB-TOTAL | | | | | | 23000 | | | 1050 | | |
| | PRODUCTIVITY (1.80 × 1050) | 1890 | MH | | | 21.70 | | | | 1890 | 41010 | |
| | SUB-TOTAL | | | | | | 23000 | | | | 41010 | 64010 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 8050 | | | | 32810 | 40890 |
| | TOTAL | | | | | | 31050 | | | | 73850 | 104900 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW  PRICED BY RW  DATE JULY, 1981  SHEET ____ OF ____

JOB NO.: 6154-3  CLIENT: US DOE  TYPE OF ESTIMATE:  CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION/SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | SPECIAL BLDG. COMPONENTS | | | | | | | | | | | |
| | PRODUCT STORAGE | | | | | | | | | | | |
| | 7'-6" x 7'-6" x 26' STORAGE ASSEMBLY CONSTRUCTED OF 304LSS ANGLE & PLATE W/ NITRONIC 60 ROLLERS, 2 PAIR ON 6" C/C, TYP. OF 36 POSITIONS, TOTAL OF 468 STORAGE SPACES | | | | | | | | | | | |
| | 7488 1" O.D. x 9/16" I.D. ROLLS | 2285 | LB | 8.00 | .20 | | 18280 | | | 457 | | |
| | 7488 1/2" ϕ STAY BOLTS | 1260 | LB | 4.00 | .05 | | 5040 | | | 63 | | |
| | 14976 1/2" PLATE BRACKETS | 12760 | LB | 3.00 | .10 | | 38280 | | | 1276 | | |
| | 72-4x4x1/2" x 26' ANGLES | 25520 | LB | 3.00 | .02 | | 76560 | | | 510 | | |
| | 35-4x4x1/2" x 7'-6" COLUMNS | 7160 | LB | 3.00 | .02 | | 21480 | | | 143 | | |
| | 35-6"x6"x1" BASE PL. | 716 | LB | 3.00 | 1.0 | | 2150 | | | 716 | | |
| | SUB-TOTAL | 49700 | LB | | | | 161790 | | | 3165 | | |
| | SHIELDING WINDOWS | | | | | | | | | | | |
| | 3-30" x 30" WINDOWS (CELL OPERATING, INSPECTION, AND SEALING) | | | | | | | | | | | |
| | 1-18" x 16" (PRODUCT LOAD-IN) SUB-TOTAL | 1 | LOT | | | | 42000 | | | 360 | | |
| | SUB-TOTAL | | | | | | 203790 | | | 3425 | | |
| | PRODUCTIVITY (1.80 x 3425) | 6165 | MH | | | 20.30 | | | | 6165 | 125150 | |
| | SUB-TOTAL | | | | | | 203790 | | | | 125150 | 328940 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 71330 | | | | 100130 | 171460 |
| | TOTAL | | | | | | 275120 | | | | 225280 | 500400 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

DESCRIPTION: KRYPTON ENCAPSULATION ION IMPLANTATION/SPUTTERING

| ACCNT | DESCRIPTION | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT | | | | | | | | | | | |
| | SUMMARY | | | | | | | | | | | |
| | VESSELS & TANKS | | | | | | 152730 | | | 350 | | |
| | PUMPS | | | | | | 20800 | | | 220 | | |
| | AGITATORS | | | | | | 4400 | | | 40 | | |
| | HEAT EXCHANGERS | | | | | | 98000 | | | 280 | | |
| | COMPRESSORS | | | | | | 29000 | | | 160 | | |
| | SPUTTERING CHAMBERS | | | | | | 52000 | | | 160 | | |
| | PROCESS SPECIALTIES | | | | | | 1650 | | | 20 | | |
| | OTHER MAJOR EQUIPMENT | | | | | | 554000 | | | 1940 | | |
| | SUB-TOTAL | | | | | | 912580 | | | 3170 | | |
| | SEISMIC QUALIFICATION (20% OF MAT'L) | | | | | | 182520 | | | | | |
| | PRODUCTIVITY (1.80 × 3170) | 5706 | MH | | | 20.30 | | | | 5706 | 115830 | |
| | SUB-TOTAL | | | | | | 1095100 | | | | 115830 | 1210930 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 383290 | | | | 98460 | 481750 |
| | TOTAL | | | | | | 1478390 | | | | 214290 | 1692680 |
| | USE | | | | | | 1480000 | | | | 215000 | 1695000 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

DESCRIPTION KRYPTON ENCAPSULATION ION IMPLANTATION/SPUTTERING

| ACCNT | DESCRIPTION | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT | | | | | | | | | | | |
| | VESSELS & TANKS | | | | | | | | | | | |
| | KEF-II-TK1, SUMP CATCH TANK 3'-6" Ø x 6'-0" T/T, T304LSS, 15 PSIG DESIGN | 4750 | LB | 7.50 | LOT | | 35,630 | | | 40 | | |
| | KEF-II-TK101, DECON. SOLUTION MAKE-UP TANK, 3'-6" Ø x 4'-0" T/T, T304LSS, 15 PSIG DESIGN | 3200 | LB | 7.50 | LOT | | 24,000 | | | 40 | | |
| | KEF-II-TK2, LAG STORAGE TANKS, (TOTAL FOR 8) 12" Ø x 12'-0" T/T, T316LSS, 1270 PSIG DESIGN W/ SUPPORT FRAME | 10000 | LB | 7.00 | LOT | | 70,000 | | | 192 | | |
| | KEF-II-TK3&4 RUN TANKS, (TOTAL FOR 2), 12" Ø x 12'-0" T/T, T316LSS, 1270 PSIG DESIGN | 2500 | LB | 7.00 | LOT | | 17,500 | | | 48 | | |
| | KEF-II-TK5, PRESSURE RELIEF ACCUMULATOR, 18" Ø x 4'-6" T/T, T316LSS, 500 PSIG DESIGN | 700 | LB | 8.00 | LOT | | 5,600 | | | 30 | | |
| | SUB-TOTAL | | | | | | 152,730 | | | 350 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION/SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT | | | | | | | | | | | |
| | PUMPS | | | | | | | | | | | |
| | KEF-II-P101, DECON SOLUTION PUMP, HORIZONTAL CENTRIFUGAL, 1800rpm, 50 GPM w/ 40 TDH, 316 SS | 1 | EA | 4000 | 80 | | 4000 | | | 80 | | |
| | KEF-II-P1&P2, COOLING WATER PUMP, HORIZONTAL CENTRIFUGAL, 1800rpm, 15 GPM w/ 60 TDH, DUCTILE IRON | 2 | EA | 700 | 20 | | 1400 | | | 40 | | |
| | KEF-II-VP1-4, KRYPTON VACUUM PUMP | 4 | EA | 3200 | 20 | | 12400 | | | 80 | | |
| | SUMP & CATCH TANK EDUCTOR, STEAM JET, 30 GPM, 304L SS | 2 | EA | 1500 | 10 | | 3000 | | | 20 | | |
| | SUB-TOTAL | | | | | | 20800 | | | 220 | | |
| | AGITATORS | | | | | | | | | | | |
| | SUMP CATCH TANK AGITATOR, 1 HP, 304L SS WETTED PARTS | 1 | EA | 2200 | 20 | | 2200 | | | 20 | | |
| | DECON SOLUTION TANK AGITATOR 1 HP, 304L SS WETTED PARTS | 1 | EA | 2200 | 20 | | 2200 | | | 20 | | |
| | SUB-TOTAL | | | | | | 4400 | | | 40 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW  PRICED BY RW  DATE JULY, 1981  SHEET ____ OF ____

JOB NO.: 6154-3  CLIENT: US DOE  TYPE OF ESTIMATE:  CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION/SPUTTERING

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT | | | | | | | | | | | |
| | HEAT EXCHANGERS | | | | | | | | | | | |
| | KEF-II-HE1, FEED GAS COOLER, 20,000 BTU/HR, 316SS SHELL & TUBES, C.S. CHANNEL, 600 PSIG DESIGN | 1 | EA | 18000 | LOT | | 18000 | | | 80 | | |
| | KEF-II-HE2, COOLING WATER HEAT EXCHANGER, 2,000,000 BTU/HR, C.S. SHELL & BONNET, ADMIRALTY TUBES | 1 | EA | 80000 | LOT | | 80000 | | | 200 | | |
| | SUB-TOTAL | | | | | | 98000 | | | 280 | | |
| | COMPRESSORS | | | | | | | | | | | |
| | KEF-II-COM1&2, FEED GAS MIXTURE COMPRESSORS, TRIPLE DIAPHRAGM, 200 PSIG INLET, 500 PSIG OUTLET, 1CFM, 400 rpm, 316 SS | 2 | EA | 14500 | LOT | | 29000 | | | 160 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION/ SPUTTERING

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT | | | | | | | | | | | |
| | SPUTTERING CHAMBER | | | | | | | | | | | |
| | SPUTTERING HEADS, PEDASTAL SUPPORTED CONNECTOR ASSEMBLY, EST, T316SS | 8 | EA | 4000 | 20 | | 32000 | | | 160 | | |
| | SHIELDED COOLING JACKETS, LEAD & T-316 SS, EST | 8 | EA | 2500 | — | | 20000 | | | — | | |
| | SUB-TOTAL | | | | | | 52000 | | | 160 | | |
| | PROCESS SPECIALTIES | | | | | | | | | | | |
| | KEF-II-F1, FEED GAS FILTER, IN-LINE, 2 μ, 750 PSIG DESIGN, 316 SS | 1 | EA | 450 | 8 | | 450 | | | 8 | | |
| | SUMP SAMPLER, SUMP CATCH TANK SAMPLER, PLUNGER TYPE, AIR OPERATED, SOLENOID ACTIVATED, MANUAL INITIATED | 2 | EA | 600 | 6 | | 1200 | | | 12 | | |
| | SUB-TOTAL | | | | | | 1650 | | | 20 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY A. SMITH PRICED BY A. SMITH / RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ION IMPLANTATION / SPUTTERING

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT | | | | | | | | | | | |
| | OTHER MAJOR EQUIPMENT | | | | | | | | | | | |
| | MINITRAILER ROBO CARRIER | 2 | EA | 100,000 | 50 | | 200000 | | | 100 | | |
| | AUTOMATIC WELDER | 1 | EA | 80,000 | 200 | | 80000 | | | 200 | | |
| | LEAK DETECTOR | 1 | EA | 20,000 | 150 | | 20000 | | | 150 | | |
| | MASTER SLAVE MANIPULATOR, MODEL "F" | 4 | EA | 21,000 | 60 | | 84000 | | | 240 | | |
| | SPECIAL TOOLS & FIXTURES | 1 | LOT | 10,000 | 10 | | 10000 | | | 10 | | |
| | BRIDGE CRANE, 5TON/2-1/2T | 1 | EA | 150,000 | 1200 | | 150000 | | | 1200 | | |
| | 2TON MONORAIL HOIST | 1 | EA | 10,000 | 40 | | 10000 | | | 40 | | |
| | SUB-TOTAL | | | | | | 554000 | | | 1940 | | |

RMP THE RALPH M. PARSONS COMPANY



PROJECT NAME: KRYPTON ENCAPSULATION PRECONCEPTUAL DESIGN ZEOLITE ENCAPSULATION FACILITY DATE JULY, 1981

ESTIMATE OF COST PAGE ___ OF ___

PROJECT NO. 6154-3 SUMMARY BY ___

| ACCT. NO. | DESCRIPTION | LABOR COST $ | MATERIAL COST $ | TOTAL COST $ |
|---|---|---|---|---|
| | DIRECT COST | | | |
| 400 | IMPROVEMENTS TO LAND | 22,000 | 2,000 | 24,000 |
| 500 | BUILDING & OTHER STRUCTURES | 1,325,000 | 1,290,000 | 2,615,000 |
| 600 | UTILITIES (NOT INCLUDED) | — | — | — |
| 700 | EQUIPMENT | 230,000 | 1,895,000 | 2,125,000 |
| 800 | DEMOLITION & REMOVALS (NONE) | — | — | — |
| | TOTAL DIRECT COST | 1,577,000 | 3,187,000 | 4,764,000 |
| | CONTRACTOR INDIRECTS @ 10% | | | 476000 |
| | TOTAL CONSTRUCTION COST | | | 5,240,000 |
| | TITLE I @ 6% | | | 315,000 |
| | TITLE II @ 14% | | | 734,000 |
| | TITLE III @ 8% | | | 421,000 |
| | A - FIELD INSPECTION | | | |
| | B - SHOP INSPECTION | | | |
| | PROJECT ADMINISTRATION @ 10% | | | 525,000 |
| | SUB-TOTAL ENGINEERING | | | 1,995,000 |
| | SUB-TOTAL | | | 7,235,000 |
| | ESCALATION (NOT INCLUDED) | — | — | — |
| | SUB-TOTAL | | | 7,235,000 |
| | CONTINGENCY @ 40% | | | 2,895,000 |
| | TOTAL JOB COST | | | 10,130,000 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW  PRICED BY RW  DATE JULY, 1981  SHEET ____ OF ____

JOB NO.: 6154-3  CLIENT: U.S. DOE  TYPE OF ESTIMATE:  CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ZEOLITE ENCAPSULATION

CAPACITY:

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 400 | IMPROVEMENTS TO LAND | | | | | | | | | | | |
| | SITE CLEARING | 6000 | SY | – | .014 | | | | | 84 | | |
| | EXCAVATION | 610 | CY | – | .15 | | | | | 92 | | |
| | COMPACTED BACKFILL | 200 | CY | 2.00 | .16 | | 400 | | | 32 | | |
| | GRADING | 4700 | SF | – | .012 | | | | | 56 | | |
| | DISPOSAL | 410 | CY | – | .10 | | | | | 41 | | |
| | CONCRETE WALKS (EST) 6" THK | 400 | SF | 1.60 | .10 | | 640 | | | 40 | | |
| | SUB-TOTAL | | | | | | 1040 | | | 345 | | |
| | PRODUCTIVITY (1.80 × 345) | 621 | MH | | | 19.50 | | | | 621 | 12110 | |
| | SUB-TOTAL | | | | | | 1040 | | | | 12110 | 13150 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 360 | | | | 9690 | |
| | TOTAL 400 | | | | | | 1400 | | | | 21800 | 23200 |
| | USE | | | | | | 2000 | | | | 22000 | 24000 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: U.S. DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS & STRUCTURES | | | | | | | | | | | |
| | CONCRETE | | | | | | 170 460 | | | 4646 | 154 740 | 325 200 |
| | MASONRY | | | | | | 2 620 | | | 616 | 21 480 | 24 100 |
| | STRUCTURAL STEEL & MISC. METALS | | | | | | 52 840 | | | 835 | 31 260 | 84 100 |
| | FINISHES | | | | | | 33 510 | | | 3130 | 108 790 | 142 300 |
| | PAINTING & SPECIAL COATING | | | | | | 3 860 | | | 1546 | 54 340 | 58 200 |
| | DOORS & WINDOWS | | | | | | 23 950 | | | 378 | 13 250 | 37 200 |
| | SPECIALTIES | | | | | | 7 210 | | | 166 | 5 890 | 13 100 |
| | PIPING | | | | | | 84 210 | | | 3991 | 155 890 | 240 100 |
| | INSTRUMENTATION | | | | | | 92 460 | | | 1492 | 31 180 | 148 600 |
| | ELECTRICAL | | | | | | 221 810 | | | 7151 | 275 990 | 497 800 |
| | HVAC | | | | | | 190 200 | | | 2621 | 91 500 | 281 700 |
| | FIRE PROTECTION | | | | | | 29 700 | | | 792 | 30 900 | 60 600 |
| | PLUMBING | | | | | | 27 000 | | | 1620 | 54 300 | 91 300 |
| | SPECIAL BLDG. COMPONENTS | | | | | | 344 790 | | | 8048 | 294 010 | 668 800 |
| | TOTAL 500 | | | | | | 1 284 620 | | | | 1 323 520 | 2 608 140 |
| | USE | | | | | | 1 290 000 | | | | 1 325 000 | 2 615 000 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW  PRICED BY RW  DATE JULY, 1981  SHEET ____ OF ____

JOB NO.: 6154-3  CLIENT: U.S. DOE  TYPE OF ESTIMATE:  CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | CONCRETE | | | | | | | | | | | |
| | FOUNDATION | 207 | CY | | | | 37970 | | | 845 | | |
| | WALLS | 188 | CY | | | | 65380 | | | 1182 | | |
| | SUSPENDED SLABS | 94 | CY | | | | 22920 | | | 554 | | |
| | SUB-TOTAL | 489 | CY | | | | 126270 | | | 2581 | | |
| | PRODUCTIVITY (1.80 x 2581) | 4646 | MH | | | 18.50 | | | | 4646 | 85950 | |
| | SUB-TOTAL | | | | | | 126270 | | | | 85950 | |
| | SUB-CONTRACTOR MARK-UP | | % | 35 | 80 | | 44190 | | | | 68790 | |
| | TOTAL | | | | | | 170460 | | | | 154740 | 325200 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: U.S. DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS & STRUCTURES | | | | | | | | | | | |
| | CONCRETE | | | | | | | | | | | |
| | FOUNDATION | | | | | | | | | | | |
| | VAPOR BARRIER | 4700 | SF | .20 | .005 | | 940 | | | 24 | | |
| | CONCRETE FOOTINGS | 159 | CY | 60 | .40 | | 9540 | | | 64 | | |
| | SLAB ON GRADE (3900 SF) | 48 | CY | 60 | .30 | | 2880 | | | 14 | | |
| | FORMWORK | 3400 | SF | .71 | .01 | | 2410 | | | 34 | | |
| | REBAR (190#/CY) | 20 | TON | 700 | 16 | | 14000 | | | 320 | | |
| | EMBEDS (C.S., 75#/CY) | 8 | TON | 2500 | 40 | | 20000 | | | 320 | | |
| | FINISH | 4600 | SF | .04 | .015 | | 180 | | | 69 | | |
| | SUB-TOTAL | | | | | | 37970 | | | 845 | | |
| | WALLS | | | | | | | | | | | |
| | CONCRETE WALLS (12" THK) | 179 | CY | 60 | .70 | | 10740 | | | 125 | | |
| | PARAPET (8" THK) | 7 | CY | 60 | .70 | | 420 | | | 5 | | |
| | COLUMNS (12" x 12") | 1.5 | CY | 60 | .70 | | 90 | | | 1 | | |
| | FORMWORK | 14500 | SF | .71 | .02 | | 10300 | | | 290 | | |
| | REBAR (240#/CY) | 22.5 | TON | 700 | 18 | | 15750 | | | 405 | | |
| | EMBEDS (120#/CY) | 11 | TON | 2500 | 60 | | 27500 | | | 66 | | |
| | FINISH | 14500 | SF | .04 | .02 | | 580 | | | 290 | | |
| | SUB-TOTAL | | | | | | 65380 | | | 1182 | | |
| | SUSPENDED SLAB | | | | | | | | | | | |
| | CONCRETE (12" THK) | 94 | CY | 60 | .40 | | 5640 | | | 38 | | |
| | FORMWORK | 2600 | SF | 1.30 | .04 | | 3380 | | | 104 | | |
| | REBAR (190#/CY) | 9 | TON | 700 | 20 | | 6300 | | | 180 | | |
| | EMBEDS (60#/CY) | 3 | TON | 2500 | 60 | | 7500 | | | 180 | | |
| | FINISH | 2400 | SF | .04 | .02 | | 100 | | | 52 | | |
| | SUB-TOTAL | | | | | | 22920 | | | 554 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: U.S. DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS & STRUCTURES | | | | | | | | | | | |
| | MASONRY | | | | | | | | | | | |
| | 8" CONCRETE BLOCK | 1680 | SF | 1.10 | 0.15 | | 1850 | | | 252 | | |
| | 12" CONCRETE BLOCK | 60 | SF | 1.50 | 0.20 | | 90 | | | 90 | | |
| | SUB-TOTAL | | | | | | 1940 | | | 342 | | |
| | PRODUCTIVITY (1.80 × 342) | 616 | MH | | | 19.40 | | | | 616 | 11950 | |
| | SUB-TOTAL | | | | | | 1940 | | | | 11950 | 13890 |
| | SUB-CONTRACTOR MARK-UP | | % | 35 | 80 | | 680 | | | | 9530 | 10210 |
| | TOTAL | | | | | | 2620 | | | | 21480 | 24100 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: U.S. DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | STRUCTURAL STEEL & MISC. METALS | | | | | | | | | | | |
| | OPEN WEB STEEL JOISTS (12 @ 1200) | 7.2 | TON | 600 | 8 | | 4320 | | | 58 | | |
| | METAL DECKING | 1700 | SF | 3.20 | .02 | | 5440 | | | 34 | | |
| | PIPES, PLATES & RODS (EST) | 2 | TON | 1360 | 10 | | 2720 | | | 20 | | |
| | MISCELLANEOUS SUPPORTS (EST) | 14 | TON | 1390 | 20 | | 19460 | | | 280 | | |
| | MISC. (EST) | 6 | TON | 1200 | 12 | | 7200 | | | 72 | | |
| | SUB-TOTAL | | | | | | 39140 | | | 464 | | |
| | PRODUCTIVITY (1.80 × 464) | 835 | MH | | | 20.80 | | | | 835 | 17370 | |
| | SUB-TOTAL | | | | | | 39140 | | | | 17370 | 56510 |
| | SUBCONTRACTORS MARK-UP | | % | 35 | 80 | | 13700 | | | | 13890 | 27590 |
| | TOTAL | | | | | | 52840 | | | | 31260 | 84100 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW — PRICED BY RW — DATE JULY, 1981 — SHEET ____ OF ____

JOB NO.: 6154-3 — CLIENT: U.S. DOE — TYPE OF ESTIMATE: — CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ZEOLITE ENCAPSULATION

CAPACITY:

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | FINISHES | | | | | | | | | | | |
| | INSULATED METAL SIDING | 4250 | SF | 2.80 | .08 | | 11900 | | | 340 | | |
| | INVERTED ROOFING SYSTEM | 4400 | SF | 1.80 | .25 | | 7920 | | | 1100 | | |
| | FLASHING & SHEET METAL | 550 | LF | 1.00 | .15 | | 550 | | | 83 | | |
| | 4" METAL STUDS × 9'-6" (16" c/c) | 210 | LF | 5.80 | .19 | | 1220 | | | 40 | | |
| | 5/8" THK. GYPSUM BOARD (TYPE X) | 1650 | SF | 0.30 | .015 | | 500 | | | 25 | | |
| | 5/8" THK. GYPSUM BOARD | 2280 | SF | 0.20 | .015 | | 460 | | | 34 | | |
| | SUSPENDED PLASTER CEILING | 600 | SF | 1.15 | .05 | | 690 | | | 30 | | |
| | SUSPENDED ACOUSTICAL CEILING | 750 | SF | 0.80 | .02 | | 600 | | | 15 | | |
| | CERAMIC TILE WALLS | 130 | SF | 1.45 | .10 | | 190 | | | 13 | | |
| | CERAMIC TILE FLOORING | 250 | SF | 1.45 | .10 | | 360 | | | 25 | | |
| | VINYL ASBESTOS TILE FLOORING | 850 | SF | 0.60 | .04 | | 430 | | | 34 | | |
| | SUB-TOTAL | | | | | | 24820 | | | 1739 | | |
| | PRODUCTIVITY (1.80 × 1739) | 3130 | MH | | | 19.30 | | | | 3130 | 60410 | |
| | SUB-TOTAL | | | | | | 24820 | | | | 60410 | 85230 |
| | SUB-CONTRACTOR MARK-UP | | % | 35 | 80 | | 8690 | | | | 48380 | 57070 |
| | TOTAL | | | | | | 33510 | | | | 108790 | 142300 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE July, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | PAINTING & SPECIAL COATING | | | | | | | | | | | |
| | PAINTING | | | | | | | | | | | |
| | GYPSUM BOARD | 3930 | SF | .12 | .03 | | 470 | | | 118 | | |
| | MASONRY BLOCK | 1740 | SF | .12 | .05 | | 210 | | | 87 | | |
| | PIPING (EST) | 1000 | SF | .12 | .05 | | 120 | | | 50 | | |
| | DUCTWORK (EST) | 3000 | SF | .12 | .04 | | 360 | | | 120 | | |
| | SPECIAL COATING | | | | | | | | | | | |
| | PLASTER WALLS & CEILING | 600 | SF | .20 | .05 | | 120 | | | 30 | | |
| | CONCRETE WALLS | 2800 | SF | .20 | .06 | | 560 | | | 168 | | |
| | CONCRETE FLOORS | 2100 | SF | .20 | .06 | | 420 | | | 126 | | |
| | PIPING (EST) | 1000 | SF | .20 | .06 | | 200 | | | 60 | | |
| | DUCTWORK (EST) | 2000 | SF | .20 | .05 | | 400 | | | 100 | | |
| | SUB-TOTAL | | | | | | 2860 | | | 859 | | |
| | PRODUCTIVITY (1.80 × 859) | 1546 | MH | | | 19.50 | | | | 1546 | 30150 | |
| | SUB-TOTAL | | | | | | 2860 | | | | 30150 | 33010 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 1000 | | | | 24190 | 25190 |
| | TOTAL | | | | | | 3860 | | | | 54340 | 58200 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | DOORS & WINDOWS | | | | | | | | | | | |
| | TORNADO PROOF DOORS | | | | | | | | | | | |
| | 8'-0"×8'-0" METAL OVERHEAD | 1 | EA | 4200.00 | 16 | | 4200 | | | 16 | | |
| | 3'-0"×7'-0" METAL CLAD | 3 | EA | 1200.00 | 12 | | 3600 | | | 36 | | |
| | HOLLOW METAL DOORS | | | | | | | | | | | |
| | 3'-0"×7'-0" | 7 | EA | 300.00 | 6 | | 2100 | | | 42 | | |
| | HOLLOW CORE WOOD | | | | | | | | | | | |
| | 2'-9"×7'-0"×1 3/4" | 8 | EA | 80.00 | 4 | | 640 | | | 32 | | |
| | METAL DOOR (RAD. RESIST.) | | | | | | | | | | | |
| | 3'-0"×7'-0" | 4 | EA | 480.00 | 3 | | 1920 | | | 12 | | |
| | EXPLOSION PROOF DOOR | | | | | | | | | | | |
| | 3'-6"×7'-0" | 2 | EA | 1200.00 | 12 | | 2400 | | | 24 | | |
| | 3'-0"×4'-0" SLIDING | 1 | EA | 1600.00 | 8 | | 1600 | | | 8 | | |
| | OFFICE WINDOW | | | | | | | | | | | |
| | 11'-0"×4'-0" | 1 | EA | 800.00 | 16 | | 800 | | | 16 | | |
| | WIRE GLASS | | | | | | | | | | | |
| | 12"×24" | 6 | EA | 80.00 | 4 | | 480 | | | 24 | | |
| | SUB-TOTAL | | | | | | 17740 | | | 210 | | |
| | PRODUCTIVITY (1.80×210) | 378 | MH | | | 19.50 | | | | 378 | 7370 | |
| | SUB-TOTAL | | | | | | 17740 | | | | 7370 | 25110 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 6210 | | | | 5880 | 12090 |
| | TOTAL | | | | | | 23950 | | | | 13250 | 37200 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE July, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA: Krypton Encapsulation

DESCRIPTION: Zeolite Encapsulation

CAPACITY:

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | Buildings | | | | | | | | | | | |
| | Specialties | | | | | | | | | | | |
| | Bath Accessories | | | | | | | | | | | |
| | Toilet Partition | 2 | EA | 250 | 6 | | 500 | | | 12 | | |
| | Urinal Screen | 1 | EA | 60 | 2 | | 60 | | | 2 | | |
| | Mirror w/ SS Frame & Ledge | 2 | EA | 30 | 2 | | 60 | | | 4 | | |
| | Comp. Towel Disp. & Recept. | 2 | EA | 200 | 4 | | 400 | | | 8 | | |
| | Feminine Napkin Dispenser | 1 | EA | 170 | 2 | | 170 | | | 2 | | |
| | Toilet Paper Dispenser | 2 | EA | 20 | 1 | | 40 | | | 2 | | |
| | Soap Dispenser | 2 | EA | 24 | 1 | | 50 | | | 2 | | |
| | Toilet Seat Dispenser | 2 | EA | 30 | 1 | | 60 | | | 2 | | |
| | Cabinet Work | | | | | | | | | | | |
| | 24×72×36 w/ Lam. Top & SS Sink | 1 | EA | 1650 | 20 | | 1650 | | | 20 | | |
| | 12×72×24 Wall Hung | 1 | EA | 300 | 4 | | 300 | | | 4 | | |
| | 36×168×36 w/ Lam. Top | 1 | EA | 1450 | 24 | | 1450 | | | 24 | | |
| | 15×18×60 Metal Lockers | 10 | EA | 60 | 1 | | 600 | | | 10 | | |
| | Sub-Total | | | | | | 5340 | | | 92 | | |
| | Productivity (1.80×92) | 166 | MH | | | 19.50 | | | | 166 | 3240 | |
| | Sub-Total | | | | | | 5340 | | | | 3240 | |
| | Subcontractor Mark-Up | | % | 35 | 80 | | 1870 | | | | 2650 | |
| | Total | | | | | | 7210 | | | | 5890 | 13100 |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS PRICED BY RW DATE JULY, 1981 SHEET 1 OF 14

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| CODE | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | PIPING SUMMARY | | | | | | | | | | | |
| | FROM SHT. 2 | | | | | | 1 830 | | | 28 | | |
| | " " 3 | | | | | | 11 890 | | | 277 | | |
| | " " 4 | | | | | | 1 427 | | | 114 | | |
| | " " 5 | | | | | | 2 110 | | | 229 | | |
| | " " 6 | | | | | | 1 215 | | | 91 | | |
| | " " 7 | | | | | | 2 895 | | | 99 | | |
| | " " 8 | | | | | | 1 214 | | | 65 | | |
| | " " 9 | | | | | | 1 256 | | | 96 | | |
| | " " 10 | | | | | | 940 | | | 69 | | |
| | " " 11 | | | | | | 4 351 | | | 146 | | |
| | " " 12 | | | | | | 4 870 | | | 153 | | |
| | " " 13 | | | | | | 7 119 | | | 361 | | |
| | " " 14 | | | | | | 7 466 | | | 209 | | |
| | SUBTOTAL | | | | | | 48 580 | | | 1937 | | |
| | FIELD WELD & TEST (EST) | | | | | | 800 | | | 80 | | |
| | UTILITY SUPPORTS (ALLOW) | | | | | | 8 000 | | | 80 | | |
| | CLEAN & TEST (ALLOW) | | | | | | 5 000 | | | 120 | | |
| | SUB-TOTAL | | | | | | 62 380 | | | 2217 | | |
| | PRODUCTIVITY (1.80 × 2217) | 3991 | MH | | | 21.70 | | | | 3991 | 86 610 | |
| | SUB-TOTAL | | | | | | 62 380 | | | | 86 610 | 148 990 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 21 830 | | | | 69 280 | 91 110 |
| | TOTAL | | | | | | 84 210 | | | | 155 890 | 240 100 |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. Brooks PRICED BY RW DATE JULY, 1981 SHEET 2 OF 14

JOB NO.: 6154-3 CLIENT: USDOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HIGH PRESSURE STEAM | | | | | | | | | | | |
| | SPEC N, CARBON STEEL | | | | | | | | | | | |
| | PIPE | | | | | | | | | | | |
| | 3", STD. WT, BEVELED ENDS | 25 | LF | 4.20 | .35 | | 105 | | | 9 | | |
| | FITTINGS, | | | | | | | | | | | |
| | TEES 3"x3"x3" | | 1 | 12.50 | – | | 13 | | | | | |
| | ELBOWS 3" LR | | 3 | 5.30 | – | | 16 | | | | | |
| | VALVES | | 1 | | | | | | | | | |
| | GATE 3", 150 # ANSI | | 2 | 364 | 4.5 | | 730 | | | 9 | | |
| | PRESSURE CONTROL V. 3" | | 1 | 850 | 6 | | 850 | | | 6 | | |
| | STRAINER 3", 150 # ANSI | | 1 | 120 | 4 | | 120 | | | 4 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS    PRICED BY RW    DATE JULY, 1981    SHEET 3 OF 14

JOB NO.: 6154-3    CLIENT: US DOE    TYPE OF ESTIMATE:    CKD BY:

| UNIT/AREA: KRYPTON ENCAPSULATION; DESCRIPTION: ZEOLITE ENCAPSULATION; CAPACITY | QUANTITY | UNIT | COST OR M/HRS PER UNIT | | | MATERIAL EXPENSE | SUBCONTRACT | | LABOR | | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ACCNT | | | MATL | M/H | LAB $ | | M/HRS | DOLLARS | M/HRS | DOLLARS | |
| LOW PRESSURE STEAM | | | | | | | | | | | |
| SPEC N, CARBON STEEL | | | | | | | | | | | |
| PIPE | | | | | | | | | | | |
| 2" SCH XS THREADED ENDS | 50 | LF | 2.90 | .35 | | 145 | | | 18 | | |
| 1½" SCH XS THREADED ENDS | 100 | LF | 1.90 | .30 | | 190 | | | 30 | | |
| 1" SCH XS THREADED ENDS | 100 | LF | 1.30 | .25 | | 130 | | | 25 | | |
| FITTINGS | | | | | | | | | | | |
| TEES 2"×2"×2" | | 3 | 14.– | 2.3 | | 42 | | | 7 | | |
| 1"×1" 1" | | 4 | 8.20 | 1.5 | | 33 | | | 6 | | |
| ELBOWS 2" LR | | 10 | 10.– | 2.3 | | 100 | | | 23 | | |
| 1½" LR | | 10 | 8.50 | 1.7 | | 85 | | | 17 | | |
| 1" LR | | 20 | 6.20 | 1.5 | | 124 | | | 30 | | |
| VALVES | | | | | | | | | | | |
| GATE 2" | | 6 | 280.– | 4 | | 1680 | | | 24 | | |
| GATE 1½" | | 2 | 220.– | 3 | | 440 | | | 6 | | |
| GATE 1" | | 8 | 190.– | 3 | | 1520 | | | 24 | | |
| GLOBE 1" | | 8 | 210.– | 3 | | 1680 | | | 24 | | |
| GATE ¾" | | 5 | 160.– | 2 | | 800 | | | 10 | | |
| PCV 2" | | 1 | 620.– | 4 | | 620 | | | 4 | | |
| TCV 2" | | 2 | 620.– | 4 | | 1240 | | | 8 | | |
| TCV 1½" | | 1 | 480.– | 3 | | 480 | | | 3 | | |
| TCV 1" | | 4 | 370.– | 2 | | 1480 | | | 8 | | |
| TRAPS ¾" | | 5 | 220.– | 2 | | 1100 | | | 10 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS PRICED BY RW DATE JULY, 1981 SHEET 4 OF 14

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CONDENSATE | | | | | | | | | | | |
| | SPEC N, CARBON STEEL | | | | | | | | | | | |
| | PIPE 1½" SCH XS, THREADED | 20 | LF | 1.90 | .30 | | 38 | | | 6 | | |
| | 1" SCH XS THREADED | 70 | LF | 1.30 | .25 | | 91 | | | 18 | | |
| | ¾" SCH XS THREADED | 100 | LF | 0.95 | .20 | | 95 | | | 20 | | |
| | FITTINGS | | | | | | | | | | | |
| | TEES 1½ × 1½ × 1 | | 1 | 10.40 | 1.7 | | 10 | | | 2 | | |
| | 1" × 1" × ¾" | | 5 | 8.20 | 1.5 | | 41 | | | 8 | | |
| | ELBOWS 1½" | | 4 | 8.50 | 1.7 | | 34 | | | 7 | | |
| | 1" | | 10 | 6.20 | 1.5 | | 62 | | | 15 | | |
| | ¾" | | 20 | 4.80 | 1.3 | | 96 | | | 26 | | |
| | VALVES ¾" GATE | | 6 | 160.– | 2 | | 960 | | | 12 | | |
| | | | | | | | 1427 | | | 114 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS PRICED BY RW DATE JULY, 1981 SHEET 5 OF 14

JOB NO.: 6154-3 CLIENT: TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT / DESCRIPTION | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PROCESS EQUIPMENT DRAINS | | | | | | | | | | | |
| SPEC D, 304L SS | | | | | | | | | | | |
| PIPE 2" SCH 80S, THREADED | 200 | LF | 14.30 | .35 | | 286 | | | 70 | | |
| FITTINGS | | | | | | | | | | | |
| 90° LR ELBOWS | | 2 | 14.20 | 2.3 | | 28 | | | 5 | | |
| 45° ELBOWS | | 10 | 12.80 | 2.3 | | 128 | | | 23 | | |
| 45° LATERALS | | 10 | 14.20 | 2.3 | | 142 | | | 23 | | |
| FLOOR DRAINS 2" | | 18 | 85.00 | 6 | | 1530 | | | 108 | | |
| | | | | | | 2110 | | | 229 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS | PRICED BY RW | DATE JULY, 1981 | SHEET 6 OF 14

JOB NO.: 6154-3 | CLIENT: US DOE | TYPE OF ESTIMATE: | CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ZEOLITE ENCAPSULATION

CAPACITY:

| Description | Quantity | Unit | Cost per Unit MATL | Cost per Unit M/H | Cost per Unit LAB $ | Material Expense | Subcontract M/HRS | Subcontract Dollars | Labor M/HRS | Labor Dollars | Total Dollars |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HIGH PRESSURE COMPRESSED AIR | | | | | | | | | | | |
| SPEC N, CARBON STEEL | | | | | | | | | | | |
| PIPE 1½" SCH XS, THREADED | 110 | LF | 1.90 | .30 | | 209 | | | 33 | | |
| 1" SCH XS, THREADED | 50 | LF | 1.30 | .25 | | 65 | | | 13 | | |
| FITTINGS | | | | | | | | | | | |
| TEES 1½"×1½"×1" | | 4 | 10.40 | 1.7 | | 42 | | | 7 | | |
| 1½"×1½"×½" | | 10 | 10.40 | 1.7 | | 104 | | | 17 | | |
| 1½"×1½" 1½" | | 1 | 10.40 | 1.7 | | 10 | | | 2 | | |
| ELBOWS 1½" LR ELLS | | 3 | 8.50 | 1.7 | | 25 | | | 5 | | |
| VALVES | | | | | | | | | | | |
| GATE 1" | | 4 | 190 | 3 | | 760 | | | 12 | | |
| | | | | | | 1215 | | | 91 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS PRICED BY RW DATE JULY, 1981 SHEET 7 OF 14

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (SITE) COOLING WATER SUPPLY | | | | | | | | | | | |
| | SPEC Q, CARBON STEEL | | | | | | | | | | | |
| | PIPE: 2" SCH XS, THREADED | 100 | LF | 2.90 | .35 | | 290 | | | 35 | | |
| | FITTINGS | | | | | | | | | | | |
| | ELBOWS 2" LR | | 10 | 10- | 2.3 | | 100 | | | 23 | | |
| | TEES 2"x2"x 1½" | | 1 | 14- | 2.3 | | 14 | | | 2 | | |
| | 2"x2" x ½" | | 4 | 14- | 2.3 | | 56 | | | 9 | | |
| | VALVES | | | | | | | | | | | |
| | GATE 2" | | 4 | 280- | 4 | | 1120 | | | 16 | | |
| | CHECK 2" | | 1 | 95- | 3 | | 95 | | | 3 | | |
| | FCV 2" | | 1 | 620- | 4 | | 620 | | | 4 | | |
| | BELLOWS SEAL VALVE 2" | | 1 | 480- | 4 | | 480 | | | 4 | | |
| | FLOW ELEMENT 2" | | 1 | 120- | 3 | | 120 | | | 3 | | |
| | | | | | | | 2895 | | | 99 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS    PRICED BY RW    DATE JULY, 1981    SHEET 8 OF 14

JOB NO.: 6154-3    CLIENT: US DOE    TYPE OF ESTIMATE:    CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (SITE) COOLING WATER RETURN | | | | | | | | | | | |
| | SPEC Q, CARBON STEEL | | | | | | | | | | | |
| | PIPE 2" SCH XS, THREADED | 100 | LF | 2 90 | .35 | | 290 | | | 35 | | |
| | FITTINGS | | | | | | | | | | | |
| | ELBOWS 90° LR | | 7 | 10- | 2.3 | | 70 | | | 16 | | |
| | TEES 2"x2"x½" | | 1 | 14- | 2.3 | | 14 | | | 2 | | |
| | VALVES GATE 2" | | 3 | 280- | 4 | | 840 | | | 12 | | |
| | | | | | | | 1214 | | | 65 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS | PRICED BY RW | DATE JULY, 1981 | SHEET 9 OF 14

JOB NO.: 6154-3 | CLIENT: US DOE | TYPE OF ESTIMATE: | CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| Item | Quantity | Unit | Cost or M/Hrs per Unit: Mat'l | M/H | Lab $ | Material Expense | Subcontract M/Hrs | Subcontract Dollars | Labor M/Hrs | Labor Dollars | Total Dollars |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CLOSED LOOP COOLING WATER SUPPLY | | | | | | | | | | | |
| SPEC Q, CARBON STEEL | | | | | | | | | | | |
| PIPE 2" SCH XS, THREADED | 100 | LF | 2.90 | .35 | | 290 | | | 35 | | |
| FITTINGS | | | | | | | | | | | |
| ELBOWS 45° 2" | | 1 | 10- | 2.3 | | 10 | | | 2 | | |
| 90° LR 2" | | 15 | 10- | 2.3 | | 150 | | | 35 | | |
| TEES 2"x2"x2" | | 2 | 14- | 2.3 | | 28 | | | 5 | | |
| 2"x2"x ½" | | 2 | 14- | 2.3 | | 28 | | | 5 | | |
| VALVES | | | | | | | | | | | |
| GATE 2" | | 2 | 280- | 4 | | 560 | | | 8 | | |
| CHECK 2" | | 2 | 95 | 3 | | 190 | | | 6 | | |
| FLOW ELEMENT | | | | | | | | | | | |
| | | | | | | 1256 | | | 96 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS PRICED BY BW DATE JULY, 1981 SHEET 10 OF 14

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CLOSED LOOP COOLING WATER RETURN | | | | | | | | | | | |
| | SPEC Q, CARBON STEEL | | | | | | | | | | | |
| | PIPE 2" SCH XS, THREADED | 80 | LF | 2.90 | .35 | | 232 | | | 28 | | |
| | FITTINGS | | | | | | | | | | | |
| | ELBOWS 2" 90° LR | | 12 | 10- | 2.3 | | 120 | | | 28 | | |
| | TEES 2"x2"x2" | | 2 | 14- | 2.3 | | 28 | | | 5 | | |
| | VALVES | | | | | | | | | | | |
| | GATE 2" | | 2 | 280- | 4 | | 560 | | | 8 | | |
| | | | | | | | 940 | | | 69 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS — PRICED BY RW — DATE JULY, 1981 — SHEET 11 OF 14

JOB NO.: 6154-3 — CLIENT: US DOE — TYPE OF ESTIMATE: — CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ZEOLITE ENCAPSULATION

CAPACITY:

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISOSTATIC GAS SUPPLY TO COMPRESSORS | | | | | | | | | | | |
| | SPEC U, 316L SS CONE & THD | | | | | | | | | | | |
| | TUBING | | | | | | | | | | | |
| | 9/16" OD x .125" WALL | 50 | LF | 5.35 | .5 | | 268 | | | 25 | | |
| | FITTINGS | | | | | | | | | | | |
| | 90° ELBOWS | 12 | | 85 | 1.5 | | 1020 | | | 18 | | |
| | TEES | 6 | | 123 | 2.5 | | 738 | | | 15 | | |
| | PRE-CONED TUBING, 4" UNIONS | 36 | | 20 | 1.0 | | 720 | | | 36 | | |
| | VALVES | | | | | | | | | | | |
| | SHUT OFF VALVES 9/16" | 4 | | 155 | 6 | | 620 | | | 24 | | |
| | REMOTE OPERATING VALVES 9/16" | 3 | | 255 | 8 | | 765 | | | 24 | | |
| | FLOW ELEMENT | 1 | | 220 | 4 | | 220 | | | 4 | | |
| | | | | | | | 4351 | | | 146 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS  PRICED BY RW  DATE JULY, 1981  SHEET 12 OF 14

JOB NO.: 6154-3  CLIENT: US DOE  TYPE OF ESTIMATE:  CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISOSTATIC GAS SUPPLY FROM COMPRESSORS TO PRESS | | | | | | | | | | | |
| | SPEC U, 316L SS | | | | | | | | | | | |
| | TUBING | | | | | | | | | | | |
| | 9/16" OD X .125" WALL | 50 | LF | 5.35 | .5 | | 268 | | | 25 | | |
| | FITTINGS | | | | | | | | | | | |
| | 90° ELBOWS | 8 | | 85.- | 1.5 | | 680 | | | 12 | | |
| | TEES | 4 | | 123.- | 2.5 | | 492 | | | 10 | | |
| | PRE-CONED TUBING, 4" | 24 | | 20.- | 1.0 | | 480 | | | 24 | | |
| | UNIONS | 12 | | 100.- | 2.5 | | 1200 | | | 30 | | |
| | VALVES | | | | | | | | | | | |
| | REMOTE OPERATING 9/16" | 5 | | 255.- | 8 | | 1275 | | | 40 | | |
| | PSV | 1 | | 255.- | 8 | | 255 | | | 8 | | |
| | RUPTURE DISC | 1 | | 220.- | 4 | | 220 | | | 4 | | |
| | | | | | | | 4870 | | | 153 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY: L. BROOKS | PRICED BY: BW | DATE: JULY, 1981 | SHEET 13 OF 14

JOB NO.: 6154-3 | CLIENT: US DOE | TYPE OF ESTIMATE: | CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ZEOLITE ENCAPSULATION

CAPACITY:

| ACCNT | DESCRIPTION | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PRESSURIZED FEED GAS MIX SYSTEM | | | | | | | | | | | |
| | 300 PSIG | | | | | | | | | | | |
| | SPEC V, CARBON STEEL | | | | | | | | | | | |
| | PIPE 1" SCH XS, PLAIN ENDS | 250 | LF | 1.30 | .25 | | 325 | | | 63 | | |
| | FITTINGS | | | | | | | | | | | |
| | FLANGES 300# WN RF | | 20 | 85 | 1.5 | | 1700 | | | 30 | | |
| | ELBOWS 1" LR ELLS | | 45 | 6.20 | 1.5 | | 279 | | | 68 | | |
| | 1" 45° ELLS | | 5 | 6.20 | 1.5 | | 31 | | | 8 | | |
| | TEES 1" x 1" x 1" | | 18 | 8.20 | 1.5 | | 148 | | | 27 | | |
| | 1" x 1" x 1/2" | | 4 | 8.20 | 1.5 | | 33 | | | 6 | | |
| | 1 1/2" x 1 1/2" x 1 1/2" | | 4 | 10.40 | 1.7 | | 42 | | | 7 | | |
| | REDUCERS 1 1/2" x 1" | | 8 | 6.40 | 1.5 | | 51 | | | 12 | | |
| | VALVES 1" 300# GATE | | 5 | 240 | 4 | | 1200 | | | 20 | | |
| | 1" 300# SOLENOIDS | | 19 | 160 | 6 | | 3040 | | | 114 | | |
| | FLOW ELEMENTS | | 3 | 90 | 2 | | 270 | | | 6 | | |
| | | | | | | | 7119 | | | 361 | | |

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY L. BROOKS | PRICED BY RW | DATE JULY, 1981 | SHEET 14 OF 14

JOB NO.: 6154-3 | CLIENT: US DOE | TYPE OF ESTIMATE: | CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ZEOLITE ENCAPSULATION

CAPACITY

| ACCT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HI PRESS GAS MIX TO PRESS | | | | | | | | | | | |
| | SPEC U, 316L S.S. CONE & THD. | | | | | | | | | | | |
| | TUBING 9/16" OD × .125" WALL | 60 | LF | 5.35 | .5 | | 321 | | | 30 | | |
| | FITTINGS | | | | | | | | | | | |
| | ELBOWS | | 8 | 85 | 1.5 | | 680 | | | 12 | | |
| | UNIONS | | 20 | 100 | 2.5 | | 2000 | | | 30 | | |
| | TEES | | 10 | 123 | 2.5 | | 1230 | | | 25 | | |
| | PRE-CONED TUBING, 4" | | 36 | 20 | 1.0 | | 720 | | | 36 | | |
| | VALVES | | | | | | | | | | | |
| | 9/16" FCV | | 8 | 255 | 8 | | 2040 | | | 64 | | |
| | PSU | | 1 | 255 | 8 | | 255 | | | 8 | | |
| | RUPTURE DISC | | 1 | 220 | 4 | | 220 | | | 4 | | |
| | | | | | | | 7466 | | | 209 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW  PRICED BY RW  DATE JULY, 1981  SHEET ____ OF ____

JOB NO.: 6154-3  CLIENT: US DOE  TYPE OF ESTIMATE:  CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | INSTRUMENTATION | | | | | | | | | | | |
| | CONTROL INSTRUMENTATION (15% OF PIPING) | LS | | | | | 9400 | | | 333 | | |
| | HVAC (10% OF HVAC) | LS | | | | | 14090 | | | 146 | | |
| | RADIATION MONITORING (ALLOW) | LS | | | | | 10000 | | | 100 | | |
| | PROCESS CONTROLS (ALLOW) | LS | | | | | 15000 | | | 150 | | |
| | DATA PROCESSING (ALLOW) | LS | | | | | 20000 | | | 100 | | |
| | SUB-TOTAL | | | | | | 68490 | | | 829 | | |
| | PRODUCTIVITY (1.80 × 829) | 1492 | | | | 20.90 | | | | 1492 | 31180 | |
| | SUB-TOTAL | | | | | | 68490 | | | | 31180 | 99670 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 23970 | | | | 24961 | 48930 |
| | TOTAL | | | | | | 92460 | | | | 56140 | 148600 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY SHR PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

DESCRIPTION KRYPTON ENCAPSULATION ZEOLITE ENCAPSULATION

| ACCNT | DESCRIPTION | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | ELECTRICAL SUMMARY | | | | | | 164 300 | | | 3973 | | |
| | PRODUCTIVITY (1.80 × 3973) | 7151 | MH | | | 20.86 | | | | 7151 | 149 170 | |
| | SUB-TOTAL | | | | | | 164 300 | | | | 149 170 | |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 57 510 | | | | 126 820 | |
| | | | | | | | 221 810 | | | | 275 990 | 497 800 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY SH Rowe PRICED BY DATE 6/12/81 SHEET 1 OF 2

JOB NO.: 6154-3 CLIENT: DOE TYPE OF ESTIMATE: CONCEPTUAL CKD BY:

UNIT/AREA

DESCRIPTION Zeolite Encapsulation

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | Cost or M/HRS per Unit: MATL | M/H | LAB $ | MATERIAL EXPENSE | Subcontract: M/HRS | Subcontract: DOLLARS | Labor: M/HRS | Labor: DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ELECTRICAL | | | | | | | | | | | |
| | 300 KVA Unit Substation US1 | 1 | EA | | | | 31700 | | | 50 | | |
| | MCC1 480/277V Cl II Type B | 1 | EA | | | | 27500 | | | 80 | | |
| | 45KVA Xfrm 480-208Y/120V | 1 | EA | | | | 1550 | | | 16 | | |
| | 9KVA Xfrm 480-208Y/120V | 1 | EA | | | | 470 | | | 9 | | |
| | Panelboard ELA, 8CKT | 1 | EA | | | | 200 | | | 8 | | |
| | Panelboard ELB, 4CKT | 1 | EA | | | | 170 | | | 6 | | |
| | Panelboard LPA 42CKT | 1 | EA | | | | 800 | | | 28 | | |
| | Panelboard ELPB 12 CKT | 1 | EA | | | | 244 | | | 10 | | |
| | 60A Welding Recp & SW | 1 | EA | | | | 400 | | | 4 | | |
| | 30A Disc Sw | 2 | EA | 35 | 2 | | 70 | | | 4 | | |
| | 480 V Motor & Load Conn <10HP | 11 | EA | 1.20 | 2 | | 13 | | | 22 | | |
| | 15 HP | 2 | EA | 1.30 | 2.1 | | 3 | | | 4 | | |
| | 30HP | 4 | EA | 2.50 | 2.4 | | 10 | | | 16 | | |
| | 40 KW | 2 | EA | 3.10 | 2.6 | | 6 | | | 5 | | |
| | Area Ltg, Wire & Conduit | 4300 | SF | 2.40 | .08 | | 10320 | | | 344 | | |
| | Special Cell Lts. | 8 | EA | 1000 | 5 | | 8000 | | | 40 | | |
| | Recp, Wire & Conduit | 4300 | SF | 1.80 | .06 | | 7740 | | | 258 | | |
| | Multiplexer & Terminal Bd | 1 | EA | | | | 5000 | | | 60 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY S H Rowe PRICED BY DATE 6/12/81 SHEET 2 OF 2

JOB NO.: 6154-3 CLIENT: TYPE OF ESTIMATE: Conceptual CKD BY:

UNIT/AREA

DESCRIPTION Zeolite Encapsulation

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grounding | | LS | | | | 2000 | | | 80 | | |
| | Lightning Protection | | LS | | | | 5000 | | | 110 | | |
| | Cathodic Protection | | LS | | | | 25000 | | | 750 | | |
| | Intercom | | LS | | | | 9000 | | | 320 | | |
| | Fire Alarm | | LS | | | | 8000 | | | 260 | | |
| | Evacuation Alarm | | LS | | | | 5500 | | | 160 | | |
| | Conduit Fittings | | LS | | | | 700 | | | 75 | | |
| | Connect Instrumentation | | LS | | | | 6000 | | | 500 | | |
| | Motor: Wire & Conduit | | LS | | | | 6000 | | | 560 | | |
| | Solenoid Valve Wire & Conduit | | LS | | | | 3000 | | | 200 | | |
| | TOTAL | | | | | | 164,296 | | | 3973 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY E. Hom PRICED BY E. Hom / RW DATE July, 1981 SHEET 1 OF 5

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA Krypton Encapsulation
DESCRIPTION Zeolite Encapsulation
CAPACITY

| ACCNT | Description | Quantity | Unit | Cost or M/Hrs per Unit: Matl | M/H | Lab $ | Material Expense | Subcontract M/Hrs | Subcontract Dollars | Labor M/Hrs | Labor Dollars | Total Dollars |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | Buildings | | | | | | | | | | | |
| | HVAC Summary | | | | | | | | | | | |
| | From Sht. 2 | | | | | | 9600 | | | 142 | | |
| | " " 3 | | | | | | 108900 | | | 306 | | |
| | " " 4 | | | | | | 4900 | | | 173 | | |
| | " " 5 | | | | | | 17490 | | | 835 | | |
| | Sub-Total | | | | | | 140890 | | | 1456 | | |
| | Productivity (1.80 × 1456) | 2621 | MH | | | 19.40 | | | | 2621 | 50850 | |
| | Sub-Total | | | | | | 140890 | | | 2621 | 50850 | 191740 |
| | Subcontractor Mark-Up | | % | 35 | 80 | | 49310 | | | | 40650 | 89960 |
| | Total | | | | | | 190200 | | | | 91500 | 281700 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY E. HOM | PRICED BY | DATE 6-9-81 | SHEET 2 OF 5

JOB NO.: 6154-3 | CLIENT: DOE | TYPE OF ESTIMATE: | CKD BY:

UNIT/AREA
DESCRIPTION KRYPTON ENCAPSULATION
CAPACITY HIGH PRESSURE CONCEPT

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HVAC | | | | | | | | | | | |
| | SUPPLY FAN | 2 | EA | 1500 | 20 | | 3000 | | | 40 | | |
| | CAP. 2670 CFM AT 3"SP, 3 HP | | | | | | | | | | | |
| | BUFFALO FORGE CO. | | | | | | | | | | | |
| | TYPE BL-AEROFOIL SIZE 270 | | | | | | | | | | | |
| | SWSI - ARRG. 3 W/INLET VANES | | | | | | | | | | | |
| | EXHAUST FAN | 2 | EA | 2500 | 20 | | 5000 | | | 40 | | |
| | CAP. 2800 CFM AT 10"SP, 10 HP | | | | | | | | | | | |
| | BUFFALO FORGE CO. | | | | | | | | | | | |
| | INDUSTRIAL EXHAUSTER | | | | | | | | | | | |
| | RADIAL BLADE SIZE 30MV | | | | | | | | | | | |
| | SWSI, ARRG. 9 | | | | | | | | | | | |
| | STEAM PREHEAT COIL | 2 | EA | 600 | 24 | | 1200 | | | 48 | | |
| | 2670 CFM & 168,000 BTU/HR | | | | | | | | | | | |
| | 5-FT² FACE AREA, 2-ROW | | | | | | | | | | | |
| | -20°F ENT. & +50°F LV. AIR | | | | | | | | | | | |
| | 15 PSIG STEAM | | | | | | | | | | | |
| | STEAM HEATING COIL | 1 | EA | 150 | 6 | | 150 | | | 6 | | |
| | 570 CFM & 26,000 BTU/HR | | | | | | | | | | | |
| | 1-FT² FACE AREA, 1-ROW | | | | | | | | | | | |
| | +40°F ENT. & 90°F LV. AIR | | | | | | | | | | | |
| | 15 PSIG STEAM | | | | | | | | | | | |
| | STEAM HEATING COIL | 1 | EA | 250 | 8 | | 250 | | | 8 | | |
| | 1180 CFM & 32,000 BTU/HR | | | | | | | | | | | |
| | 2-FT² FACE AREA, 1-ROW | | | | | | | | | | | |
| | +40°F ENT. & +70°F LV. AIR | | | | | | | | | | | |
| | 15 PSIG STEAM | | | | | | | | | | | |
| | | | | | | | 9600 | | | 142 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY E. HOM | PRICED BY | DATE 6-9-81 | SHEET 3 OF 5

JOB NO.: 6154-3 | CLIENT: DOE | TYPE OF ESTIMATE: | CKD BY:

UNIT/AREA

DESCRIPTION KRYPTON ENCAPSULATION

CAPACITY HIGH PRESSURE CONCEPT

| ACCNT | Description | Quantity | Unit | Cost or M/Hrs per Unit: Matl | M/H | Lab $ | Material Expense | Subcontract: M/Hrs | Dollars | Labor: M/Hrs | Dollars | Total Dollars |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HVAC | | | | | | | | | | | |
| | STEAM HEATING COIL | 1 | EA | 200 | 6 | | 200 | | | 6 | | |
| | CAP. 920 CFM & 41400 BTU/HR | | | | | | | | | | | |
| | 1.5 FT² FACE AREA, 1-ROW | | | | | | | | | | | |
| | +40°F ENT. & 90°F LV. AIR | | | | | | | | | | | |
| | 15 PSIG STEAM | | | | | | | | | | | |
| | SPRAY COOLING CHAMBER | 2 | EA | 4000 | 40 | | 8000 | | | 80 | | |
| | FILTER FIRE PROTECTION | | | | | | | | | | | |
| | 2800 CFM & 5.6 FT² FACE AREA | | | | | | | | | | | |
| | 1-BANK SPRAY NOZZLES, | | | | | | | | | | | |
| | MOISTURE SEPARATOR, DRAIN PAN | | | | | | | | | | | |
| | EXHAUST AIR HEPA FILTER | 2 | EA | 50000 | 100 | | 100000 | | | 200 | | |
| | PLENUM, 3000 CFM RATING | | | | | | | | | | | |
| | FLANDERS FILTER CO. | | | | | | | | | | | |
| | 2-STAGES OF HEPA FILTERS | | | | | | | | | | | |
| | 24"x24"x11½" FLUID SEAL TYPE | | | | | | | | | | | |
| | ARRANGED 3-WIDE BY 1-HIGH | | | | | | | | | | | |
| | BAG-OUT TYPE E-4 FILTER | | | | | | | | | | | |
| | HOUSINGS WITH IN-PLACE | | | | | | | | | | | |
| | REMOTE DOP TEST SECTIONS | | | | | | | | | | | |
| | T-I, T-C, & T-O. | | | | | | | | | | | |
| | SUPPLY AIR FILTER BOX | 2 | EA | 350 | 10 | | 700 | | | 20 | | |
| | CAP. 2670 CFM | | | | | | | | | | | |
| | FARR CO. SIDE LOADING | | | | | | | | | | | |
| | MODEL 3P UNIVERSAL GLIDEPACK | | | | | | | | | | | |
| | WITH 2-24"x24"x4" TYPE 30/30 | | | | | | | | | | | |
| | 30% EFF. PREFILTERS & | | | | | | | | | | | |
| | 2-24"x24"x12"-90% EFF. | | | | | | | | | | | |
| | TYPE HP-200 HIGH EFF. FILTERS | | | | | | | | | | | |
| | | | | | | | 108900 | | | 306 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY E. HOM    PRICED BY    DATE 6-9-81    SHEET 4 OF 5

JOB NO.: 6154-3    CLIENT: DOE    TYPE OF ESTIMATE:    CKD BY:

UNIT/AREA

DESCRIPTION KRYPTON ENCAPSULATION

CAPACITY HIGH PRESSURE CONCEPT

| ACCNT | Description | Quantity | Unit | Cost per unit: MATL | Cost per unit: M/H | Cost per unit: LAB $ | Material Expense | Subcontract M/HRS | Subcontract Dollars | Labor M/HRS | Labor Dollars | Total Dollars |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HVAC | | | | | | | | | | | |
| | REFRIGERANT COOLING COIL | 1 | EA | 300 | 8 | | 300 | | | 8 | | |
| | CAP. 920 CFM & 24,000 BTU/HR | | | | | | | | | | | |
| | 2.0 FT² FACE AREA, 6-ROW DX | | | | | | | | | | | |
| | VENT FAN | 1 | EA | 1400 | 20 | | 1400 | | | 20 | | |
| | CAP. 4000 CFM AT 1.0"SP, 1-HP | | | | | | | | | | | |
| | BUFFALO FORGE CO. | | | | | | | | | | | |
| | TYPE BL-AEROFOIL SIZE 270 | | | | | | | | | | | |
| | SWSI-ARRG. 3 W/INLET VANES | | | | | | | | | | | |
| | STEAM UNIT HEATER | 4 | EA | 350 | 20 | | 1400 | | | 80 | | |
| | CAP. 50,000 BTU/HR, 15 PSIG STEAM | | | | | | | | | | | |
| | HORIZ. SUSPENDED TYPE | | | | | | | | | | | |
| | TRANE CO. MODEL 60-S | | | | | | | | | | | |
| | POWER ROOF VENTILATOR | 1 | EA | 100 | 10 | | 100 | | | 10 | | |
| | 100 CFM AT 3/8"SP | | | | | | | | | | | |
| | SPUN ALUMINUM, LOW SILHOUETTE | | | | | | | | | | | |
| | TYPE | | | | | | | | | | | |
| | AIR COOLED REFRIGERANT | 1 | EA | 1500 | 40 | | 1,500 | | | 40 | | |
| | CONDENSING UNIT | | | | | | | | | | | |
| | CAP. 24,000 BTU/HR, 95°F ENT. AIR | | | | | | | | | | | |
| | CARRIER 38 GS 024, 2.7 KW | | | | | | | | | | | |
| | GRAVITY ROOF VENTILATOR | 2 | EA | 200 | 15 | | 200 | | | 15 | | |
| | 2-FT² THROAT AREA | | | | | | | | | | | |
| | ALL ALUMINUM CONSTRUCTION | | | | | | | | | | | |
| | | | | | | | 4900 | | | 173 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY E. HOM PRICED BY DATE 6-9-81 SHEET 5 OF 5

JOB NO.: 6154-3 CLIENT: DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA

DESCRIPTION KRYPTON ENCAPSULATION

CAPACITY HIGH PRESSURE CONCEPT

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HVAC | | | | | | | | | | | |
| | DUCTWORK, GALV. STEEL | 2000 | LB | 1.50 | 0.08 | | 3000 | | | 160 | | |
| | DUCTWORK, STAINLESS STEEL | 1300 | LB | 3.90 | 0.10 | | 5070 | | | 130 | | |
| | GRILLES & REGISTERS | 1 | LS | | | | 1500 | | | 50 | | |
| | MANUAL, BALANCING, BACKDRAFT DAMPERS | 1 | LS | | | | 2000 | | | 40 | | |
| | REFRIG. TUBING, COPPER TYPE "L" | | | | | | | | | | | |
| | 20' - 1/2" OD | 1 | LS | | | | 100 | | | 20 | | |
| | 20' - 5/8" OD | 1 | LS | | | | 120 | | | 20 | | |
| | INSULATION | 1 | LS | | | | 400 | | | 35 | | |
| | AUTOMATIC CONTROLS - HONEYWELL | 1 | LS | | | | 2000 | | | 200 | | |
| | PRESS. DIFFERENTIAL CONTROL AIR MONITOR | 1 | LS | | | | 2500 | | | 100 | | |
| | TEST & BALANCE | 1 | LS | | | | 800 | | | 80 | | |
| | | | | | | | 17490 | | | 835 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: U.S DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT | | | MATERIAL EXPENSE | SUBCONTRACT | | LABOR | | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MATL | M/H | LAB $ | | M/HRS | DOLLARS | M/HRS | DOLLARS | |
| 500 | BUILDINGS | | | | | | | | | | | |
| | FIRE PROTECTION, EST | 4400 | SF | 5.00 | .10 | | 22000 | | | 440 | | |
| | PRODUCTIVITY (1.80 x 440) | 792 | MH | | | 21.70 | | | | 792 | 17190 | |
| | SUB-TOTAL | | | | | | 22000 | | | | 17190 | |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 7700 | | | | 13710 | |
| | TOTAL | | | | | | 29700 | | | | 30900 | 60600 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY BW PRICED BY BW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: USDOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | Description | Quantity | Unit | Cost or M/Hrs per Unit: MATL | Cost or M/Hrs per Unit: M/H | Cost or M/Hrs per Unit: LAB $ | Material Expense | Subcontract M/HRS | Subcontract Dollars | Labor M/HRS | Labor Dollars | Total Dollars |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | PLUMBING | | | | | | | | | | | |
| | ROOF DRAINS, EST. | | | | | | 4000 | | | 200 | | |
| | LAVATORY FIXTURES, EST. | | | | | | 5000 | | | 100 | | |
| | DRAINS AND VENTS, EST. | | | | | | 8000 | | | 400 | | |
| | WATER SERVICES, EST. | | | | | | 3000 | | | 200 | | |
| | SUB-TOTAL | | | | | | 20000 | | | 900 | | |
| | PRODUCTIVITY (1.80 × 900) | 1620 | | | | 21 70 | | | | 1620 | 36150 | |
| | SUB-TOTAL | | | | | | 20000 | | | | 36150 | 56150 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 7000 | | | | 28150 | 35150 |
| | TOTAL | | | | | | 27000 | | | | 54300 | 91300 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY BW  PRICED BY BW  DATE July, 1981  SHEET ____ OF ____

JOB NO.: 6154-3  CLIENT: US DOE  TYPE OF ESTIMATE:  CKD BY:

UNIT/AREA Krypton Encapsulation

DESCRIPTION Zeolite Encapsulation

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | BUILDINGS | | | | | | | | | | | |
| | SPECIAL BLDG. COMPONENTS | | | | | | | | | | | |
| | PRODUCT STORAGE | | | | | | | | | | | |
| | 7'x7'x26' STORAGE ASSEMBLY CONSTRUCTED OF 304L SS ANGLE & PLATE W/ NITRONIC 60 ROLLERS, 2 PAIR ON 6" C/C, TYP. OF 49 POSITIONS, TOTAL OF 637 STORAGE SPACES | | | | | | | | | | | |
| | 10192 1" O.D. x 9/16" I.D. ROLLS | 3110 | LB | 8.00 | .20 | | 24880 | | | 622 | | |
| | 10192 1/2" ϕ STAY BOLTS | 1710 | LB | 4.00 | .05 | | 6840 | | | 86 | | |
| | 2x10192 1/2" PLATE BRACKETS | 17370 | LB | 3.00 | .10 | | 52110 | | | 1737 | | |
| | 98 - 4"x4"x1/2"x26' ANGLES | 34730 | LB | 3.00 | .02 | | 104210 | | | 695 | | |
| | 40 - 4x4x1/2"x7' COLUMNS | 7630 | LB | 3.00 | .02 | | 22910 | | | 153 | | |
| | 40 - 6"x6"x1" BASE PL | 818 | LB | 3.00 | 1.0 | | 2450 | | | 818 | | |
| | SUB-TOTAL | 65270 | LB | | | | 213400 | | | 4111. | | |
| | SHIELDING WINDOWS | | | | | | | | | | | |
| | 3-30"x30" WINDOWS (CELL OPERATIONS, INSPECTION, AND SEALING) | | | | | | | | | | | |
| | 1-18"x16" WINDOW (PRODUCT LOAD-IN) | | | | | | | | | | | |
| | SUBTOTAL | 1 | LOT | | | | 42000 | | | 360 | | |
| | SUB-TOTAL | | | | | | 255400 | | | 4471 | | |
| | PRODUCTIVITY (1.80 x 4471) | 8048 | MH | | | 20.30 | | | | 8048 | 163310 | |
| | SUB-TOTAL | | | | | | 255400 | | | | 163310 | 418770 |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 89390 | | | | 130640 | 250030 |
| | TOTAL | | | | | | 344790 | | | | 294010 | 668800 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW    PRICED BY RW    DATE JULY, 1981    SHEET ____ OF ____

JOB NO.: 6154-3    CLIENT: US DOE    TYPE OF ESTIMATE:    CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT | | | | | | | | | | | |
| | SUMMARY | | | | | | | | | | | |
| | VESSELS & TANKS | | | | | | 176380 | | | 440 | | |
| | PUMPS | | | | | | 20400 | | | 220 | | |
| | AGITATORS | | | | | | 4400 | | | 40 | | |
| | HEAT EXCHANGERS | | | | | | 64000 | | | 240 | | |
| | COMPRESSORS | | | | | | 29000 | | | 160 | | |
| | HOT ISOSTATIC PRESS | | | | | | 261400 | | | 240 | | |
| | PROCESS SPECIALTIES | | | | | | 19650 | | | 44 | | |
| | OTHER MAJOR EQUIPMENT | | | | | | 594000 | | | 2090 | | |
| | SUB-TOTAL | | | | | | 1169230 | | | 3474 | | |
| | SEISMIC QUALIFICATION (@ 20% OF MAT'L) | | | | | | 233840 | | | | | |
| | PRODUCTIVITY (1.80 × 3474) | 6110 | MH | | 20.30 | | | | | 6110 | 124030 | |
| | SUB-TOTAL | | | | | | 1403070 | | | | 124030 | |
| | SUBCONTRACTOR MARK-UP | | % | 35 | 80 | | 491070 | | | | 99290 | |
| | TOTAL EQUIPMENT | | | | | | 1894140 | | | | 223320 | |
| | USE | | | | | | 1895000 | | | | 230000 | 2125000 |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW　　PRICED BY RW　　DATE JULY, 1981　　SHEET ____ OF ____

JOB NO.: 6154-3　　CLIENT: U.S. DOE　　TYPE OF ESTIMATE:　　CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT | | | | | | | | | | | |
| | VESSELS & TANKS | | | | | | | | | | | |
| | KEF-HP-TK1, SUMP CATCH TANK 3'-6"φ x 6'-0' T/T, T304LSS, 15 PSIG DESIGN | 4750 | LB | 7.50 | LOT | | 35630 | | | 40 | | |
| | KEF-HP-TK101 DECON. SOLUTION MAKE-UP TANK, 3'-6"φ x 4'-0" T/T, T304LSS, 15 PSIG DESIGN | 3200 | LB | 7.50 | LOT | | 24000 | | | 40 | | |
| | KEF-HP-TK2, 3 LAG STORAGE & RUN TANKS (TOTAL FOR 10) 12"φ x 12'-0" T/T, T316LSS, 1270 PSIG DESIGN W/ SUPPORT FRAME | 12500 | LB | 7.00 | LOT | | 87500 | | | 240 | | |
| | KEF-HP-TK4, ISOSTATIC RUN TANKS, (TOTAL OF 2) 12"φ x 12'-0" T/T T316LSS, 1100 PSIG DESIGN | 2300 | LB | 8.00 | LOT | | 18400 | | | 60 | | |
| | KEF-HP-TK102, ISOSTATIC SUPPLY CYLINDERS, 9"φ x 52" T/T, W/ SUPPLY HEADERS (TOTAL OF 3) | 900 | LB | 4.50 | LOT | | 4050 | | | 30 | | |
| | KEF-HP-TK5, PRESSURE RELIEF ACCUMULATOR, 18"φ x 4'-6" T/T, T316LSS, 900 PSIG DESIGN | 850 | LB | 8.00 | LOT | | 6800 | | | 30 | | |
| | SUB-TOTAL | | | | | | 176380 | | | 440 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT | | | | | | | | | | | |
| | PUMPS | | | | | | | | | | | |
| | KEF-HP-P101, DECON SOLUTION PUMP, HORIZONTAL CENTRIFUGAL, 1800 rpm, 50 GPM w/ 40 TDH, 316 SS | 1 | EA | 4000 | 80 | | 4000 | | | 80 | | |
| | KEF-HP-P1 & 2, COOLING WATER PUMP, HORIZONTAL CENTRIFUGAL, 1800 rpm, 15 GPM w/ 60 TDH, DUCTILE IRON | 2 | EA | 700 | 20 | | 1400 | | | 40 | | |
| | KEF-HP-VP1 & 2, KRYPTON VACUUM PUMP | 2 | EA | 3200 | 20 | | 6400 | | | 40 | | |
| | KEF-HP-VP3 & 4, HELIUM VACUUM PUMP | 2 | EA | 2800 | 20 | | 5600 | | | 40 | | |
| | SUMP & CATCH TANK EDUCTOR, STEAM JET, 30 GPM, 304L SS | 2 | EA | 1500 | 10 | | 3000 | | | 20 | | |
| | SUB-TOTAL | | | | | | 20400 | | | 220 | | |
| | AGITATORS | | | | | | | | | | | |
| | SUMP CATCH TANK AGITATOR, 1 HP, 304L SS WETTED PARTS | 1 | EA | 2200 | 20 | | 2200 | | | 20 | | |
| | DECON SOLUTION TANK AGITATOR 1 HP, 304L SS WETTED PARTS | 1 | EA | 2200 | 20 | | 2200 | | | 20 | | |
| | SUB-TOTAL | | | | | | 4400 | | | 40 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ___ OF ___

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | Description | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT | | | | | | | | | | | |
| | HEAT EXCHANGERS | | | | | | | | | | | |
| | KEF-HP-HE1, FEED GAS COOLER, 20,000 BTU/HR, 316 SS SHELL & TUBES, C.S. CHANNEL, 600 PSIG DESIGN | 1 | EA | 18000 | LOT | | 18000 | | | 80 | | |
| | KEF-HP-HE2, COOLING WATER HEAT EXCHANGER, 200,000 BTU/HR, C.S. SHELL & BONNET, ADMIRALTY TUBES | 1 | EA | 46000 | LOT | | 46000 | | | 160 | | |
| | SUB-TOTAL | | | | | | 64000 | | | 240 | | |
| | COMPRESSORS | | | | | | | | | | | |
| | KEF-HP-COM1 & 2, FEED GAS MIXTURE COMPRESSOR, TRIPLE DIAPHRAGM, 200 PSIG INLET, 500 PSIG OUTLET, 1 CFM, 400 RPM, 316 SS | 2 | EA | 14500 | LOT | | 29000 | | | 160 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY RW PRICED BY RW DATE JULY, 1981 SHEET ____ OF ____

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

UNIT/AREA KRYPTON ENCAPSULATION

DESCRIPTION ZEOLITE ENCAPSULATION

CAPACITY

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT | | | | | | | | | | | |
| | HOT ISOSTATIC PRESS | | | | | | | | | | | |
| | KEF-HP-HIP-1, TOP LOADING, SINGLE LEVEL, GRAPHITE, NATURAL CONVECTION STYLE HIP FURNACE WITH ISOLATED DUAL GAS DELTA P CAPABILITY. INCLUDES VESSEL W/ YOKE (5800#), PRESSURE GAS SYSTEM W/ CONTROL PANEL AND COMPRESSORS KEF-HP-COM3 & 4 AND KEF-HP-COM5 & 6 (3800#), CONTROL PANEL (400#), POWER PANEL (400#), TRANSFORMER (500#), AND VACUUM PUMP (250#). 50 KW MAXIMUM POWER, 41,000 Btu/hr HEAT INPUT, 15,000 PSI DESIGN, ASME SECT. VIII, DIV. 2 | 1 | LOT | | | | 261400 | | | 240 | | |
| | ESTIMATE BASIS: $30/LB ELECTRICAL & CONTROL, $25/LB COMPRESSORS & PUMPS, $15/LB VESSEL, ALLOW 15% FOR INTERCONNECTIONS | | | | | | | | | | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY BW PRICED BY BW DATE JULY, 1981 SHEET ___ OF ___

JOB NO.: 6154-3 CLIENT: US DOE TYPE OF ESTIMATE: CKD BY:

DESCRIPTION KRYPTON ENCAPSULATION ZEOLITE ENCAPSULATION

| ACCNT | DESCRIPTION | QUANTITY | UNIT | COST OR M/HRS PER UNIT: MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT: M/HRS | DOLLARS | LABOR: M/HRS | DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT PROCESS SPECIALTIES | | | | | | | | | | | |
| | KEF-HP-F1, FEED GAS FILTER, IN-LINE 2μ, 750 PSIG DESIGN, 316 SS | 1 | EA | 450 | 8 | | 450 | | | 8 | | |
| | SUMP SAMPLER, SUMP CATCH TANK SAMPLER, PLUNGER TYPE, AIR OPERATED, SOLENOID ACTIVATED, MANUAL INITIATED | 2 | EA | 600 | 6 | | 1200 | | | 12 | | |
| | KEF-HP-AF1 SUBSTRATE ACTIVATION FURNANCE, 40 KW HEAT INPUT | 2 | EA | 9000 | 12 | | 18000 | | | 24 | | |
| | SUB-TOTAL | | | | | | 19650 | | | 44 | | |

CES 2000-0

THE RALPH M. PARSONS COMPANY

# ESTIMATE WORKSHEET

M.T.O. BY A. SMITH | PRICED BY A. SMITH / RW | DATE JULY, 1981 | SHEET ____ OF ____

JOB NO.: 6154-3 | CLIENT: U.S. DOE | TYPE OF ESTIMATE: | CKD BY:

UNIT/AREA: KRYPTON ENCAPSULATION

DESCRIPTION: ZEOLITE ENCAPSULATION

CAPACITY:

| ACCNT | | QUANTITY | UNIT | COST OR M/HRS PER UNIT MATL | M/H | LAB $ | MATERIAL EXPENSE | SUBCONTRACT M/HRS | SUBCONTRACT DOLLARS | LABOR M/HRS | LABOR DOLLARS | TOTAL DOLLARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | EQUIPMENT | | | | | | | | | | | |
| | OTHER MAJOR EQUIPMENT | | | | | | | | | | | |
| | MINITRAILER ROBO CARRIER | 2 | EA | 100,000 | 50 | | 200000 | | | 100 | | |
| | BRIDGE CRANE 5T/2-1/2T | 1 | EA | 150,000 | 1200 | | 150000 | | | 1200 | | |
| | AUTOMATIC WELDER | 1 | EA | 80,000 | 200 | | 80000 | | | 200 | | |
| | LEAK DETECTOR | 1 | EA | 20,000 | 150 | | 20000 | | | 150 | | |
| | MASTER SLAVE MANIPULATORS, MODEL "F" | 4 | EA. | 21,000 | 60 | | 84000 | | | 240 | | |
| | SPECIAL TOOLS AND FIXTURES | 1 | LOT | 50000 | 160 | | 50000 | | | 160 | | |
| | 2T MONORAIL HOIST | 1 | EA | 10,000 | 40 | | 10000 | | | 40 | | |
| | SUB-TOTAL | | | | | | 594000 | | | 2090 | | |