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MHD-ETF PROGRAM FINAL REPORT

Volume II B - Parts 3,4 and 5, Reference Design Description

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MHD-ETF PROGRAM FINAL REPORT

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VOLUME IIB

PART 3. TEST AND OPERATING PHILOSOPHY

3.0 INDTRODUCTION

The purpose of the "Test and Operating Philosophy" is to document test objectives, modes of operation and overall operating plans for the ETF. Additionally, TOP has attempted to develop an overall staffing plan to ensure the efficient operation of the facility.

In the development of TOP, assumptions were made in areas where operational data or detailed component designs were lacking. This has led to recommendations which may prove to be impractical or undesirable when more detailed component information is available.

It would be advisable to review and upgrade this TOP as more operational data becomes available.

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3.1 GENERAL

3.1.1 MISSION OF THE ENGINEERING TEST FACILITY

The purpose of the ETF is to provide a flexible operating facility that will be used initially for development and testing of the MHD/Steam combined cycle and ultimately for long term demonstration tests to demonstrate that the MHD/Steam power generation concept is technology ready for commercialization. The entire system must operate in an environmentally acceptable manner in compliance with Federal, State, and local air, liquid, and solid effluent quality requirements. The ETF is sized such that data obtained is representative of the performance levels required for MHD and can be realistically applied to scaling up to a full size commercial plant while still being small enough to allow cost effective evaluation of the MHD topping cycle system operation with reasonable capability of system, and operating component modifications.

A major objective of the ETF is to conduct long term testing to evaluate the reliability and life of components and subsystems. The culmination of this long term testing will be the performance of a 2000 hour continuous run, the purpose of which is to demonstrate that the MHD power train performance (with regard to efficiency, reliability, regulatory compliance and economy) shows significant advantage with respect to other commercially operating power generation systems.

Some additional objectives would be:

1. Evaluation of the performance of components and subsystems under a broad range of operating conditions, to identify areas where modifications in design or operating conditions, or both, are required.

2. Obtain overall system performance and response data required to permit an understanding of the system interactions and dynamic behaivor. This, in turn, will lead to the development of reliable automatic control systems for future commercial application.

3. Provide a system which is flexible enough in design to allow the installation and testing of new components, materials, or operating techniques, and is capable of determining the effect of the change on the total system.

4. Develop, validate, and upgrade plant operating procedures and techniques. It is important that this be done during the ETF operation to ensure a firm base for large commercial power plant operation.

Inherent in the above is the requirement that the facility be provided with subsystems that are as independent as possible. This will ensure that operational flexibility is enhanced by allowing parameters to be varied in one subsystem while holding the balance of system conditions constant and then determining the new equilibrium conditions. This type of operation will require a comprehensive data acquisition and management system to allow the collection of data at both steady-state and dynamic operating conditions.

3.1.2 AVAILABILITY AND RELIABILITY

For a detailed discussion of the availability and reliability associated with this facility, please see Volume IV, Appendix A27.

3.1.3 TEST SETUP

Due to the nature and intended functions of the ETF, the facility has been designed to reduce the amount of time required to prepare and run a test. This was accomplished in a number of ways.

3.1.3.1 Equipment Access

The physical layout of the plant has allowed sufficient space for removal of equipment for change-out and/or maintenance.

With the possibility of removing and adding components during the life of the facility, the design allows sufficient space for the movement of equipment. It was necessary to design roads capable of handling the loads of heavy trucks and equipment without severe degradation. Doors have been placed in such a fashion as to allow ready entry to any part of the plant. Equipment hatches were sized large enough to allow the entry and removal of large components. Assembly/disassembly areas were set aside and provided with permanent shelter. The capability for lifting equipment has been provided with the inclusion of overhead cranes in the MHD and HTAH areas (See SR Dwg. G1-2). The off-loading areas will have been examined to determine equipment laydown space, the storage space for off-loading equipment, and the heating and ventilation requirements of the area.

3.1.3.2 Component Removal/Installation

With the desired equipment flexibility in mind, the impact on plant design must be assessed early in the design stages of the plant. In the overall sizing of the plant building, sufficient laydown area for the tools and equipment must be provided. The width of asisles must be designed so that components, and the segments which make up the components, are easily accessible and sufficient removal space is readily available. The ability to lift these pieces must be reviewed and a determination of how these lifts will be made must be performed. Overhead cranes and other equipment handling devices must be provided that facilitate rapid removal and reinstallation of key components. Also close attention has been given to the services required in each area to support maintenance and repair. This will require an evaluation of the type of work (detail assembly, large piece assembly, etc.) being performed in an area and providing the necessary level of illumination. For the type of work being performed, sufficient supplies of power, water and air are to be provided. For example, if electric grinders are being used it will be necessary to supply a reasonable close source of electricity of proper voltage. With welding being done, electricity (of proper voltage) will be supplied.

3.1.3.3 Instrumentation

In keeping with the theme of system flexibility, the basic design of the system has emphasized standard instrumentation as much as possible. Where this is not possible every attempt should be made to use standard connections. This allows a new component to be installed with a minimum of confusion. Instrumentation lines have been designed in such a fashion that the addition or deletion of instrumentation can be performed quickly and reliably.

Air is being used for some of the instrumentation and it will be necessary to provide sufficient compressor capacity to allow for equipment changes. Due to the nature of the high magnetic and/or stray electric fields, special shielding requirements have been incorporated.

Keeping in mind the purpose and nature of the ETF, the instrumentation must be reliable and capable of performing in a sometimes hostile environment. All the above considerations have been taken into account during the design stages of the ETF.

For a detailed description of the instrumentation associated with this facility see Appendices A22, A23, A24.

3.1.3.4 System Checkout and Start Up

In the design stage of the ETF, the coordination of systems, their construction checkout, and initial start-up should be reviewed and integrated into the overall plant design. In the design for the various subsystems, simplicity of construction, installation and subsystem start-up should be emphasized. The design should be approached in such a fashion as to eliminate, or reduce to as great an extent as possible, the possibility of installing component pieces in the wrong fashion. This would be especially true of some of the more exotic equipment, such as the magnet and its cooling equipment. When the detailed design work has been completed, it should be a relatively simple matter to formulate construction checkout, start up and operating procedures for the various subsystems. The information provided from the detailed design work will allow specification of construction and operational parameters/guidelines which will enable performance of an orderly construction checkout, startup and operational sequence.

3.1.4 TEST PROGRAM

Following the post-construction checkout of the ETF, an extensive period of testing will begin. As shown in Figure 3.1-1, this testing will consist of three phases (listed below) requiring a number of years from initiation to completion.

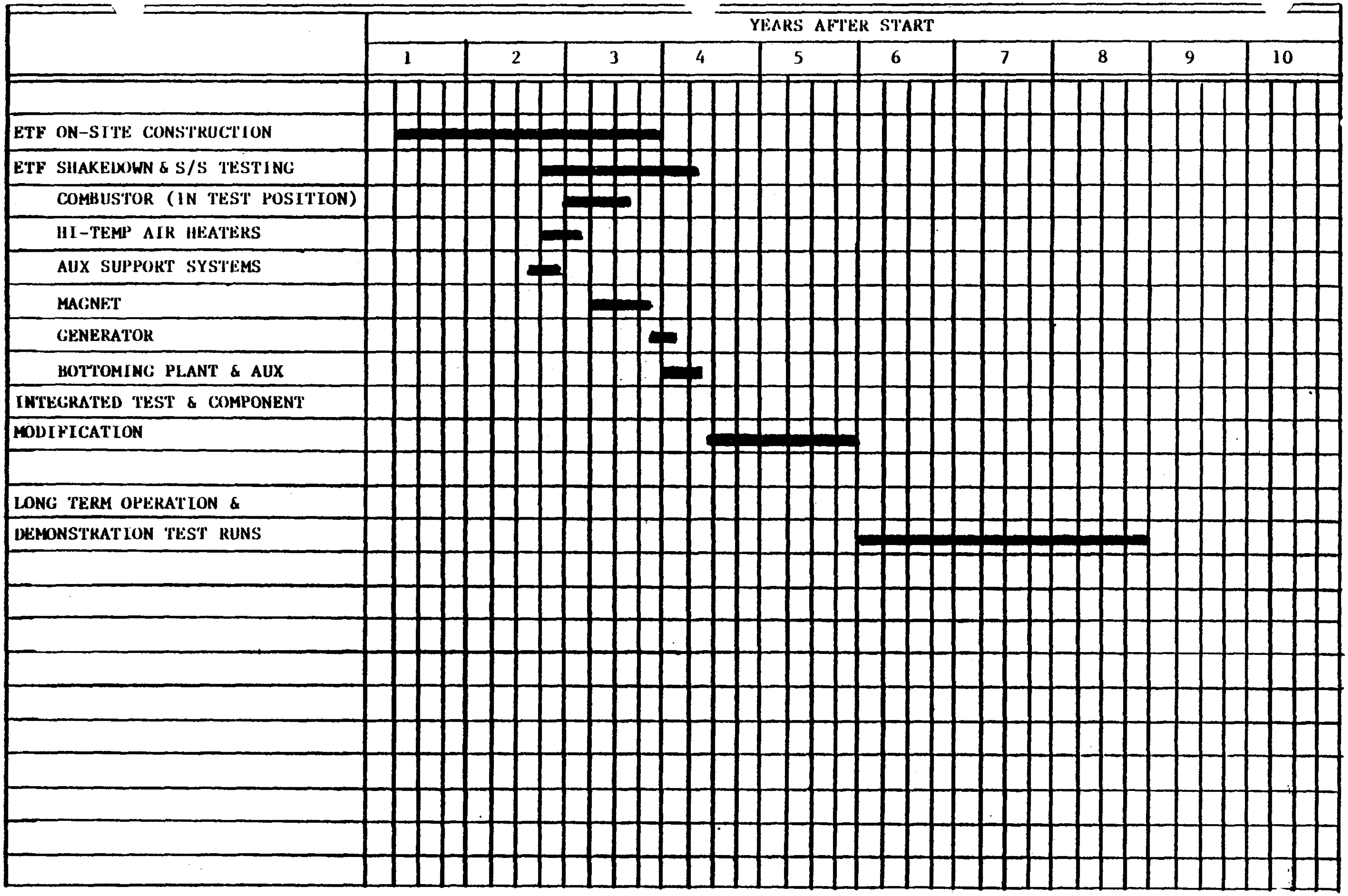

Figure 3.1-1. ETF Highlight Schedule - Tentative

1. ETF Shakedown and Subsystem Testing

2. Integrated Test and Component Modification

3. Long Term Operation and Demonstration Test Runs.

The ETF Shakedown and Subsystem Testing will consist of verifying the operability and readiness of the major components. This will include testing required by the component supplier as well as any additional testing desired by the facility management. When this phase of testing is complete, the ETF will be ready to move into the next phase of testing.

This next phase, the "Integrated Test and Component Modification" phase, will attempt to demonstrate the compatibility of the various subsystems and major components. Any system or component incompatibilities will be identified, analyzed and corrected in this phase of testing. At the completion of this phase, the final phase of testing will begin.

The "Long Term Operation and Demonstration Test Runs" phase of testing will consist of performing the 2000 hour continuous test run and any other long term testing required or desired by the facility management. The ultimate objective of the long term demonstration runs is to demonstrate that the MHD/steam combined cycle generation concept is "technology ready" for commercilization.

3.1.5 MAINTENANCE AND RECONFIGURATION

A major factor in determining the ability of the ETF to achieve the desired availability objectives will be the maintenance performed on the various subsystems.

A thorough review has been made of the operation of each piece of equipment to determine maintenance requirements and these have been integrated into an overall maintenance plan. The design of equipment has been reviewed and any items which have a major impact on system maintenance have been listed in Appendix A27. For example, the maintenance associated with the channel is directly affected by the expected life of the electrode material. Experience with present electrode materials indicates the probable need for frequent scheduled outages for repair and/or replacement of the electrode material. The present approach for reducing the amount of required downstime for these repairs is to have a "spare" channel. It is presently planned to shut down the MHD topping cycle three times a year for generator changeout. When it becomes necessary to perform this changeout, the entire system will enter a shutdown sequence. It will require approximately 12 hours for an orderly shutdown and cooldown at which time, the isolation damper will be activated and the diffuser section will be removed. When this has been completed, the boiler will enter a startup sequence and the removal of the generator will proceed. After the installation of the new generator, startup of the MHD cycle will begin and operation will continue until the next scheduled generator changeout. The generator which had been removed will be taken to the maintenance shop and refurbishment will begin.

In keeping with the philosophy of providing spare equipment to lessen the outage time required to effect repairs, it is planned to have on site a number of spare components, a listing of which can be found in Vol. III, Part 3, Paragraph

3.2. The spares and associated equipment have been reviewed and necessary storage space and utilities have been included.

The overall test plan (See Vol. III, Part 1) has been developed to incorporate time periods for general maintenance. Allowances have also been made for component modification and reconfiguration. It is expected that modification and reconfiguration will be performed in the early (first three years) stages of the test plan before long term test runs begin.

In the maintenance plan, special consideration has been given to limiting the total amount of downtime attributable to a forced outage. The results of this study indicate that the maximum manpower level is as described in the Organization and Staffing section of Test and Operating Philosophy. The approach taken to determine staffing requirements has been to view the operation of the facility as if it were a standard commercial power plant. This led to the maintenance manpower requirements. Some of the manpower could be deleted in later stages of plant life once the maintenance requirements have been reduced (by having experienced people familiar with equipment, reduction in the amount of modification, etc.).

3.1.6 ORGANIZATION AND STAFFING

In its combined role as a test facility and an operating power plant, the ETF will present a number of interfaces requiring cooperation between the test group and the local utility company.

3.1.6.1 Staffing

To determine an appropriate staffing level, it was necessary to view the facility as both an operating power plant and a test facility. Using this approach, an organizational outline was developed and then staff levels were determined. Once these tasks were completed, the results were compared with the manpower requirements of existing power plants and it was shown that a high correlation exists. On the strength of these results the definition of responsibilities continued as follows.

The staff is separated into two distinct groups. One group will be concerned solely with the performance of tests and evaluation of test results. The remaining group will initially be responsible for the daily operation and maintenance of the steam bottoming plant, and, as operational experience and confidence is gained, operation of the MHD topping cycle will gradually be transferred to the second group.

3.1.6.1.1 Test Group

The staffing of the test group will be affected as described below.

3.1.6.1.1.1 Automation

The system has been developed to allow for very flexible operation. Portions of the system will be under direct computer control but will be capable of manual control should situations develop which necessitate hand operation. The data collection system will be entirely automated and therefore will require an operations group with a background different from that of a standard power plant operator. The differing backgrounds of the facility operators necessitates physically separate work location. This has been addressed in the design of the facility and in the staffing requirements and responsibilities.

3.1.6.1.1.2 Type of Testing

The type and length of testing has been reviewed and the impact of these tests and their schedules have been included in the staffing requirements of the facility.

3.1.6.1.1.3 Duration of the Tests

A determination must be made as to the length of time a test will be run. It will be necessary to provide trained manpower during the actual performance of the test and this will affect the staffing requirements. Obviously a test designed to run for 24 hours a day, seven days a week for a period of three weeks will be different than those for a test designed to run for three hours on a one shot basis. The 2000 hour continuous run will require staffing for three shifts per day, seven days per week for approximately 12 weeks.

3.1.6.1.2 Plant Operators

The ETF steam bottoming plant in being designed as a commercial power plant capable of base load operation (for further description see Volume I Paragraph 1.7). By definition, this type of operation requires that the facility run 24 hours a day, seven days a week all year long (with the exception of scheduled maintenance outages). This type of operation will require a large number of knowledgeable, experienced power plant operators to ensure the safe operation of the facility.

To obtain the necessary number of qualified people there are two approaches;

1. Institute a training program to take people with basically no knowledge of power plant operations and teach them the techniques required to run such a facility. This approach would require either entering into an agreement with a utility to train the people at a power plant or building a "simulator" where this type of training could take place.

2. Enter into an agreement with a local utility for the supply of qualified people to operate the facility. This approach is probably the more desirable and practical. The facility must connect to the local utility grid, so it appears the legal complications would be greatly minimized by having the local utility operate the facility.

3.1.6.2 Organization

In keeping with the Staffing Requirements outlined above, the organizational structure of the ETF must be established. A possible structure would be similar to that shown in Figure 3.1-2. The organizational arrangement and responsibilities assume a three shift per day seven day per week operation for key functions. They are intended to be a guideline for an actual arrangement and further study will be required to determine the separation of the test group and the utility operating group required to fit the specific needs of the evolving Engineering Test Facility. A brief description of responsibilities follows:

3.1.6.2.1 ETF Station Superintendent

This individual would be responsible for the total operation of the facility. He will be the final on-site authority for any changes in plant configuration, component material or operating philosophy. He would be the interface between facility operations and the technical administration specifying experimental and operating goals.

3.1.6.2.1.1 Station Assistant Superintendent

Will be responsible for overseeing the operations of the Administrative and Support Group and the Operations and Testing Group; will report directly to the Station Superintendent.

3.1.6.2.2 Administration and Support

3.1.6.2.2.1 Manager

Responsible for overall coordination of activities relevant to the daily non-technical operation and upkeep of the facility. Will report directly to and make non-technical recommendations to the Station Superintendent. He will have a staff of approximately 17 people under him. Their responsibilities are as follows:

3.1.6.2.2.1.1 Purchasing. Issue purchase orders for material and equipment required for the operation of the facility; technical items will be purchased based on recommendations of the engineering staff.

3.1.6.2.2.1.2 Financial. Maintain records of purchases and any revenues; perform cost-benefit analyses of any proposed system changes; provide bookkeeping services for the entire facility.

3.1.6.2.2.1.3 Planning. Develop long range plans for operation of the facility; coordinate efforts between long range test objectives and the groups necessary to accomplish those goals.

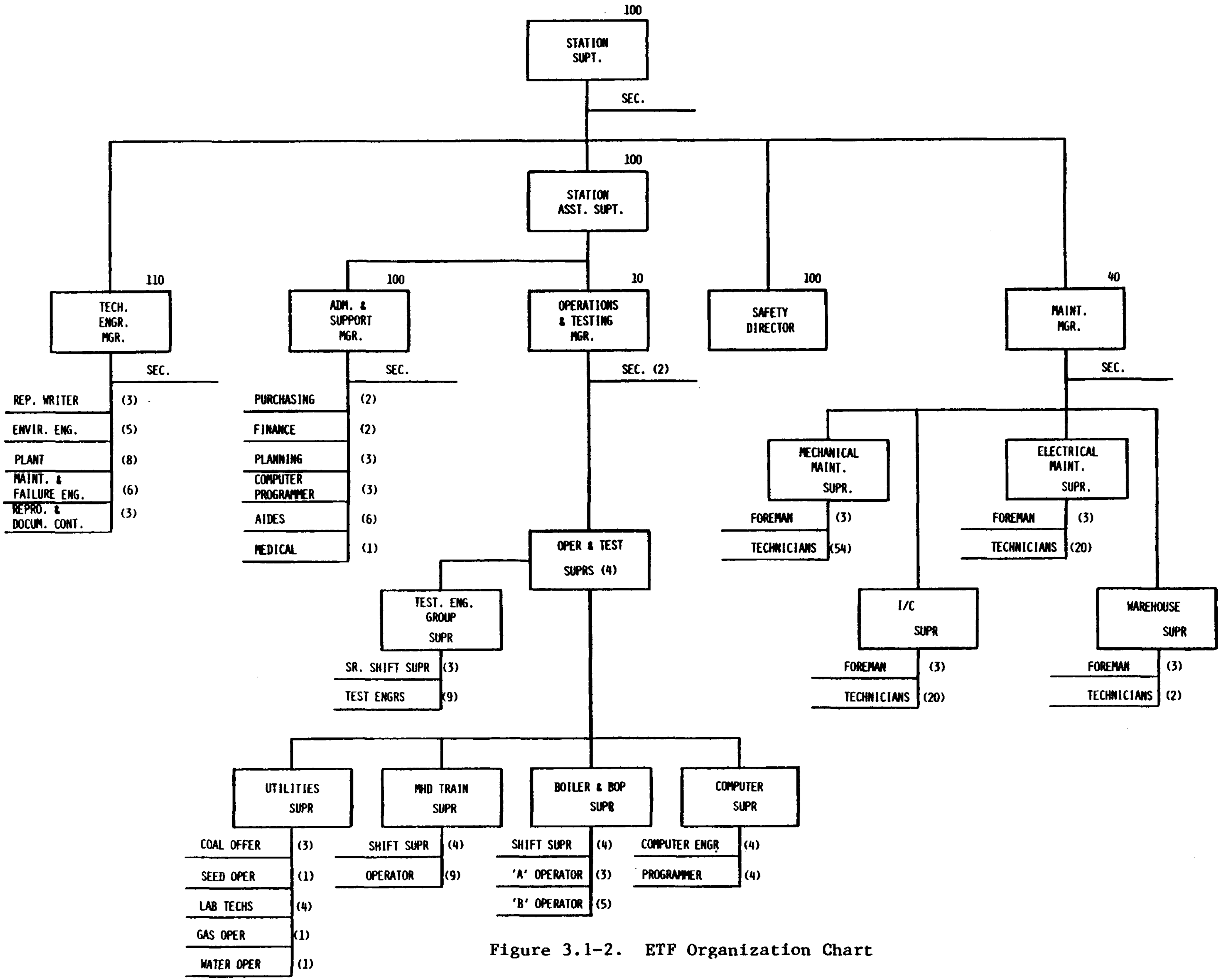

Figure 3.1-2. ETF Organization Chart

3.1.6.2.2.1.4 Computer Programmer. Provide access to the computer for other groups functioning under the Administration and Support section; undertake computer studies on long range system operation.

3.1.6.2.2.1.5 Aides. General purpose office workers responsible for filing, reproducing material, etc.

3.1.6.2.3 Maintenance

3.1.6.2.3.1 Manager

Responsible for total plant maintenance and reconfiguration; reports directly to the Station Superintendent; will make technical suggestions on ways to reduce system downtime due to maintenance; will support changes in system operation to reduce maintenance and will suggest equipment replacements; will have a staff of approximately 114 people broken down as follows:

3.1.6.2.3.1.1 Mechanical Maintenance Supervisor. Responsible for overseeing maintenance on all mechanical equipment such as pumps, fans, valves, etc.; this includes daily, preventive and outage maintenance and reconfiguration; reports directly to Manager.

3.1.6.2.3.1.1.1 Mechanical Maintenance Foreman. Responsible for overseeing maintenance on particular assignments given to him; will follow through on work started on previous shift but not yet completed; reports to Supervisor.

3.1.6.2.3.1.1.2 Mechanical Maintenance Technician. Responsible for actual performance of maintenance on assigned equipment; reports to Foreman.

3.1.6.2.3.1.2 Electrical Maintenance Supervisor. Responsible for overseeing maintenance on all electrical equipment such as generators, switchgear, etc.; this includes daily, preventive and outage maintenance and reconfiguration; reports directly to Manager.

3.1.6.2.3.1.2.1 Electrical Maintenance Foreman. Responsible for overseeing maintenance on particular assignments given to him; will follow through on work started on previous shift but not yet completed; reports to Supervisor.

3.1.6.2.3.1.2.2 Electrical Maintenance Technician. Responsible for actual performance of maintenance on assigned equipment; reports to Foreman.

3.1.6.2.3.1.3 Instrumentation and Control Supervisor. Responsible for overseeing maintenance on all instrumentation and control equipment such as temperature detectors, valve actuators, etc.; this includes daily, preventive and outage maintenance and reconfiguration; reports directly to Manager.

3.1.6.2.3.1.3.1 Instrumentation and Controls Foreman. Responsible for overseeing maintenance on particular assignments given to him; will follow through on work started on previous shift but not yet completed; reports to Supervisor.

3.1.6.2.3.1.3.2 Instrumentation and Controls Technician. Responsible for actual performance of maintenance on assigned equipment; reports to Foreman.

3.1.6.2.3.1.4 Warehousing Supervisor. Responsible for maintaining an adequate supply of spare parts and required maintenance items; will require close work with other supervisors and with purchasing; reports directly to Manager.

3.1.6.2.3.1.4.1 Warehousing Technican. Responsible for maintaining an inventory of tools and material and informing Supervisor of need to reorder material; reports directly to Supervisor.

3.1.6.2.4 Operations

3.1.6.2.4.1 Operation and Testing Manager

Responsible for overall system operation; reports to the Assistant Station Superintendent; will make technical recommendations on ways to increase efficiency of plant and how to improve operating techniques; will have a staff of approximately 71 people broken down as follows:

3.1.6.2.4.1.1 Operation and Test Supervisor. Will be responsible for coordination of the daily test and operation activities, will make technical recommendations to the Operation and Testing Manager; will have authority of determining priorities of plant activities.

3.1.6.2.4.1.2 Test Supervisor. Will develop testing to be performed on system; this includes scheduling of time, sequence of tests, etc.; will coordinate activities of plant to allow orderly performance of test sequence; will report directly to Manager.

3.1.6.2.4.1.2.1 Senior Shift Supervisor. Will oversee daily test activity; make initial evaluation of test data to determine its validity; will coordinate daily performance of system components; reports directly to Testing Supervisor.

3.1.6.2.4.1.2.2 Test Engineers. Provide coverage of test performance, collection of test data and detailed analysis and evaluation of test data; report directly to Senior Shift Supervisor.

3.1.6.2.4.1.3 MHD Power Train Supervisor. Will be responsible for overall MHD train performance; this includes combustor, magnet, channel and diffuser and high temperature air heaters; will make technical recommendation on ways to improve the performance/efficiency of the MHD power train; will interface with other operating sections of the total system; will report directly to Operations and Testing Supervisor.

3.1.6.2.4.1.3.1 Shift Supervisor. Responsible for the daily performance of the MHD power train; will make recommendations on operation of system; will report directly to MHD Power Train Supervisor.

3.1.6.2.4.1.3.2 Operators. Responsible for daily operation of MHD Power train; will include adjusting valves, varying parameters (under supervision), etc.; will report directly to MHD Shift Supervisor.

3.1.6.2.4.1.4 Boiler/Balance of Plant Supervisor. Will be responsible for overall Boiler/BOP performance; this includes boiler, stack emissions, etc.; will make technical recommendations on ways to improve the performance/efficiency of the boiler/BOP; will report directly to Operations and Testing Supervisor.

3.1.6.2.4.1.4.1 Shift Supervisor. Responsible for daily performance of the Boiler/BOP; will make recommendations on operation of system; will report directly to Boiler/BOP Supervisor.

3.1.6.2.4.1.4.2 Operators (A & B License). Responsible for daily operation of Boiler/BOP; will include valve adjustment, varying parameters (under supervision), etc.; will report directly to the Boiler/BOP Shift Supervisor.

3.1.6.2.4.1.5 Computer Supervisor. Will be responsible for varying inputs to the computer and redirecting the data acquisition parameters of the control system; will determine feasibility of desired data acquisition for new tests and will oversee programming for increased system efficiency; will report directly to Operations and Testing Supervisor.

3.1.6.2.4.1.5.1 Computer Engineer. Will be responsible for daily computer operation as it pertains to plant operation and testing; will be responsible for implementing program changes as directed by the Computer Supervisor; will report directly to Computer Supervisor.

3.1.6.2.4.1.5.2 Programmer. Will be responsible for actual programming of changes and operation of the computer terminal (under supervision); will report directly to Computer Engineer.

3.1.6.2.4.1.6 Utilities Supervisor. Will be responsible for maintaining supplies of coal, seed, water, etc.; will be responsible for overseeing lab. tests of various substances; will report directly to the Operations and Testing Supervisor.

3.1.6.2.4.1.6.1 Coal Operator. Will be responsible for unloading and stacking coal; also responsible for maintaining coal stockpile and coal moving equipment; will report directly to Utilities Supervisor.

3.1.6.2.4.1.6.2 Seed Operator. Will be responsible for unloading and storing seed and maintaining equipment; will report directly to Utilities Supervisor.

3.1.6.2.5 Technical Engineering Manager. Will be responsible for overseeing all plant engineering functions, this includes preliminary design, modification review; will make recommendations to improve the reliability and operation of the facility; will report directly to the Station Superintendent.

3.1.6.2.5.1 Report Writer. Will be responsible for preparing reports for distribution; will take input from all plant function and will compile this information into the necessary report structures. Will report to the Technical Engineering Manager.

3.1.6.2.5.2 Environmental Engineer

Will be responsible for ensuring compliance with all Federal, State and local environmental regulations; will make recommendations to improve plant performance; will report to the Technical Engineering Manager.

3.1.6.2.5.3 Plant Engineer

Will be responsible for maintaining the plant in an operating condition; will review operational logs and determine necessary changes to plant operations; will report to the Technical Engineering Manager.

3.1.6.2.5.4 Maintenance and Failure Engineer

Will be responsible for reviewing maintenance records and making recommendations to improve maintenance of the plant; will also be responsible for reviewing failure records and performing failure analysis to determine problems areas; will make recommendations to improve availability and oepration of the facility; will report to the Technical Engineering Manager.

3.1.6.2.5.5 Reproduction and Document Control

Will be responsible for maintaining engineering files and drawing up to date; will be responsible for following changes/modifications from initiation to completion and ensuring those changes are reported to the proper organization; will report to the Technical Engineering Manager.

3.1.6.2.6 Safety Director

Will be responsible for ensuring the plant is operating in a safe fashion; will be responsible for guaranteeing compliance with Federal, State and local safety regulations. Will report directly to the Station Superintendent.

The organization as outlined above will require further refinement and definition when it is determined exactly how large a role the local utility will be willing to take. Key positions must be evaluated to determine the best group (Testing or Operations) to hold those positions. Areas of combined responsibility/authority must be defined and operational/testing priorities must be established.

3.1.7 UTILITY INTERFACE CONSIDERATIONS

The interconnection to the utility power grid raises many questions in the operation of the ETF. It will be necessary to coordinate the operation and testing of the facility with the utility. Loading characteristics of the ETF require siting of the plant in a location where the grid is stiff enough to accept load dumping from the ETF with acceptable voltage transients in the local power distribution system. Other areas of interest are:

3.1.7.1 Communication With Central Load Dispatcher

As a base load unit, it will be necessary to establish and maintain communications with the utility central load dispatcher. This is required by the utility to optimize the use of the units in the system and to ensure that power requirements of the grid are met as quickly and effectively as possible. Due to the operating characteristics of the ETF, it will be necessary to notify the load dispatcher when testing of the MHD system is about to begin. This will allow the dispatcher to place units on stand-by for use in the event the ETF trips due to a testing induced transient.

3.1.7.2 Loading Schedule

As mentioned earlier, the loading characteristics of the MHD generator will require close coordination with the local utility. Since the MHD generator cannot be brought on line in a short period of time, it may be desirable to examine the load characteristics of the utility network and then develop an operating schedule which would allow an orderly and predictable loading of the MHD generator. This is peculiar to the ETF and not to an eventual base load MHD plant.

3.1.7.3 Value of Power Delivered

While the ETF is operating, power being produced will be delivered to the utility network for its usage. It will be necessary to determine a fair value for the amount of power delivered to the grid. A system must be devised to keep track of power used (for startup, etc.) and power delivered to the grid. A rate schedule must be developed and a method of crediting must be established. This schedule will be a function of the involvement of the utility in the operation of the facility and its development is beyond the scope of this report.

3.2 MODES OF OPERATION

The ultimate objective of the ETF is to demonstrate that MHD/Steam combined cycle power generation is "technology ready" for commercialization. In achieving this ultimate objective, test operations in the ETF will be divided into four distinct phases. The first phase is post installation checkout, which begins when the installation of the majority of the subsystems is complete.

The second phase is shakedown and subsystem testing which can be started once post installation checkout of the necessary subsystems is complete. Phase three is integrated system testing and component modification which can commence once all subsystems have been brought to an acceptable level of operational readiness. Phase four is the long term operation of the ETF and demonstration test runs to demonstrate the overall efficiency, reliability and regulatory compliance of the MHD/Steam combined cycle power generating plant. These four phases of test operation are discussed further below. Also, a test plan has been developed and is included in Vol. III, Part 3.

In order to enhance the utilization of the ETF a number of features that will provide a high degree of operational flexibility are desirable. These are:

1. The capability to operate in a 'steam bottoming only' mode. This allows operation of the facility during periods of MHD cycle outage. To accomplish this, the radiant boiler has been provided with a separate burner system, coal preparation system and necessary balance of plant equipment. The ability to separately operate the radiant boiler allows shorter durations between tests (by maintaining MHD pressures and temperature), improves overall generation plant availability and provides less reliance on the utility grid for startup power.

2. Feedwater bypass piping and valving to permit complete isolation of any major subsystem and the capability of completely isolating the MHD cycle from the steam bottoming cycle. The valving arrangement allows varying feedwater flow to determine the optimum operating conditions for each component.

3. Turndown ratio of 3:1 in all major components. This will provide a means of greatly varying parameters either singly or in combination to determine the optimum operating characteristics of the MHD/Steam power plant.

4. The capability to test the combustor system without flowing plasma through the MHD generator and the downstream components. This has been achieved by providing a combustor test position. This test position is arranged in a way that allows utilization of the HTAH, and enables testing at full operating conditions while minimizing the amount of time required for disassembly and reinstallation in the ultimate combustor location.

   This test position has the advantages of allowing full flow combustor testing to take place before checkout and cooldown of the magnet, thus minimizing the duration of the second phase of test operations. This test position could be utilized in subsequent combustor development testing if the need were to arise.

3.2.1 POST INSTALLATION CHECKOUT

Upon completion of the installation of a component/subsystem, it will be provided with the necessary conditions (power, water, etc.) to allow operation to the extent possible. The component/subsystem will then be tested. The purpose of this test will be to verify the proper installation of the equipment and its overall operability. Some initial performance data will be recorded. The component will then be placed in a storage condition.

A typical checkout procedure or sequence would include the following:

1. Inspection

   An inspection of the equipment serves two purposes: 1) it allows the test and operations people to familiarize themselves with the facility, and 2) it verifies the condition of the equipment. The inspection phase would normally overlap equipment installation activity and continue until all installation is completed.

2. Cleaning

   As installation approaches completion, it will be necessary to begin cleaning the system. This would be the removal of all debris from the system such as scaffolding in the boiler, large pieces of trash from feedlines, etc. In addition, at this time, any oil or gas lines should be cleaned (steam cleaning is recommended). Also the boiler, steam, oil and boiler feed system must be cleaned.

   Waterside cleanliness is extremely important. Waterside impurities can lead to furnace tube failures. They can also lead to carry-over of solids in the steam which would result in superheater tube failure or turbine blade deposits. To remove the impurities (grease, paint, etc.) from the system a technique known as "boilout" is used. A solution (normally a caustic and phosphate combination) is heated and circulated through the system. It is necessary that the feedwater sytem also be cleaned in this fashion.

   While this cleaning will remove the oil, grease, etc., it will not remove any corrosion products. These products, usually in the form of iron oxides and scale, must be removed by acid cleaning, normally after some initial operation of the feedwater system.

3. Hydrostatic Test

   This normally takes place after cleaning but before any refractory or casings have been installed. At the present time the American Society of Mechanical Engineers (ASME) requires a hydrostatic test at 1.5 times the design pressure for all pressure vessels and piping. The pressure is applied and maintained for a sufficient length of time to detect any leaks in the system. Normally, after the leaks have been found and repaired the test takes place again. This continues until all the leaks have been detected and repaired.

4. Instrumentation and Controls Calibration

It is essential that, for the safe operation of this facility, the instrumentation and controls must be installed, calibrated and operational prior to startup of the facility.

5. Equipment Energization

All equipment must have been checked out and energized. This equipment would include fans, pumps, fuel equipment, etc. Power and control wiring must be checked and motors 'bumped' to check for correct rotation. Alignment between driver and driver equipment must be checked, etc.

6. Steam Blowing

This is normally the last step in the boiler section checkout. The steam lines are usually cleaned by steam blowing of the system. This is the most effective method since the high velocity and the thermal shock combine to remove most of the debris and scale.

The procedure includes placing bypass piping around the turbine and venting it to atmosphere then raising steam in the boiler and allowing it to discharge to atmosphere. This is done intermittently until it is determined that the lines are clean.

3.2.2 SHAKEDOWN AND SUBSYSTEM TESTING

At the completion of the Post Installation Checkout, the second phase of testing will begin. This phase will consist of taking each major subsystem and subjecting it to a series of tests to determine the operational readiness of the subsystem and its supporting auxiliaries. The exact sequence of testing will be dependent upon the order in which construction of these subsystems/components is completed. The test sequences should be viewed as independent intervals of testing and may take place at any point in this testing phase.

Before shakedown testing can proceed, certain "balance of plant" components/ subsystems must be operable or the capability must exist to provide the services those components/subsystems would have provided. Fuel unloading facilities should be complete, water treatment system should be operable, utilities (air, electricity, etc.) should be available, controls and instrumentation should be available and wired (either permanently or temporarily) to a data collection system. Once it has been determined that these services are available for a particular subsystem, shakedown and subsystem testing for that subsystem may begin.

3.2.3 INTEGRATED SYSTEM TESTING AND COMPONENT MODIFICATIONS

Once the subsystem shakedown testing has been completed, the next phase of testing will be Integrated System Testing and Component Modification. The basic purpose of this phase will be to verify the operability of the facility as a whole unit. Secondary goals will be the establishment of definitive operating procedures, examination of operating characteristics of the facility and development of a system test plan to allow optimization of plant performance prior to entering the long term operation and demonstration testing phase.

3.2.2.1 Startup Operations

3.2.3.1.1 Cold Startup

Facility startup can be defined as going from "cold" (materials at ambient or slightly higher temperatures) conditions to full load (full mass flow and flame temperature). For simplicity, it is assumed that the following initial conditions exist:

1. High Temperature Air Heaters

   a. Refractory has been cured.

   b. Heaters are in "hot standby" condition without any supplemental firing taking place (refractory temperature < 1500 F).

2. Magnet and Channel

   a. Magnet has been cooled to its proper operating temperature.

   b. Magnet has been charged.

   c. Cooling water flow has been established for the combustor nozzle and channel.

   d. During startup and cooldown operation, care must be taken to ensure no greater than a 2.5 C/min temperature change of the electrodes.

3. Balance of Plant

   a. Sufficient quantity of high quality water is available.

   b. All necessary controls and instruments have been calibrated and are operational.

   c. Power (electrical, pneumatic, etc.) is available.

   d. Pressurized feed systems (coal and seed) fully charged and ready for operation.

   e. Sufficient reserves of fuel (coal and oil) are available for the duration of the particular test being conducted.

4. General

   a. It is assumed total system has been checked out and declared operational.

When the above prerequisites have been met, the startup of the facility can begin. Since the radiant boiler has been designed with the ability to operate independent of the MHD cycle, it would seem logical to use this feature so as to lessen dependence on external power for startup and operation.

Therefore, using the capability of the boiler to attain full load with coal firing only, the startup would proceed in the following manner:

1. Inspect the system to assure it is in a condition which allows the startup to proceed. Areas to be checked would be valve positions, openings, electrical/pneumatic hookups, etc. When the system has been given a gross checkout, proceed to startup.

2. Fill the boiler feed subsystem and boiler with high quality feedwater. As the filling proceeds it will be necessary to vent the system to reduce the possibility of oxygen corrosion and assure that all boiler tubes are filled with water. It will be required to keep the metal/water temperature differential to approximately 100 F. (See Dwg. P3-2 in Vol. II, Part 5).

3. Purge the radiant boiler and downstream components to remove any possible accumulations of combustible gas or dust in the system.

4. As the system is being purged, circulation of water in the boiler can commence. Due to the nature of the supercritical once-through boiler, it is necessary to maintain a minimum flow of water in the furnace whenever firing is taking place. To enable this minimum flow to be maintained, all once-through units are equipped with a bypass system. The bypass system is usually sized for 25% flow.

5. During water circulation, the first major function to be performed is cleanup or flush. Feedwater flow rate is established at 15 percent of full load flow by the feedwater flow control. The feedwater flow will go through the low pressure economizer, combustor, high pressure economizer, diffuser and enter the remaining boiler sections. The feedwater flows through the pressure reducing valve and enters the Integral Separator(s). From the I.S., the feedwater is sent to the condenser and then to the water treatment equipment (usually a full flow condensate polisher) which is designed to cleanse the feedwater to the purity requirements of the system. (See Drawings P3-1, P3-2, in Vol. II, Part 5).

6. Circulation is continued until the following condition is achieved:

   Cation Conductivity - less than 1 micromho (measured after passing through a cation exchanger). This corresponds to approximately 90 ppb dissolved solids.

	ppb (maximum)
Dissolved Oxygen	10
Silica	30
Iron (as Fe)	50
Copper (as Cu)	20
pH @ 25 C for all stainless steel feedwater heaters	9.5 - 9.7

During initial circulation, the turbine is sealed, the condenser is under vacuum and the entrance of oxygen into the system must be limited.

Depending on the condition of the system prior to flushing it may take up to 8 hours to achieve the conditions described above.

7. Once the desired feedwater quality is achieved, firing of the burners in the boiler section can begin. This phase is typically known as furnace warming or final startup cleaning. Normally, the burners used for startup are oil fired and are used only long enough to generate enough heat, from the air preheater, to begin drying and transporting coal. When enough coal can be delivered, coal firing of the system begins and will continue to full load. Initially the burners are fired at approximately 10 to 15 percent of the full load firing rate. The firing rate is held to a level which does not allow the system to go above 500 F (feedwater). (See Drawing P3-1, P3-2, Vol. II, Part 5). The following feedwater quality requirements must be satisified before going to higher temperatures:

	ppb (maximum)
Total Dissolved Solids	50
Dissolved Oxygen	5
Silica	20
Iron (as Fe)	7
Copper (as Cu)	5
pH @ 25 C (all stainless steel feedwater heaters)	9.5 - 9.7

As the feedwater and steam generating subsystem is going through the final cleanup phase, the fluid traveling through the system is heating up (but not exceeding 500 F). The fluid on the upstream side of the pressure reducing valves is at approximately 3550 psi. As it enters the Integral Separators, a portion of the fluid will flash to steam. This steam is sent to the superheater sections for finishing and then is routed to the turbine seals and the deaerator. (See Drawing P3-1 Vol. II, Part 5).

Once enough steam has been supplied to the seals and deaerators, excess steam (of sufficient quality) can be used to begin warming the turbine.

The fluid which does not flash to steam is routed to the feedwater heaters, then to the hotwell, demineralizer, deaerators, and then into the system through the economizer.

8. When the final feedwater quality conditions have been met and the system is being supplied with sufficient deaerated water, the turbine loading can begin. Initially, the firing rate will increase slightly and the turbine, assuming it has been warmed properly, will accelerate. When the turbine reaches synchronous speed, it will be loaded initially and gradually raised to approximately 7 percent load. This is done by utilizing the turbine stop valve bypass with throttle pressure being held to 1000 psi. As the turbine increases loading, the amount of steam exiting the Integral Separators is increasing and the amount of fluid is decreasing.

9. After a hold at 7 percent load for system checks, the loading of the turbine continues up to 25 percent. Throttle pressure is ramped from 1000 psi to 2400 psi by control of the firing rate. Another system hold takes place at 25 percent load for further systems checks. At approximately 25 percent load, the bypass system is removed from the boiler circuitry and normal feedwater flow begins.

10. The turbine is now capable of being ramped from 25 percent to 100 percent full load. In the event loading drops to 25 percent or less it will be necessary to use the bypass system again to ensure adequate feedwater flow to the system.

11. As the steam turbine approaches 25 percent load, the HTAH will commence final heatup by starting the compressor which controls combustion and atomizing air to the burners in the HTAH.

12. Initiate heatup/blowdown cycle in HTAH* and start one main compressor. Establish minimum flow conditions through the gasifier while delivering heated air to the second stage combustor and hot MHD flow train. This heated air will replace the preheated combustion air required in the radiant boiler until the MHD combustion system becomes fully operational at reduced flow. Commence air injection into the first stage combustor to purge gasifier of any accumulated combustible material and warm up system (not to exceed 125 F/hr until materials reach 400 F). (See dwg. P3-5 Vol. II, Part 5).

13. Start compressors pressurizing the solids injection systems and CAFB gasifier vessel.

14. When pressurization is complete, start bed material injection to CAFB gasifier.

15. As gasifier continues to heat up, place fines reinjection and spent solids systems in service.

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*Depending on the length of time since the last hot operation, it may be necessary or desirable to continuously fire the HTAH units to a significantly higher temperature before cycling with blowdown air. This will require extensive thermal analysis resulting in optimized thermal paths, stored in the operating computer system, which will allow least time to full operation for the HTAH subsystem and the hot flow train in general.

16. Start second compressor and commence injection of coal into gasifier.

17. Increase preheated air flow through the first and second stage combustors and injection of gasifier product gas into second stage combustor. Start seed injection in second stage combustor as required for MHD enthalpy extraction to keep inlet conditions to the radiant boiler within design limits.

18. As the MHD generator is loaded, start remaining compressor and bring MHD system to design operating point. Coal burners in the radiant boiler will cease firing as the MHD system reaches design operating conditions.

This provides a method with the least amount of deviation from a normal power plant startup. It allows close control of system conditions, allows for rapid shutdown in the event of any problems and promises the least amount of possible damage to the total system.

This startup mode would be used whenever both the MHD and steam cycles have been out of service for a period of time longer than one day.

Two other startup modes exist. One of these is a cold start of the radiant boiler alone. This would be identical to the startup sequence described above up to the point of starting the MHD system. At this point the boiler would continue upward in loading until 100 percent loading is achieved. This mode of operation will present no significant changes to currently accepted practices in boiler operation.

The remaining mode is that in which the boiler is already in operation and the MHD train is to be brought on line.

There are two cases which can be addressed under this heading:

1. MHD train is cold (ambient)

2. MHD train is hot (channel ceramic $\geq$ 2000 F). Using this temperature, it will take approximately one hour to raise the ceramics to proper operating temperature and still maintain the 2.5 C/min rate of temperature rise.

Both cases will be examined and separate startup procedures will be recommended.

Case 1 - MHD Train is Cold (Ambient)

Initial conditions are:

1. Radiant Boiler operating at 100% rated steam flow.

2. Feedwater flow being bypassed around MHD train.

3. MHD train feedwater system is drained and under nitrogen blanket (to reduce corrosion).

4. MHD train isolation damper closed.

5. HTAH at a refractory temperature of < 1500 F.

6. Magnet cryogenic system is operable.

7. Magnet is cooled to operating temperature.

8. Magnet has <u>not</u> been charged.

9. Coal and seed injection systems are operable and filled.

10. Sufficient quantity of high quality boiler feedwater avilable for make up.

11. Inverters are operable and in standby condition.

When it has been determined that the MHD train is to be brought on-line, a sequence of events must be initiated to ensure the safe operation of the facility and plant personnel. Some of these steps will involve lengthy blocks of time but are necessary if the MHD train is to achieve reliable and dependable operation. Taking this into consideration, the startup may proceed as follows:

1. Very slowly begin to fill and vent MHD train with high quality boiler feedwater. It will be necessary to increase feedwater flow to accommodate this step. It may be desirable to direct the flow from the MHD train through a bypass system to the feedwater cleanup system rather than directly to the boiler. This would ensure high quality water throughout the system and would only be necessary for a short period of time. (See Drawing P3-2 Vol. II, Part 5).
2. Once the MHD train has been filled, vented and brought to pressure, and it is established that high water cleanliness is being maintained, the bypass to this feedwater cleanup system may be closed and MHD train feedwater flow integrated into the boiler train.

3. To minimize the control problems associated with the addition of the MHD train, it will be necessary to reduce the boiler from 100% load to some lower load (preferably 50-60% full load). This will allow better control of superheat and reheat steam temperatures. As the boiler load is being gradually reduced, channel coolant flow is to be initiated (this is to help maintain the 2.5 C/min temperature limitations on the channel ceramics). Open isolation valve at entrance of Spoiler.

4. Initiate heatup/blowdown cycle in HTAH and start one main compressor. Establish minimum flow conditions through the gasifier while delivering heated air to the second stage combustor and hot MHD flow train. This heated air will replace some of the bottoming-only furnace combustion air. Commence air injection into the first stage combustor to purge gasifier of any accumulated combustible material and warm up system (not to exceed 125 F/hr until materials reach 400 F). (See Drawing P3-5 Vol. II, Part 5).

5. Start compressors pressurizing the solids injection system and CAFB gasifier.

6. When pressurization of solids injection vessels is complete, start bed material injection to CAFB gasifier.

7. As gasifier continues to heat up, place fines reinjection and spent solids systems in service.

8. Start second compressor and commence injection of coal into gasifier and preheated air to the second stage combustor.

9. Charge magnet.

10. Increase preheated air flow though the first and second stage combustors and commence injection of gasifier product gas into second stage combustor. Start seed injection in second stage combustor as required for MHD enthalpy extraction to keep inlet conditions at the radiant boiler within design limits.

11. Activate the inverter startup system. It is currently anticipated that the startup of the generator will have begun by drawing the load to the bank of emergency dump resistors. The load continues to be dumped to the resistors until a generator loading of approximately 10-15 percent is reached. At that time, the loading will be switched to the inverter system and connection to the utility grid will take place.

12. At this time the boiler firing should have ceased and the boiler should be operating at 100% load.

13. The MHD/Radiant Boiler System is now at 100% system load and testing or operation may proceed.

<u>Case 2 - MHD Train is Hot (~2000 F)</u>

Initial conditions are:

1. Radiant Boiler operating at 100% rated steam flow.

2. Feedwater flow is going through entire system (both MHD and RB).

3. MHD train isolation dampers are closed.

4. HTAH at operating temperatures.

5. Magnet is being maintained at operating temperatures.

6. Magnet is charged.

7. Coal and seed injection systems are operable and filled.

8. Inverters are operable and in standby condition.

The conditions described in Case 2 could exist for a number of reasons (loss of compressor, loss of coal feed, plugging of coal lines, etc.) and therefore should be addressed. In a situation such as this, the startup would proceed as follows:

1. If the MHD system was down due to some malfunction or operator error, correct the problem and begin startup. Since the bulk of the requirements have already been established, it will be a fairly simple matter to proceed.

2. Reduce boiler load to approximately 50-60%.

3. Start a compressor to establish flow through MHD systems and begin HTAH heatup-blowdown cycle. Establish air and bed material flow to gasifier. (See Drawing P3-5 Vol. II, Part 5).

4. Open isolation valve (damper) and continue purge of gasifier.

5. When isolation valves (dampers) are fully opened, start an additional compressor. Bring compressors to 85% load. Maintain boiler at 50-60% load. Commence coal injection to gasifier.

6. Gradually increase compressors to 100% load. Begin to increase boiler loading. Begin product gas injection to second stage combustor.

7. Start inverter charging and let boiler load gradually rise to 100% load.

8. Commence seed injection, increase combustor firing rate and start MHD generator loading. Maintain boiler at 100%.

9. Increase MHD generator loading to 100%, maintain boiler loading at 100%.

At the conclusion of any of the above modes of startup, the system (combined MHD/steam bottoming) will be operating at or near full load, depending on grid power requirement.

3.2.3.2 Emergency Shutdown

An emergency shutdown can be defined as any rapid load reduction in the system due to a major transient. A failure modes and effects tree has been developed for the ETF and is included in Vol. IV.

A major transient leading to an immediate shutdown of the system would initiate the following sequence of events.

1. Upon receipt of a signal indicating a serious out-of-limits situation, fuel input will immediately be diverted from the combustors. The gasifier bed will be allowed to slump and any further gas coming off the bed will be vented to a flare stack (See Vol. II, Part 5, Drawing P3-5).

2. Feedwater flow will continue to ensure an orderly shutdown unless the cause for emergency shut-down has been a coolant tube rupture in which case appropriate by-passes will be activated.

3. Inverters will be separated from the grid (until firing can cease, any power extracted from the channel will be diverted to a dump resistor bank. It is expected that this condition shall not exist for greater than 30 seconds). The steam turbine-generator will be tripped and steam flow dumped to the condenser. (See Drawing X01-77F-E150 Vol. II, Part 5).

4. Emergency power supplies will be activated to provide the necessary power to operate critical components during the emergency shutdown sequence.

5. The superconducting magnet will discharge its energy, if required.

When it has been established that the initial emergency condition has not generated any additional safety hazards, the shutdown procedure will continue until the system is entirely cooled down. At that time, an evaluation of the transient and the conditions leading to it, will be performed. Repairs, if necessary, will be started and, when completed, startup of the facility will begin in accordance with the procedures outlined in Paragraph 3.2.3. A listing of the more serious transients leading to an immediate shutdown is shown below.

3.2.3.2.1 Loss of Coal

If a loss of fuel feed occurs, the system will begin an orderly shutdown procedure. Preheated air would continue to be passed through the combustor and gasifier to allow purging of any unburned combustible material (to avoid explosion danger), feedwater flow would continue until material temperatures were low enough to avoid thermal stress failures, high temperature air heater operation would then be put in a hot standby mode following combustion air shutdown.

As soon as the cause of the fuel trip is determined, a system restart can be initiated, provided the cause of the trip is not a major problem. If a major problem does exist, cooldown of the unit would proceed on an orderly basis.

3.2.3.2.2 Loss of Bed Material

The loss of bed material feed would necessitate an orderly shutdown of the MHD system. Since bed material injection is used to control the gasifier product gas temperature, loss of bed material could result in a sharp increase in bed temperature and product gas temperature. Therefore it will be necessary to cease fuel feed, cease spent solids removal, continue air flow and feedwater flow and enter an orderly shutdown sequence.

3.2.3.2.3 Loss of Seed

In the event of a complete loss of seed injection, the conductivity of the combustion products would be reduced and power extraction from the channel will cease. Flow in the MHD channel will then be supersonic, with transition back to subsonic flow occurring in the diffuser by means of a series of oblique shock waves.

This is one of the most serious operating problems. The temperature of the combustion products exiting the channel will increase to the full inlet stagnation value requiring immediate combustor shutdown, continued HTAH purging operation and feedwater flow.

After the cause of the loss of seed injection has been determined and an analysis of its impact on system operation has been completed, the system operation can be reinstated, the unit could run in the "steam bottoming only" mode, or the plant could continue in an orderly shutdown procedure.

3.2.3.2.4 Loss of Combustion Air

The loss of combustion air represents another serious condition that could occur, since a serious explosion hazard could develop. Should insufficient air exist for combustion of the fuel, the fuel would tend to collect in various passages throughout the system. If sufficient purge is not provided before combustion air is regained, a premature ignition of the system could cause downstream explosions. For this reason transport air for fuel and seed must be maintained for sufficient time to purge the lines in the event of any shutdown. This will require a backup air or nitrogen supply sized for the worst case.

The desired operation during this transient would be to divert fuel immediately upon loss of combustion air, continue purging the system and maintain feedwater flow. When fuel feed can be re-established, firing may be re-started using extreme caution.

3.2.3.2.5 Magnet Failure

In the event of a magnet failure (loss of magnetic field), the power extracted from the channel would drop off rapidly and the hot combustion products entering the downstream section of the system could thermally overload diffuser/boiler system components.

To prevent serious damage from occurring to the downstream components, the magnet conditions will be monitored continuously, (for a complete listing of parameters measured and the controls and instrumentation to be used see Vol. IV, Appendix A22). One of the most likely causes of magnet failure would be the occurrence of a "normal" zone within the magnet.

A "normal" zone is detected within the magnet by voltage taps on the winding. As the "normal" zone propogates, the local IR drop increases. This gives an indication of the size of the "normal" zone. When this condition is detected by the magnet control system a series of events takes place.

First, no immediate action is taken by the control system since the occurrence of normal zone is a common situation. However, if after several seconds, the normal zone does not automatically recede, a partial discharge will occur. If the normal zone continues to propogate, the entire magnet will be quenched. The procedure for this quench is to suddenly evacuate the helium. This forces the entire magnet to go normal and protects the magnet. The decision logic for the above scenario will take less than thirty seconds.

Whenever the magnet is forced to go normal for any reason (such as described above, or loss of power, etc.) the procedure is essentially the same. Upon receipt of signal, the entire helium inventory is dumped. This is done to ensure that the coil is "normal" throughout the winding and avoids burnouts. The mechanism for release of the helium will be primarily through an electromatic relief valve with a rupture disc as backup. The helium expulsion from the system will terminate automatically as the volume depletes itself. For economic reasons, the vaporized helium will be collected in a gas bag.

Concurrent with the dumping of the helium, the energy stored in the magnet will be absorbed by the magnet structure and an external dump resistor. Assuming a dump resistor sized at 0.11 ohms (1000 volts/9000 amps) and that the normal resistance of the magnet winding at 4K is about 0.1 ohms (increasing to 1.0 ohm at 80K) we arrive at an average discharge time constant of about 45 seconds, which gives two to three minutes for a complete discharge of the magnet and raises the temperature of the magnet to 80 K. Thus, it can be assumed that power extraction from the channel will drop off in approximately thirty seconds. Following a quench, the entire magnet volume must be refilled with liquid helium This procedure would begin by using gaseous helium and proceed with liquid helium as the magnet returns to 4.2 K. While the magnet is still at 80 K and before the cooldown to 4.2 K begins, the magnet must undergo insulation tests. Once the integrity of the insulation system is confirmed, cooldown to 4.2 K may proceed. When the magnet is at 4.2 K, a normal charging cycle may be initiated. The normal charging of the magnet takes place at a constant rate and will require approximately six hours.

Note: At the beginning of life for the magnet, energization may take place in a "charge and hold" fashion as the magnet is being trained. This requirement will depend on the tightness of the winding and internal slippage during charging.

It is expected that the magnet control system will interface with the ETF plant computer. Whenever a transient condition is detected in the magnet system, it is likely that sufficient time will be available to initiate actions to prevent any serious damage to the balance of the ETF components. In such a situation, the tripping of an emergency breaker would initiate a sequence of events leading to a safe shutdown of the plant. First the fuel feed would be stopped (continue to purge heated air through the combustor to ensure removal of all unburned combustible material), the firing/cycling of the high temperature air heaters will go to hot standby once combustor purge is no longer required, feedwater flow will be increased and an orderly shutdown will take place.

3.2.2.2.6 Electrode Failure

Electrodes experience the most severe environment of any component of an open cycle MHD power generation facility and are one of the pacing problems in open cycle MHD generator development. Present efforts in electrode development and testing in CDIF and other facilities should lead to much improved life expectancy but some local electrode degradation in ETF is likely. This can require a change in loading or temporary disconnection of an electrode or electrode section. Complete dropping of the load may also be necessary occasionally, in which case a shutdown sequence similar to that for loss of seed would be initiated.

It is highly unlikely that a total failure of all electrodes would occur. The more likely failure mode would be a gradual degradation of electrode performance until a condition exists where a failure of a group of electrodes would have the same effect as a total failure of all the electrodes. This situation can be handled by closely monitoring electrode performance and determining the failure or degradation rate. When a preset limit is reached, removal of the MHD generator and insertion of a replacement will take place. It is presently expected that generator changeout will be required three times a year during phase 4.

However, if a massive electrode failure were to take place, immediately upon loss of power extraction, the inverter system would be disconnected from the utility grid and fuel feed to the combustor would be terminated. Purge air flow would continue, feedwater flow would continue. Flow of secondary air (or gas recirculation flow) would be increased to reduce gas temperatures entering down stream components and attemperation spray and excess steam dump to the condenser would also increase.

When the high temperature gas has been reduced to normal operating temperatures, evaluation of the transient may take place and a decision on the desirability of the operation of the steam plant may be made.

3.2.3.2.7 Inverter Failure

The inverter system can fail for any number of reasons, such as lightning, grid disconnection, etc. When such a failure occurs, the power extraction from the MHD generator ceases. The loss of this power extraction capability has the same effect as loss of seed.

In an emergency condition such as described above, the recommended procedure would be to immediately divert power from the inverter to the emergency dump resistor. This resistor is sized to handle full generator output for approximately thirty seconds. As soon as the load is switched to the emergency dump resistor, the magnet would be quenched (see Magnet Failure for detailed description), seed and fuel injection would be diverted, purge air flow would continue, feedwater flow would continue, secondary air flow and/or gas recirculation flow would increase. This should allow sufficient time for the balance of the system to recover from the transient and enter into either a normal shutdown sequence or begin steam bottoming only operation, depending upon the severity of the transient and the condition of the balance of the components.

It is expected that the emergency dump resistor will be used for non-emergency shutdown purposes and the necessary interlocks and precautions must be entered into the control system to prevent an inadvertent trip during a normal shutdown.

3.2.3.2.8 Loss of Cooling Water

The use of cooling water is essential to maintain all system materials at the proper operating temperature. Should the supply of cooling water to the various components be reduced or stopped, serious damage could occur to the components. Excess thermal stresses would result leading to the cracking or warping of the components.

There are two cooling loops. One closed loop is for the express purpose of cooling the MHD generator and nozzle. The second cooling loop is for the balance of the MHD equipment and the steam bottoming plant. (See Drawings P3-1, P3-2, P3-3 Vol. II, Part 5).

Since there are two cooling loops, there are two failure modes.

1. Loss of Cooling Fluid to MHD Generator

   When a loss of MHD generator coolant is detected, steps must be taken to bring the system to an orderly shutdown. Firing must cease, high temperature air heaters will go to standby and main system cooling water will be maintained.

2. Loss of System Cooling Water

   A total loss of cooling water is assumed improbable. If leakage is detected, attempts should be made to maintain feedwater flow unless feedwater is entering the combustor or diffuser gas flow path. Combustor firing should cease, high temperature air heater should go to standby and closed loop coolant flow should continue to the channel and nozzle until the loop temperature reaches a predetermined value.

3.2.3.2.9 Loss of Radiant Boiler

Certain conditions can occur in the boiler section of the system which will require shutdown of the system. Owing to the size of the steam bottoming plant (defined as RB, SC, SH, RH, ECON), the majority of occurrences which take place will have minor short term effects on the system. Some of the occurrences which will affect the overall performance of the system are discussed below.

1. Tube Rupture

   In the event of a tube rupture, shutdown of the system should be initiated immediately. There is very little danger in a tube rupture causing a total loss of water but the leak could cause a sufficiently severe change in boiler circuitry that numerous other tubes begin to fail. Further, a tube rupture could act in a steam/water lancing action, cutting tubes in nearby locations and setting up a chain reaction where a whole section of tubes is destroyed. Therefore, when a tube rupture is detected, combustor firing should cease,feedwater flow is maintained (until tube metals reach suitable temperatures) and high temperature air heaters go to standby. When the unit has cooled sufficiently, it will be necessary to check the unit hydrostatically to find the tube rupture. After the tube(s) has(have) been replaced/repaired, it will be necessary to repeat the hydrostatic test to verify the repair work.

2. Overpressurization

   In the event of a system overpressurization (water side), a portion of the system water will be lost to the atmosphere through safety valves. It will be necessary to reduce firing in the combustor until the amount of water lost can be replaced by system makeup. When a determination has been made that there is no serious cause for the transient, normal system operation may be resumed.

3. Loss of Boiler Feed Pump (See Drawing P3-2 Vol. II, Part 5).

The boiler feed pump is used to introduce high pressure water to the boiler system. In a once-through unit the boiler feed pump is used to force the water through the boiler and maintain the proper water velocities and pressures. Therefore, any changes in the performance of the boiler feed pump will produce almost immediate effects on the water side performance of the total system.

The loss of a boiler feed pump would result in serious damage to the entire system. To prevent this occurrence, it is anticipated that there will be two high pressure boiler feed pumps, operating in parallel. The output of the pumps will be controlled by variable speed drives. Upon loss of one high pressure boiler feed pump, the remaining pump will increase load to 100 percent thereby ensuring a continued supply of cooling water to the system. When the loss of a high pressure boiler feed pump is detected and any system perturbations subside, an orderly shutdown sequence will be initiated and the cause of the pump trip will be determined. Short term operation may continue with one high pressure boiler feed pump if system operation is critical and provided proper precautions are followed.

In the unlikely event both high pressure boiler feed pumps are lost, coolant flow to the system can be maintained by the intermiediate pressure boiler feed pumps. A bypass around the high pressure boiler feed pumps has been provided and sufficient pump capacity exists in the intermediate pressure boiler feed pumps to maintain cooling water flow, although at reduced pressures, to ensure emergency shutdown capability.

3.2.3.2.10 Loss of Key Instrumentation

Should any key instrumentation be lost, shutdown procedures will have to be initiated. Depending on the instrumentation which is lost, the shutdown can vary from immediate to a normal shutdown procedure. To determine the type of shutdown required, the instrumentation which has been lost must be reviewed in light of function (control or data), impact on subsystem, impact on total system, backup instrumentation or alternative instrumentation available to obtain the necessary information.

In order to develop a list of key instrumentation, and to determine the effects of losing each instrument, a review must be performed of each subsystem and its interactions with the total system. When this has been completed, the total instrumentation for each subsystem must be determined and key areas chosen. Then a list of instrumentation in the key areas may be developed and the effect of the loss of each instrument must be determined. The ability to shift to backup or alternative instrumentation should be determined and the method of shifting defined (automatic or manual). Certain critical areas may require an automatic shifting to backup instrumentation.

3.2.3.2.11 Pollution Excursions

During the operation of the system, various pollution excursions will occur from time to time. These excursions will be due to changes in the firing conditions, system air transients, failure of the electrostatic precipitator, etc. Such excursions will normally have little effect on system performance. However, to operate as "clean" a unit as possible, should the pollution excursion last for an excessive period of time, it may be desirable to shut the system down until actions can be taken to eliminate the excess pollutants. Since no real danger exists for the system components, a normal orderly shutdown sequence should be initiated.

3.2.3.2.12 Natural Disaster

In the event of a natural disaster (earthquake, tornado, etc.) it will be necessary to bring the plant to a safe shutdown.

To ensure this capability, controls and instrumentation and cooling systems (at least) must be seismically qualified. After the natural disaster has occurred, the system will have to be checked for system integrity before the plant can be restarted.

3.2.3.3 System Testing

As part of this phase of the test program it will be desirable to vary some of the individual subsystem operating parameters and determine the overall effect on the balance of the system.

In general, system testing will be directed at operating the overall system at design point and off-design point. The system will be operated in such as fashion as to determine the total system limitations, the need for modification of components, and optimum system operating conditions. Each major subsystem will have parameters which can be varied. Within the subsystems, components will exist whose parameters can be varied. Some of these variables are discussed below.

3.2.3.3.1 Parametric Variations

3.2.3.3.1.1 Fuel

The ETF is designed to burn Montana Rosebud coal as its primary fuel source but the capability is required for burning Illinois #6 as an alternate fuel.

Owing to the different compositions of Illinois #6, the air preheat requirements may change. The amount of change in the channel and overall system performance may be small but slag composition and pollutant emissions will vary as well and will require testing.

3.2.3.3.1.2 Temperature

Varying the temperature entering the channel will have a marked effect on system performance. By reducing the flame temperature, the performance of the channel, inverter, radiant boiler, seed condenser, superheater and reheater will be changed.

3.2.3.3.1.3 Feedwater Flow

By changing the feedwater flows through the system, the heat removal rate of the components will be changed. An optimum set of operating conditions will be obtained by observing the changing performance. It may prove desirable to vary the flow rates to the various components to obtain the best system operation.

3.2.3.3.1.4 Mass Flow Rate of Combustion Products

Mass flow rates of fuel, air, and seed are primary independent variables.

Pressure distribution in the combustor and MHD generator/diffuser will vary with mass flow rate, as will flow conditions in the generator (e.g., subsonic, supersonic or mixed) and generator electrical output.

3.2.3.3.2 Component Variations

In general, each component contributes to the overall performance of the system. Some components will have a greater impact on system performance than other relatively fixed components will have. As the system develops, the exact interactions will become more apparent.

3.2.3.3.2.1 Combustor and CAFB Gasifier

The fluidized bed gasifier will have an impact on the performance of the second stage combustor and subsequently, the total facility. Variations in the performance of the gasifier could have the greatest impact on the overall operation of the facility. Testing is to include varying pressure, temperature, flow rates, etc., to determine the optimum operating conditions for the system.

The performance of the combustor has an impact on the total system performance. Varying the output of the combustor, by changing the inputs to the combustor, will cause changes in the downstream performance of the system, most noticeably the generator performance .

The system should have the capability of varying important inputs, either singly or in combination, while maintaining the new operating conditions for a period of time sufficient to allow performance data to be collected.

3.2.3.3.2.2 Magnet

While testing could be performed at different magnetic field strengths, it is anticipated that most performance data will be obtained at maximum (nominal) magnetic field (6T) once shakedown is complete.

Shakedown testing would include instrument calibration, pre-cooldown instrumentation and control validation, magnet insulation tests, power supply validation, plumbing tests (pressurization, purge, evacuation), cryogenic system validation, magnet pressurization and vacuum leak test.

The only testing of the magnet, once operational, will be the magnet insulation verification test to be performed after each emergency quench.

3.2.3.3.2.3 MHD Generator/Inverter

The MHD Generator/Inverter system will allow experimental variation of circuit/load arrangement to optimize channel loading with respect to enthalpy extraction, stability, minimization of destructive arcing and part load operation.

The MHD channel test program will include initial mechanical and hydraulic checkout prior to any electrical power generation tests. This will be followed by a series of thermal checkout tests prior to electrical power generation tests. The first power generation test will be an electrical checkout and will probably be conducted at a reduced magnetic field. These tests will be followed by full power MHD testing and, ultimately, the long duration test and subsequent additional testing.

3.2.3.3.2.4 <u>Diffuser</u>

The diffuser is a fixed component in the system and parametric variation is not intended unless modifications such as active boundary layer control prove necessary.

3.2.3.3.2.5 <u>Radiant Boiler</u>

Since the performance of the boiler is dependent upon input from the MHD train on the gas side, only water side flow rate can be varied as dictated by desired steam generation requirements.

3.2.3.3.2.6 High Temperature Air Heaters (HTAH)

The high temperature air heaters provide a major input to the MHD train. Any change in the output of the HTAH's will directly affect the performance of the entire system. Some of the areas of possible parametric variation include cycle schedule, and amount of flue gas recirculation.

3.2.4 LONG TERM OPERATION AND DEMONSTRATION TESTING

When integrated system testing is complete to the point where acceptable overall system operation has been achieved, long term operation can commence. During long term operation, the durability and reliability of the overall system and of components within the system is determined. Defects in both component and overall system design that limit plant availability and operation will be uncovered. Further design revision and component modification may be required as a result of long term operation. When it is considered that satisfactory operation has been achieved, from the standpoint of overall reliability, station efficiency, etc., the Demonstration Test Runs can be conducted. A successful demonstration test run will extend for a period of a year or more and will demonstrate that the MHD/Steam generating plant can produce 437,000 MW-Hrs/Year (equivalent to 88.9% availability) while operating as a base load plant providing power to an electric utility grid.

3.3 CONTROL REQUIREMENTS

To insure the safe and reliable operation of the ETF, it will be necessary to provide a control system that can coordinate the activity of several subsystems while maintaining overall system operation. The control system will be capable of monitoring several points simultaneously and initiating proper control commands to the total system. Some conditions will develop which will require immediate evaluation and response. The control system must be capable of responding to this type of operation. The entire control system is described in detail in Vol. IV, Appendix A22.

3.3.1 FLEXIBILITY OF CONTROL SYSTEM

Since one of the functions of the Engineering Test Facility is to allow for developmental testing of the system, the control system needed to allow this must be very flexible. A desirable feature of the control system would be the ability to adjust quickly to system reconfiguration or special test requirements. The control system should be designed in such a fashion that the inputs can be modified in a relatively short period of time. The control logic should be in such a form that modifications can be made quickly.

The control system should be capable of receiving modified input for one section or component without requiring a complete input change. This would enhance the ability of the ETF to vary only specific inputs to determine the effect on total system performance.

The control system must be flexible enough to allow system modifications to take place yet be rigid enough to provide safe operation of the system. The control system must be able to maintain monitoring functions and be capable of shutting the system down in the event of serious excursions. A discussion of the control system flexibility is presented in greater detail in Vol. IV, Appendix A22.

3.3.2 CONTROL AND INSTRUMENTATION CLASSIFICATION

There will be categories of instrumentation and control that are considered critical to the safe operation of the facility. Other categories of instrumentation and control that are not essential for safe operation will be regarded as non-critical. All critical instrumentation and control will require special consideration regarding power source, routing of cables, etc. These considerations have been developed as part of the Instrumentation and Control System conceptual design and are discussed in Appendices A22, A24.

3.3.3 INTERLOCKS AND PERMISSIVE LOGIC

To insure safe operation of the system, certain subsystems/components will be interlocked. This interlocking is done to prevent the accidental or premature starting of component pieces. Interlocks can be of two types: electrical or mechanical. An electrical interlock will require a relay to be actuated (either opened or closed) before a piece of equipment can start or stop. A mechanical interlock will require a piece of equipment be actuated prior to the start, or stop, of another piece of equipment. Most interlocks are a combination of these two types.

A second set of conditions for equipment protection is described as permissive logic. These are normally a set of conditions which must be met prior to starting or stopping a piece of equipment. When all these conditions exist, within preset boundaries, the permissive logic is satisfied and the equipment is allowed to start.

It will be necessary to determine interlocks and permissive logic for each piece of equipment in a subsystem, each subsystem with regard to other subsystems, and the total system.

3.4 TEST DATA ACQUISITION AND MANAGEMENT REQUIREMENTS

It is necessary that a comprehensive data acquisition and management system be provided. One of the purposes of the ETF is to verify the technology of building and operating a full size commercial MHD/steam power plant. The acquisition of component and subsystem performance data is implicit in obtaining a basic understanding of this technology. A good data base will provide the foundation for the extrapolation to a full size power plant. The test data acquisition and management system is discussed in greater detail in Vol. IV, Appendix A23

3.5 SAFETY REQUIREMENTS

To insure the safe operation of the ETF, certain safety conditions will have to be met. The majority of these safety requirements are defined by various organizations in the form of codes. Other requirements must be met by careful design work in the initial design stages of the facility and by operating procedures.

3.5.1 CODES

Numerous organizations, both governmental and private, set up codes to insure the safe operation of equipment. Some of those organizations and their codes are discussed below.

3.5.1.1 Occupational Safety and Health Administration (OSHA)

OSHA has undertaken to provide safe working conditions for all types of industries. OSHA safety requirements cover all areas of plant operation from lighting to noise. It is expected that the ETF will comply with all OSHA regulations.

3.5.1.2 National Fire Protection Association (NEPA)

NFPA is concerned with fire hazards and explosion hazards. With the amounts and types of combustible material (pulverized coal, oxygen, etc.) present on the site and in the type of atmosphere that these materials will exist, all efforts will be made to design and operate the plant in such a way as to comply with all NFPA regulations.

3.5.1.3 National Electrical Manufacturers Association (NEMA)

NEMA concerns itself with the electrical aspects of the plant (in addition to the National Electrical Code). It is expected that all design and operation of the ETF will comply with NEMA regulations.

3.5.1.4 American Society of Mechanical Engineers (ASME)

ASME concerns itself with all aspects of power plant operation. The codes it generates will affect all aspects of design and operation. The ETF will comply with all applicable ASME codes.

3.5.2 PERSONNEL

During the operation of the facility, it will be necessary to provide protection for the operating personnel from various hazards. Some of these hazards are discussed below.

3.5.2.1 Equipment

All operating equipment will pose certain hazards to personnel. Some of the major hazards are as follows.

3.5.2.1.1 Noise

Operating equipment has a tendency to produce noise. Some of the noise levels can be high enough that prolonged stays in an area can cause serious physical harm (loss of hearing, etc.).

Where possible, equipment should be designed or insulated in such a fashion that noise levels comply with OSHA sound level requirement (90 dBA at 6 feet). Where this is not possible, the area should be designated as a high noise hazard and appropriate safeguards (earplugs, headphones, etc.) should be specified.

3.5.2.1.2 Temperature

Some equipment in the ETF will be operating at very high temperatures. Where the use of insulation is insufficient in providing a relatively cool surface, the area should be designated as a high temperature hazard area and appropriate safeguards should be specified.

3.5.2.1.3 Operational Safeguards

Numerous pieces of equipment could present operational hazards to plant personnel. If moving or rotating sections of a piece of equipment are exposed they present a greater likelihood of injury than a section which is covered. If a piece cannot be covered, the danger should be called out and safeguards specified. Every effort will be made in the equipment design and/or specification stage to eliminate or reduce this type of situation.

3.5.2.2 Hall Voltage

Due to the nature of the MHD generator an, axial dc voltage will exist. This Hall voltage will be no more than 30 kV and will require electrical isolation of at least one end of the MHD generator, as discussed in Volume II, Paragraph 2.17.1.

To insure the safety of the facility personnel and the operability of equipment, controls, and instrumentation in the immediate area of the MHD generator, certain areas will require detailed study. These areas include, but are not limited to, equipment protection from arcing, the use of fiber optics to isolate the instrumentation from the MHD section and the use of restricted access areas to limit the number of personnel in the area. In addition, instrumentation to monitor the performance of electrical isolation joint axial supports may be required.

3.5.2.3 Hazardous Materials

It will be necessary to provide special design features in areas where various hazardous materials (coal, oil, oxygen, etc.) are present. These features include inert gas blanketing, explosion proof electrical installations, controlled access and materials compatibility.

3.5.2.4 High Magnetic/Electric Fields

To enable the ETF to perform properly, a superconducting magnet of very high field strength (6 Tesla) is required. Very few studies have been performed on the biological effects of such a large field. Until more knowledge can be obtained, areas of high magnetic/electric fields should be designated and limited "stay times" should be specified. As more experience is gained, the restrictions can be lessened or increased as the situation dictates.

Another area of consideration is the actual performance of work in the area of the magnetic field. When the field is energized, care must be taken to provide non-magnetic tools and equipment.

3.6 PROCEDURE REQUIREMENTS

To allow for the orderly startup, performance, and operation of the Engineering Test Facility, it will be necessary to develop a full set of procedures. Development of these procedures is beyond the scope of this conceptual design contract. However, the type and purpose of required procedures are identified below. Each procedure should provide step-by-step detail on how to start a piece of equipment, equipment string or subsystem. The procedure should include hold points where data taken must agree, within prescribed limits, with established setpoints. The procedures should also specify corrective actions to be taken in the event data varies from the setpoints. A brief description of the various categories of procedures follows.

3.6.1 STARTUP PROCEDURE

This group of procedures should deal with the orderly startup and initial testing of the ETF following construction check-out.

3.6.1.1 Component Startup

These procedures would address the startup of individual components in the system. The procedures would call out the requirements for startup, the necessary controls and instrumentation required to be operable, any prerequisites (such as other equipment being operated or energized), expected performance and an acceptance criteria. Some data taking would occur at this point.

3.6.1.2 Subsystem Startup

These procedures should deal with the startup of a subsystem. This would include all the components in a subsystem and all necessary controls and instrumentation. As in the component startup, requirements for subsystem startup, prerequisites, expected performance, and acceptance criteria should be specified.

The purpose of these procedures would be to verify the operability of the subsystem (for example, it would verify that the feedwater system develops the proper flows, pressures and temperatures). These procedures would be developed for each subsystem in the entire facility. The majority of the required test and performance data will be obtained at this point.

3.6.1.3 Integral Subsystems Startup

These procedures should be developed to allow the orderly startup of the entire facility. This would entail taking the subsystems tested in the subsystem startup procedures and linking everything together to form a total system. It is expected that a majority of the time devoted to the ETF will be spent in this mode of operation. Therefore, particular attention should be given to these procedures.

3.6.2 OPERATING PROCEDURES

After the system has been operational for a sufficient period of time, the mode of operation will switch from startup to operation. The continued operation of this facility will require another set of procedures. These procedures should address the following areas.

3.6.2.1 Plant Startup

When sufficient operating experience has been gained, a plant startup will become a routine event. The procedures for this section should be prepared with this in mind. It is assumed that no significant changes have been made in the components. Therefore, the startup should present no surprises and may be considered as a routine functioning of the facility.

3.6.2.2 Normal Operating Procedures

These procedures should address the operation of the system (subsystems and individual components) in a normal, full load, design point operation.

The procedures should include feed rates for various materials (coal, seed, oil, water, etc.) to assure steady state operation. They should specify operation of the equipment necessary to maintain steady state design point operation. Data requirements at this point should be specified by procedures.

3.6.2.3 System Transients

These procedures should address all the anticipated transients and describe in detail the actions required to minimize the transient's impact on the total system performance.

3.6.2.4 Plant Shutdown

These procedures should address the normal orderly shutdown of the facility. The procedures should describe the sequence of shutdown, the timing of the sequences and final condition of the components after shutdown.

3.6.2.5 Emergency Shutdown

These procedures should cover the rapid shutdown of the systems in response to a major system transient. The procedures should specify emergency conditions which must be met and maintained. They should call out the time frames required for meeting these conditions and how long they must be maintained. The procedures should specify plant conditions after the emergency shutdown.

3.6.3 SURVEILLANCE PROCEDURES

This group of procedures deals with the review of equipment and subsystems to verify performance. Any severe degradation of performance would be indicative of equipment malfunction and possible failure.

These procedures become particularly important when testing the critical plant safety-related controls and instrumentation. If these systems show failure or poor performance a plant shutdown would be desirable to determine the cause of failure and correct it.

3.6.3.1 Periodic Performance Evaluation

On a given periodic basis (which will be determined for each piece of equipment), all equipment in the facility will be given a minor performance test. The purpose of this procedure is to determine any degradation of performance and subsequent impending failure. The procedure will specify ranges of acceptable performance and corrective action, if needed.

3.6.3.2 Periodic Subsystem Checkout

These procedures should consider an entire subsystem and verify performance. The frequency of the performance of these procedures will be determined based on importance of subsystems and possible impact on the total subsystem operation. Once again, the procedures should specify a range of acceptable performance and corrective actions, if required.

3.6.4 MAINTENANCE PROCEDURES

To maintain the facility in as high a state of readiness as possible, it is necessary to be prepared to repair or replace equipment on a timely basis. Therefore the purpose of these procedures will be to address the maintenance requirements prior to their actual need.

3.6.4.1 Equipment Replacement Procedure

This group of procedures should deal with the wholesale replacement of a piece of equipment. The procedure should specify welding techniques, weld material, control and instrumentation hookups, testing to verify performance, etc. Having this information available quickly will reduce time lost for maintenance and assure a timely return to testing and operation.

3.6.4.2 Equipment Repair Procedure

This group should deal with primarily the same areas as Paragraph 3.6.4.1 with in-place repair as the main objective. The same procedural requirements should be included.

3.6.5 TEST PROCEDURES

A major function of the ETF is to provide a facility whereby testing of the MHD train and steam bottoming plant can be performed. Therefore, a major portion of the time will be spent engaged in test activities.

To allow the performance of a test and the obtaining of meaningful data, it will be necessary to develop a set of test procedures.

A procedure will be required for each test to be performed. These procedures must include the purpose of the test, anticipated performance changes, impacts on total system, any special materials required for the test, and all data points to be sampled.

The procedure should also include an acceptance criteria and method of data analysis/interpretation. These procedures will be required, in a completed form, some time prior to the actual performance of the test.

In general, the procedure requirements detailed above provide a fairly flexible basis from which the total system operation and testing can be documented. Additional procedural requirements will be defined as more information becomes available.

VOLUME IIB

PART 4 - FUNCTIONAL SPECIFICATIONS

Functional specifications for components and subsystems of the MHD-ETF considered to be balance-of-plant, supportive subsystems, are contained in this part.

These specifications are arranged in the same order as the narratives in Part 2 were, which is an order which corresponds to the modified FPC Code of Accounts for the MHD-ETF. Numbering and ordering of the specifications within each category is arbitrary and is denoted by the dashed number, i.e. 2.17.1-6, which follows the Code of Account category number. Note that the Code of Account number is found by replacing the first number, 2 and the following decimal point with a 3.

Table 4-1 is a complete list of these specifications in the order they appear in Part 4.

TABLE 4-1

COMPONENT/SUBSYSTEM FUNCTIONAL SPECIFICATIONS
FOR THE
MHD ENGINEERING TEST FACILITY

2.12.1-23	Sand Silo/Sand Handling
2.12.1-24	Sand Hoppers/Sand Handling
2.12.2-1	Slag Hopper & Clinker Grinder/ Slag & Ash Handling
2.12.2-2	Main Slurry Pumps/Slag & Ash Handling
2.12.2-3	Recirculation and Settling Tanks/ Slag & Ash Handling
2.12.2-4	Flushing Pumps/Slag & Ash Handling
2.12.2-5	Dewatering Bins/Slag & Ash Handling
2.12.2-6	Slag Water Reuse Pumps/Slag & Ash Handling
2.12.2-7	Sludge Pumps/Slag & Ash Handling
2.12.2-8	Overflow Control Pumps/Slag & Ash Handling
2.12.2-9	Hopper Overflow Tank/Slag & Ash Handling
2.12.5-1	Stack/Flue Gas Emission
2.12.5-2	Ionizer/Electrostatic Precipitator/ Flue Gas Emission
2.12.6.3-1	Hot Gas Duct/Cold Blowdown Air
2.12.6.3-2	Hot Gas Duct/Flue Gas (Stack)
2.12.6.3-3	Hot Gas Duct/Flue Gas (HTAH)
2.12.6.3-4	Hot Gas Duct/Flue Gas (Attemperator)
2.12.6.3-5	Hot Gas Duct/Atomizing Air
2.12.6.3-6	Hot Gas Duct/Dilution Air
2.12.6.3-7	Hot Gas Duct/Combustion Air
2.12.7.1-1	Condensate Pumps/Condensate and Feedwater
2.12.7.1-2	Condensate Booster Pumps/Condensate and Feedwater
2.12.7.1-3	Emergency Makeup Pumps/Condensate and Feedwater
2.12.7.1-4	Deaerator/Condensate and Feedwater
2.12.7.1-5	Closed Feedwater Heaters/Condensate and Feedwater
2.12.7.1-6	Boiler Feed Pumps/Condensate and Feedwater
2.12.7.1-7	Intermediate Pressure Boiler Feed Pumps/Condensate and Feedwater
2.12.7.1-8	Desuperheating Valves/Steam Conditioning
2.12.7.1-9	Pressure Reducing Valves/Steam Conditioning
2.12.7.1-10	Expansion Surge Tank/Condenser Circulating Water
2.12.7.1-11	Chemical Pump & Tank Equipment/ Chemical Feed System
2.12.7.1-12	Water Sampling & Monitoring Equipment

2.10 SITE

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SEWAGE TREATMENT SYSTEM NO. 2.10.0-1

COMPONENT: SEWAGE TREATMENT PLANT

COMPONENT FUNCTION:

Treatment of all domestic wastes to reduce the effluent biological oxygen demand (BOD) to 90% of the influent BOD loading.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

One extended aeration type sewage treatment plant complete with aeration tank, settling tank and chlorine contact tank. The following design criteria will apply:

Daily Hydraulic Loading	4,000 Gallons
Daily Organic Loading	8 Lbs $(BOD)_5$
Peak Hydraulic Loading	500 GPH
Aeration Tank Requirement	5,000 Gallons
Plant Dimensions Estimate	15' Long x 9'-6" Wide x 9'-6" deep
Plant Weight Estimate	Dry - 10,000 lbs Wet - 72,000 lbs

The plant shall be designed in accordance with all applicable state design standards.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Lift stations as required.
Effluent sump and transfer pumps, if required.
Building to house treatment plant.

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2.11 STRUCTURES & IMPROVEMENTS

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: ANALYTICAL LABORATORIES NO. 2.11.5.2-1

COMPONENT: WATER TESTING LABORATORY

COMPONENT FUNCTION:

The water testing laboratory will be used for the performance of analytical work necessary for the control of the various plant water treatment facilities, for the maintenance of prescribed quality levels in the various plant water systems, and for analysis of problems in the water treatment facilities and plant water systems.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Table 1 provides a list of major water testing laboratory component requirements. Manufacturer names and model or catalog numbers are provided to facilitate the component description and the estimating procedure.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

The water testing laboratory requires potable (hot and cold) and demineralized water supplies, a chemical resistant drain system such as Duriron or PVC, instrument air, and a natural or bottled gas supply.

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Table 1

COMPONENT DESCRIPTION

ITEM NO.	QUANTITY	DESCRIPTION	DIMENSIONS LxWxH WHERE APPLICABLE (APPROXIMATE)
1	1	Fume Hood, Duralab Type DS	3'-0" x 2'-6" x 8'-0"
2	2	Wall Table, Duralab Type W-120	14'-9" x 2'-6" x 3'-1"
3	1	Center Table, Duralab Type C-400	14'-9" x 4'-6" x 3'-1"
4	1	Desk, Duralab Type 756	4'-0" x 2'-6" x 2'-7"
5	1	Balance Table, Duralab B-301	4'-1" x 2'-0" x 2'-7"
6	1	Storage Cabinet, Duralab Type CSC	4'-1" x 2'-0" x 7'-0"
7	1	Refrigerator, Undercounter	2'-0" x 2'-0" x 3'-0"
8	1	Oven, Gravity Convection	2'-1" x 1'-7" x 1'-7"
9	1	Analytical Balance, Mettler H-20	
10	1	Balance, Ohaus Dial-O-Gram 1610	
11	1	pH Meter, Corning, Model 12 with Electrodes	
12	1	Conductivity Meter, Hach 2511	
13	1	Turbidimeter, Hach 2100A	
14	1	Spectrophotometer, Hach 2582 with Range Expander	
15	1	BOD Apparatus, Hach 2173	
16	1	Incutrol Temperature Regulator, Hach 2597	
17	1 ea.	Analytical Set-ups for Hach DR/2 as follows: Chlorine, Free Hydrazine Iron, Total 0-2 mg/l Phosphate, Ortho Silica, Low Range Silica, High Range Sulfate Copper	
18	1 ea.	Hach Reagent and Apparatus Sets as follows: Alkalinity, Set No.A1312B Acidity, Set No. A1212B Acidity, Set No. A1213B Chloride, Set No. C1512B Hardness, Calcium, Set No. H1212B Hardness, Total, Set No. H1213B *Sulfite, Set. No. S1913	
19	1	Calgon Oxygen Colormetric Unit - Dissolved-Complete, Cat. No. K0079	
20	N.A.	General Apparatus and Supplies	

* Reagent Set Only

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TESTING LABORATORY NO. 2.11.5.2-2

COMPONENT: COAL ANALYSIS LABORATORY EQUIPMENT

COMPONENT FUNCTION:

The coal analysis laboratory equipment will be used in the preparation of coal samples, to perform a proximate analysis, and to make a sizing determination on coal feed in accordance with the requirements of ASTM D2013, D3172 and D410.

NOTE: Potassium carbonate (seed) purity above 99.6% is anticipated, analysis for control purposes appears unnecessary. Seed analysis, where required, will be performed by an outside laboratory.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Preparing samples and performing tests described above requires: Electric heated, mechanical convection drying oven, approximate cabinet size 19" x 19" x 19", regulated temperature range of 40°C to 110°C, blower and air flow controls; porcelain-jar ball mill, 9" diamter by 10" high complete with flint pebbles or equivalent for final reduction of sample to pass a No. 60 sieve; vertical electric furnace to be regulated to 1000°C with thermocouple and rheostat; 3200 watt electric furnace regulated to 1200°C with thermocouple and lead to remote furnace control; "Ro-Tap" sieve shaker, 32" high by 34" wide by 17" deep, weighing approximately 290 pounds complete with motor and timer; sieves, 1/4" mesh thru 200 mesh; balance or scales; capsules for samples; platinum crucibles with covers; bomb calorimeter; miscellaneous chemicals; laboratory containers; and sink and lab furniture consisting of tables, counters and storage cabinets.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

POWER: 110 and 120 Volt

INTERFACE REQUIREMENTS: Hot Water (above 160°F) and cold water (below 50°F); Vacuum cleaning system

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: ADMINISTRATION BUILDING NO. 2.11.5.2-3

COMPONENT: ADMINISTRATION BUILDING ELEVATOR

COMPONENT FUNCTION:

The elevator will be used for the movement of passengers, freight and miscellaneous equipment components from grade level to the intermediate and upper flow levels.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

4000 pound capacity, hydraulic, combination passenger-freight elevator having a travel of approximately 25 feet. The elevator shall consist of a double-entrance type car having a platform size approximately 5.75 feet wide by 9.2 feet deep; electrically operated two-speed doors providing a clear entry opening of 4 feet wide by 9 feet high; a travel speed of 125 feet per minute when loaded; hydraulic system power unit complete with pump, motor, oil reservoir, valves, tubing and piping; hydraulic jack with cylinder; electrical controls for start, stop, emergency stop and selective-collective operation; and hoistway doors and operators. The elevator shall meet all applicable requirements of ANSI A17.1, Safety Code for Elevators, and all applicable Addenda; and Federal, State and local codes.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power:
Circuit breaker and 480 volt, 3-phase, 60 hertz supply;
115 volt, single phase, 60 hertz supply.

Major Interfaces:
Elevator pit with drains, lighting, heating and ventilation, and access ladder.
Drilling and casing of oil hydraulic jackhole.
Cathodic protection.
Elevator Structure and enclosure.

REV. NO. ________

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2.12 BOILER PLANT

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-1

COMPONENT: LOADING CONVEYOR

COMPONENT FUNCTION:

Transport coal from under the railcar unloading position to top of sampling/distribution train in transfer building. At the transfer building an operational decision is made to load storage silos or stockpile coal in dead storage piles.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

450 tons/hr. (50 lb/ft^3 material density), 30" x 320' troughed belt conveyor, vertical gravity take-up, belt scraper, tail end hopper and transfer chute, impact idlers at load point, zero speed switch and tail end anchor. Head drive to have permanent magnet drum in lieu of standard drive/pulley for tramp iron removal.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Drive approximately 100 HP (T.E.F.C.), 173 ft. of conveyor in tunnel travel, 147 ft. in gallery. Conveyor on intermediate channel steel frame in gallery with walkway. Conveyor to have roller bearing idlers, pull cord with emergency stop switches, structural supports to grade, etc.

Recommended Source: Barber-Green Co.
Aurora, Illinois

REV. NO. 0

REV. DATE 11/29/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-2

COMPONENT: STACKER FEED CONVEYOR

COMPONENT FUNCTION:

Transfer coal from the bottom of the sampling train in the transfer house to the loading hopper for the radial stacker.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

450 tons/hr. (50 lb/ft^3 material density), 30" x 150" troughed belt conveyor along grade, screw take-up, belt scraper, tail end hopper and transfer chute, impact idlers at load point, zero speed switch, tail end anchor.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Drive approximately 20 HP (T.E.F.C.), with belt covers, pull cord with emergency stop switch, roller bearing idlers, conveyor proper supported on structural steel to grade level.

Recommended Source: Barber-Green Co.
Aurora, Illinois

REV. NO. 0
REV. DATE 11/29/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-3

COMPONENT: RECLAIM CONVEYOR

COMPONENT FUNCTION:

Transport coal from underside of reclaim hopper to transfer point for loading of conveyor to silos.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

450 tons/hr. (50 lb/ft^3 material density), 30" x 180' troughed belt conveyor, vertical gravity take-up, belt scraper, tail end and head end transfer chutes, impact idlers at load point, zero speed switch and tail end anchor.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Drive approximately 50 HP (T.E.F.C.), 66 ft. conveyor in tunnel travel, 114 ft. in gallery. Conveyor in intermediate channel steel frame in gallery with walkway, roller bearing idlers, pull cord with emergency stop switches, structural supports to grade, etc.

Recommended Source: Barber-Green Co.
Aurora, Illinois

REV. NO. 0

REV. DATE 11/29/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL

NO. 2.12.1-4

COMPONENT: RADIAL STACKER

COMPONENT FUNCTION:

Unit performs coal stack-out function by transporting coal from end of stacker feed conveyor to the top of the dead storage piles.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

450 tons/hr. (50 lb/ft^3 material density), 30" x 150' throughed belt with integral take-up as part of assembly. Mast-type design radial stacker with removable belt covers, load hopper at tail end with bolster fixed pivot, impact idlers at load point and zero speed switch. Auto powered hoist with end position controlled by capacitance sensor(s). Unit can have retractable telescoping chute with automatic end positioning (capacitance or equal) instead of power hoist. Discharge head to be hooded at end for dust control or to have enclosed transition to telescoping section, as applicable.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

All motors T.E.F.C. - approximately 50 HP belt drive, 15 HP hoist, 5 HP radial positioning with gear transmissions designed for outdoor winter use in Montana. Stacker proper to have walkway on one side and entire assembly to have power-propelled, tired swivel truck for radial travel. All electrical equipment must conform to NEC Class II, Division 1 category.

Recommended Source: Barber-Greene Co.
Aurora, Illinois

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-5

COMPONENT: SILO LOADING CONVEYOR

COMPONENT FUNCTION:

Transport coal from the yard transfer building to the top of (2) coal silos located inside the silo building.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

450 tons/hr (50 lb/ft^3 material density), 30" x 470' troughed belt conveyor, vertical gravity take-up, belt scraper, tail end hopper loading at (2) locations with impact idlers at loading points. Top (head) transition to diverting gate structure allowing alternate or dual filling of (2) silos. Conveyor to have zero speed switch and tail end anchor.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Drive approximately 125 HP (T.E.F.C.). Conveyor to be enclosed in gallery on intermediate channel steel frame with gallery walkway. Conveyor to have roller bearing idlers, pull cord with emergency stop switches, structural supports to grade, etc.

Recommended Source: Barber-Greene Co.
Aurora, Illinois

REV. NO. 0

REV. DATE 11/29/77

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL — NO. 2.12.1-6

COMPONENT: VIBRATORY CAR SHAKER (RAILCAR)

COMPONENT FUNCTION:

Mounted above railcar unloading station and suspended from hoist. Use of shaker when operationally desired, assists flow of coal from bottom of bottom-dump railcars.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Standard size unit - 11"-2" wide by 5'-0" top of car model with wide-faced shoes to fit standard U.S. hopper-bottom gondola cars.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Unit to be furnished with hoist to hold shaker above railcars when not needed. Shaker and hoist to have one-man integral pendant control in moisture and dust-tight enclosure. Motor drive 15 HP (T.E.F.C.) with V-belt drive.

Recommended Source: Allis-Chalmers Co.
Appleton, Wisconsin

REV. NO. 0

REV. DATE 11/29/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-7

COMPONENT: COAL SILOS (2)

COMPONENT FUNCTION:

To provide coal storage surge capacity prior to delivery of coal to Petrocarb injection system.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

28' diameter x 70' high silos* with 60° unloading transition pieces, vibro feeders with flow quantity adjustment and shut-off gates. Stave or steel construction with vibratory unloading assist and conical or double sloped bottoms. Silo design must be self-cleaning with epoxy coating on silo walls. Transition cones to be stainless steel, type 304 or equal (minimum thickness 3/8"). Silos must be designed for a minimum of 24" w.g. pressure for inert gas sealing.

* Silo dimensions can vary slightly to allow selection of "standard" manufactured sizes. Combined useable storage of both silos must be a minimum of 52,000 ft^3.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Bag type bin vent and overpressure-vacuum relief valve must be supplied with each silo. Each silo to be equipped with bin vent or silo dust filter for silo exhaust (used during loading).

Recommended Vendor:

Butler Manufacturing Co., Kansas City, Missouri
1ST Colony-Nicholson, Marietta, Ohio

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REV. DATE 12/1/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-8

COMPONENT: COAL UNLOADING BUILDING

COMPONENT FUNCTION:

To provide weather protection and dust containment during railcar unloading of coal.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Single story building - 100' long x 30' wide x 32'+ high with open entry on one end (abuts thawing shed) and open exit end with weather curtain 24' minimum inside height clearance for car hoe operation. Support steel to be provided for car shaker and hoist. Door clearance for largest Burlington & Northern R.R. engine in use.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)
Building with steel frame and insulated, prefabricated siding and roofing panels. Uniform Building Code and other national, state and local building codes to apply.

Recommended Source:

Space Building Co., East Taunton, Mass.
Butler Building Co., Kansas City, Mo.

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-9

COMPONENT: THAWING SHED

COMPONENT FUNCTION:

To provide heat containment and weather protection during heat and soak sequence needed to skin thaw coal/steel interfaces of railcars.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Single story building - 132' long x 30' wide x 26' high with open exit on one end (abuts Unloading Shed) and open entry on other end with weather curtain. Door clearance for largest Burlington & Northern R.R. engine in use.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Building with steel frame and prefabricated siding and roofing panels. Uniform Building Code and other national, state and local building codes to apply. Heat station section structure design to withstand 3,000 KW/hr. radiant heat input in 66 ft. section of building during winter heat station use.

Recommended Source:

Space Building Co., East Taunton, Mass.
Butler Building Co., Kansas City, Mo.

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COMPONENT SPECIFICATION

SUB-SYSTEM: COAL   NO. 2.12.1-10

COMPONENT: PROCESS/BUNKER BUILDING

COMPONENT FUNCTION:

To provide weather protection and house equipment and silos to support coal and seed (potassium carbonate) processing and storage operations.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Main Building - 100' long x 100' tall plus top cover enclosure x 36' wide with attached seed (70' x 24'-6" x 22') and conveyor unloading (108' x 14' x 28') auxiliary structures. Building steel and foundation to support and building to house (2) large coal silos and (3) smaller seed silos, pulverizers, conveyors and other auxiliary equipment needed including dust control and make-up air equipment to slightly pressurize building proper.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Building with steel frame and insulated, prefabricated siding and roofing panels. Uniform Building Code and other national, state and local building codes to apply.

Recommended Source:

Wonder Building Co., Plato Center, Illinois
Space Building Co., East Taunton, Mass.

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-11

COMPONENT: CAR HOE

COMPONENT FUNCTION:

Mounted near coal railcar unloading position and used when operationally desired to assist flow of coal from bottom of bottom-dump railcars.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

15'-6" tower with tripod and cast-in concrete base. Unit to be designed for (1) man operation and to be furnished with motion limiting stops to prevent building/equipment damage.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Unit to be furnished with 7-1/2 HP, integral hydraulic drive, and interchangeable tool ends - pick and spade. Hydraulic drive pump to be furnished as winterized for outdoor use.

Recommended Source:

Alberts Products, Springfield, Illinois

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-12

COMPONENT: COAL (ICE) CRACKER (3)

COMPONENT FUNCTION:

To size coal to 2" x 0" size and/or perform ice crushing as needed when coal is:

1. Unloaded from railcars
2. Reclaimed from dead storage
3. Loaded under emergency conditions

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

450 TPH design rate, 30" x 50" single roll crusher with automatic overload release, one-piece roll construction and adjustable breaker plates set to pass 2" lump coal/ice. Maximum frozen entry lump size - 18" cube.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

50 HP Drive

Recommended Source:

Pennsylvania Crusher Corp., Broomall, Pa.
American Pulverizer Co., St. Louis, Mo.

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-13

COMPONENT: SAMPLING SYSTEM

COMPONENT FUNCTION:

Provide primary and secondary sampling of incoming coal in accordance with ASTM D-2234 to allow testing via ASTM D-2013. System to be totally integrated and as automatic as practical to allow minimum of applied labor and maintenance.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Coal input rate is 450 tons per hour. System to consist of primary sampler with belt feeder, crusher with belt feeder, secondary sampler, sample collector including collection turntable (with sufficient metal sample cans to allow continuous sampling of a 2,600 ton train lot), all bins, gates and dust covers, hydraulic power pack and controls, weigh electronics and controls, motor control center, print-out equipment, operator console, flood loading chute and return conveyor(s) to allow excess material to be reloaded to silo or stacker feed conveyors.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

System to be equipped with heat rise detection and monitoring and fire protection safeguards at key coal retention locations. System bins and feeders to be designed to allow complete purging of coal accumulations prior to system shutdown. All

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COMPONENT DESCRIPTION, Continued

System to be automatic, completely interlocked and electrically monitored at all stages to allow shutdown in the event of plugged chutes or component malfunction. System to include annunciation on control panel for visual monitoring and signalling lights with audible alarm at system or component malfunction. Controls shall be equipped to allow manual override for maintenance.

MISCELLANEOUS REQUIREMENTS, Continued

electrical equipment must conform to NEC Class II, Division 1 category.

Recommended Sources:

Ramsey Engineering, Inc. St. Paul, Minnesota
Joy Manufacturing Co., Denver Equipment Div., Denver, Colorado

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-14

COMPONENT: R.R. UNLOADING BIN HOPPER

COMPONENT FUNCTION:

To receive coal and serve as a surge hopper to facilitate even-loading of plant conveyor equipment.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Local shop or field fabricated and erected hopper approximately 5,800 C.F. with 3" x 3" grizzly bar at top along with provisions for air pollution control ducting around periphery of bin near top edge. Hopper to be fabricated of 1/2" thick steel plate with 1/4" stainless (type 304) steel liner wear plates on slope portions of bin. Bin interior to be smooth with radius corner to minimize cial fines hang-up. Bin slope to have 60° minimum discharge angle to facilitate coal flow. Bin structure to be reinforced as required for application and to support bin vibrators.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Bin to be equipped with (2) electromagnetic vibrators with cushioned, semi-noiseless construction and control box with independent variable control. All electrics must conform to NEC Class II, Division 1 category. Vibrators to be Magic Flow Company Model SV 200 or equal.

Suggested Sources:

Bin - Local steel fabricator
Vibrators - Magic Flow Company, Carrollton, Ohio

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-15

COMPONENT: STATIONARY LOADING BIN HOPPER (2)

COMPONENT FUNCTION:

To receive coal at outdoor locations and serve as a surge hopper to facilitate even-loading of plant conveyors. One hopper is used at normal reclaim position; one hopper is used for an emergency loading unit.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Local shop or field fabricated and erected - approximtaely 530 C.F. each with top 18" x 18" grizzly bar. Hopper proper to be fabricated of 3/8" thick stainless steel plate - type 304L or 316L. Bin interior to be smoothe with radius corners to minimize coal fines hang-up. Bin slope to have 60° minimum discharge angle to facilitate coal flow. Bin structure to be reinforced as required for support of bin vibrators.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Each bin to be equipped with an electro-magnetic vibrator with cushioned, semi-noiseless construction and control box with variable control. All electrics must conform to NEC Class II, Division 1 category. Vibrator to be Magic Flow Co. Model SV-80 or equal.

Suggested Sources:

Bin - Local steel fabricator
Vibrators - Magic Flow Co., Carrollton, Ohio

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-16

COMPONENT: VIBRO-FEEDERS (4)

COMPONENT FUNCTION:

Units feed coal from a surge bin uniformly to crusher. Four units are required:

1. (2) at R.R. unloading position
2. (1) at reclaim position
3. (1) at emergency loading position

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

36" wide units, 450 TPH (50 "/ft^3 material density) - variable rate (adjustable) units mounted at approximately 15° decline. Suspension-mounted to structural frame preferred.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor Drive - minimum 2 HP - T.E.F.C.

Recommended Source:

Carrier FRB, E.V. Systems, Stamford, Conn.
Para-Mount II, General Kinematics Corp., Barrington, Illinois

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-17

COMPONENT: DUMP POSITION DUST COLLECTION EQUIPMENT

COMPONENT FUNCTION:

To collect fugitive coal fines emitted during R.R. coal unloading operations.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

System to move and collect approximately 61,200 CFM (total) of dust-laden air from around the periphery of the approximately 40' x 16" dump R.R. opening through ducting and combination cyclone separator/baghouse filter units by system exhaust fans. The exhaust fans to consist of (4) 33" wheel, backward-inclined, Class III, exhaust driven each by 30 HP reduced and belted drives for proper RPM. Fans will be ducted (2) per filter unit. Each fan shall be capable of moving 15,300 CFM of air at 8" SP. The filter units will be (2) Model No. 144RJ96 CEA-Carter-Day Industrial Dust Filters with automatic reversible jet cleaning. Total minimum cloth area 6,120 sq. ft. Filter units to each include rotary valve - 12" at bottom dust drop for pneumatic or gravity take-off. All equipment must be capable of being mounted outdoors in a dusty ambient atmosphere.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Backpressure blower HP - (2) 20 HP; (2) 1/2 HP purge drive; (4) 30 HP exhaust fans, (2) 3/4 HP 12" rotaey air locks. System and ducting will be designed so that 1/2 of system (30,600 CFM) can be shutdown to allow operation variability.

Recommended Source:

CEA-Carter-Day Co., Minneapolis, Minnesota

REV. NO. 0

REV. DATE 12/6/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-18

COMPONENT: ELECTRIC RADIANT HEATING/THAWING EQUIPMENT

COMPONENT FUNCTION:

To skin thaw the sides and bottoms of 100 ton coal-bearing railroad hopper cars to allow bottom dumping of 2" x 0" coal with a minimum of applied labor.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

System will consist of electric, infrared heating and thawing sections applied in a geometric arrangement to heat the bottom and sides of 100 ton open top hopper cars. Heat shall come from 3,000 KW, total, of electric resistance heating, 3,000 KW shall be considered minimum; system design to be based on adequate skin thawing of (5) 100 ton hopper cars of sub-bituminous "C" coal per hour so as to allow uninterrupted bottom dumping of coal at the 500 TPH rate. Heater sections shall be furnished on integral or structural steel stands in modular sections. Modular sections to be assembled and pre-wired to terminal blocks in a water-tight wireway. Unit construction to be watertight and weatherproof with access doors for servicing. Units to be furnished with controls as a complete system with selectable switching features at a remote location incorporating time activated start-up and shut-down with system wired to allow separate zone sontrol and partial use as operationally desired. System shall also include automatic alarm features to prevent damage to the thawing equipment from railcar obstructions. All cabinetry and controls furnished must be suitable for NEC Class II, Division 1 category. Power input voltage to be 480 VAC, 3 phase.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Source:

Johnson-March Co., Philadelphia, Pennsylvania

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-19

COMPONENT: DUST CONTROL EQUIPMENT - TRANSFER HOUSE

COMPONENT FUNCTION:

Provide dust collection and control of fugitive coal dust fines at (1) prime unloading position plus (6) belt transfer locations.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

System to be ducted to coal placement positions via ducts and transfer hoods. System to move and collect approximately 10,000 CFM (total) of dust laden air from (7) locations. System filter/separator to be (1) Model 72RJ72 CEA-Carter-Day Industrial Dust Filter or equal with automatic reversible jet cleaning and 1,154 sq. ft. of cloth area. Filter unit to include (1) 10" rotary valve at bottom dust drop for pneumatic or gravity take-off. Exhaust fans, (2), to be 20" wheel, backward-inclined, Class III exhaust fans driven by 10 HP reduced and belted drives for proper RPM. Each fan shall be capable of moving 5,500 CFM of air at 8" SP. All equipment shall be capable of being mounted outdoors in a dusty ambient atmosphere. Backpressure blower - 10 HP; purge drive - 1/3 HP; exhaust fans - (2) 10 HP; rotary air lock - 3/4 HP.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Source:

CEA-Carter-Day Co., Minneapolis, Minnesota

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COAL NO. 2.12.1-20

COMPONENT: BELT SCALES (2)

COMPONENT FUNCTION:

To indicate flow rate and weigh totalize coal amounts being delivered to:

1. Stackout - unit to be mounted on conveyor that is between the R.R. unloading position to the Coal Transfer Building.

2. Silos - unit to be mounted on conveyor between the Coal Transfer Building and the Coal Silos.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(2) Weigh sensing and readout systems - belt mounted on 30" trough conveyors, rate of weighing 0-600 TPH; totalize to 3,000 tons. Each system to consist of integrator, belt travel pulser, speed signal and location compensating controls. Controls to be mounted in totally enclosed, weatherproof cabinets. Output functions to be digital with totalize and rate recording on tape or ticket output (TBD). Output metering and printing to be mounted near dump position or transfer building. Auxiliary contact points to be provided for rate and totalizing information to send logic to a central control station. System specifications to match Thayer Scale Co. Model 2RF-2-30 system bulletin 5D66, Rev. 1, 7/76, including published tolerance ranges. Power - 115 VAC (± 15%), 60 cycle, 0.5 amp.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Source:

Thayer Scale Co., E-V Systems. Inc., Stamford, Conn.

REV. NO. 0

REV. DATE 12/15/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SAND NO. 2.12.1-21

COMPONENT: SAND UNLOADING BUCKET ELEVATORS (GASIFIER BED MATERIAL) (2)

COMPONENT FUNCTION:

To lift sand from floor level to the top of the sand silo.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(2) - Bucket elevators, Sprout-Waldron or equal - standard Model #2410, 50 RPM, 2,200 CFH each of 1/8" x 0' sand. Conveyors with (2) 10' mid-section pieces with access doors, OSHA-switch, ladder and cage, platform at top, roller chain drive with guard, TEFC gear motor, solid head and boot, 14" T.U. on boot section.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power - (2) 5 HP motors, T.E.F.C.

Recommended Source:

Sprout-Waldron, B. Brown Co., Pittsford, N.Y.

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SAND NO. 2.12.1-22

COMPONENT: SAND UNLOADING SCREW CONVEYORS (2)

COMPONENT FUNCTION:

To transport sand horizontally from floor level and load bucket elevators.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(2) Screw conveyors - Sprout-Waldron or equal, Model # 14CS612, 3" shaft with standard trough, outboard bearings, drives opposite discharge side, packing glands on bearings, speed reducer and V-belt drive to approximately 28 RPM. Units to deliver 1/8" x 0" (100 lb/ft^3) sand at approximately 2,000 CFH to elevator boot sections.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power - (2) 15 HP motors, T.E.F.C.

Recommended Source:

Sprout-Waldron, B. Brown Co., Pittsford, N.Y.

REV. NO. 0
REV. DATE 12/8/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SAND NO. 2.12.1-23

COMPONENT: SAND SILO (STORAGE BIN)

COMPONENT FUNCTION:

To provide sand storage surge capacity prior to delivery of sand to crushing and/or drying operations.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

9' diameter x 16' high standard silo size (size can vary slightly) with 45° discharge cone opening, 740 CF (37 tons of sand) capacity.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Silo to be equipped with filter bag bin vent and silo transition piece to have (2) silent-type vibrators powered by air and knife-type shutoff gate.

Recommended Source:

Butler Manufacturing Co., Kansas City, Mo.
or locally designed and fabricated

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SAND NO. 2.12.1-24

COMPONENT: SAND HOPPERS (2)

COMPONENT FUNCTION:

To provide surge feeding capacity to uniformly load screw conveyors.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Top dimensions 4' x 10', bottom dimensions to fit screw conveyor troughs, height approximately 3' or to suit. Top of unit covered with heavy open grid. Material 1/4" stainless steel plate - type 304L or 316L. Top of unit to be flush with floor at installation.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SLAG & ASH HANDLING SYSTEM NO. 2.12.2-1

COMPONENT: SLAG HOPPER WITH CLINKER GRINDER

COMPONENT FUNCTION:

To collect, cool, grind for hydraulic transport and disposal up to 12,150 lbs/hr of molten slag and hot ash from the bottom of the MHD/ETF radiant boiler. The slag shall be delivered from the boiler in molten and near molten form at a pressure of 17.7 psia.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

The size of the hopper will be approximately 28' long by 8' wide with (2) circular entries on the top of the hopper for transition to the slag hopper through expansion joints. The hopper unit will be filled with cooling and flushing water to an approximate 1700 cubic foot capacity. Water for neck cooling, slag bar cooling, particle agitation, level control and hydraulic transport will be supplied to the hopper to facilitate proper design use. Attached to the bottom of the hopper will be a hold-back gate approximately 2' x 2' in size and a clinker grinder with water sealing and pressure equalizing features. The hopper will be constructed of plate steel, refractory lined and structurally reinforced to take ash and water loads plus underwater quenching shocks. Unit shall have access, inspection and rodding doors, floodlights and pressurized windows at convenient locations to support operational needs. Wear resistant protective castings shall be furnished at points of ash and water impingement, The clinker grinder furnished will be a double roll style to crush and feed slag to a hydraulic conveyor at a uniform rate to facilitate a one per shift hopper unloading cycle. The grinder fixed centers shall be 1" or as recommended by the hopper/grinder supplier to allow grinding to a size which will readily pass through the conveying system - tenative lined piping size is 6".

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Source:

United Conveyor Corp., Deerfield, Illinois
Detroit Stoker Co., Monroe, Michigan

REV. NO. 0

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SLAG & ASH HANDLING SYSTEM NO. 2.12.2-2

COMPONENT: MAIN SLURRY PUMPS (2)

COMPONENT FUNCTION:

Pumps are to used to transport ground clinker slurry from near the slag hopper to the top of the dewatering bins or to the slag disposal pond.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Pumps to be designed specifically for abrasive slurry service and shall be capable of pumping ground clinker-water mix in a concentration up to 30% by weight of crushed clinker at 840 GPM each against a 75 ft. minimum head. Pump design shall be capable of passing a 2" spherical piece and shall be Model #6M163, type M, abrasion resistant hard metal pump of 28% chrome iron steel as manufactured by the Worthinton Pump Co., Mountainside, New Jersey, or a pump of equal design capability.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Pumps to have 50 bhp drives belted or reduced to run at approximately 900 RPM.

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SLAG & ASH HANDLING SYSTEM NO. 2.12.2-3

COMPONENT: RECIRCULATION & SETTLING TANKS (2)

COMPONENT FUNCTION:

Tanks provide clarification and surge settling for the water discharged from dewatering basins. Tanks also provide sludge retention, water reservoir and heat sink functions in the overall hydraulic slag handling system.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Tanks to be 35' diameter x 7' deep with influent baffles, skimmer troughs, clear water effluent overflow troughs and other internals as required to promote sludge settling. Tanks can be concrete, steel or a combination structure and shall be built of 1/4" minimum thickness structural plate (A36 type) structurally reinforced to AISC standards. Concrete structures will be 3,000 psi type concrete reinforced to AISC standards. Piping and associated appurtenances shall conform to AWWA standards. Design of tank will allow 2.5 - 3.0 hours of retention time under either steady state or hopper flushing conditions.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Source:

United Conveyor Corp., Deerfield, Illinois
Detroit Stoker Co., Munroe, Michigan

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SLAG & ASH HANDLING SYSTEM NO. 2.12.2-4

COMPONENT: FLUSHING PUMPS (2)

COMPONENT FUNCTION:

To provide recirculated clarified water to the slag handling system.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Pumps shall be end-suction centrifugal type for clean water service and shall be capable of pumping 990 GPM each against a 231 ft. head. Pumps shall be D6x4x10-A type D-1000 pump as manufactured by Worthington Pump Co., Mountainside, New Jersey, or a pump of equal design capability.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Pumps to have 100 HP direct drives at 3350 RPM.

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COMPONENT SPECIFICATION

SUB-SYSTEM: SLAG & ASH HANDLING SYSTEM — NO. 2.12.2-5

COMPONENT: DEWATERING BINS (2)

COMPONENT FUNCTION:

To concentrate and dewater pump slurry to an approximate 85% dewatered value to facilitate land fill disposal.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Units shall be approximately 30 ft. diameter x 38 ft. in body height, mounted 11'-6" for truck clearance on structural steel. Unit shall hold 550 tons of 90 #/ft^3 slag for an approximate 12,222 cubic ft. capacity. Units shall be used alternately for maximum drainage capability. Units shall be equipped with floating decanters, bar screens, overflow features. Units shall be designed for winter use in Montana. Gates, gate frame, annular discharge regions susceptible to freezing shall be steam (preferred) or electric traced.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Source:

United Conveyor Corp., Deerfield, Illinois
Detroit Stoker Co., Munroe, Michigan

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SLAG & ASH HANDLING SYSTEM NO. 2.12.2-6

COMPONENT: SLAG WATER REUSE PUMPS (2)

COMPONENT FUNCTION:

Pumps are used to reclaim decanted slurry water from lined slag disposal pond.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Pumps shall be single stage, industrial vertical turbine pump for clean water wet-pit service and shall be capable of pumping 840 GPM each against a 90 ft. minimum head. Pumps shall be 10 HH1 10.3 type with 14' of extra length on each shaft as manufactured by Worthington Pump Co., Mountainside, New Jersey, or a pump of equal design capability.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Pump shall be mounted and wired to run alternately as signaled from a mechanical float with cut-in provisions for excess capacity or in the event of alternate pump failure. Pumps shall have clip-on strainers, suction bells and sand collars. Pump drives - 25 HP at 1760 RPM.

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COMPONENT SPECIFICATION

SUB-SYSTEM: SLAG & ASH HANDLING SYSTEM NO. 2.12.2-7

COMPONENT: SLUDGE PUMPS (2)

COMPONENT FUNCTION:

To remove settled sludge periodically from the bottoms of the recirculating and settling tanks.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Pumps shall be end suction, centrifugal type for clean water service and shall be capable of pumping 250 GPM each against 125 ft. minimum head. Pumps shall be D-3x2x2-A, type D-1000 pump as manufactured by Worthington Pump Co., Mountainside, New Jersey, or a pump of equal design capability.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Pumps to have 15 HP direct drives at 3550 RPM.

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COMPONENT SPECIFICATION

SUB-SYSTEM: SLAG & ASH HANDLING SYSTEM NO. 2.12.2-8

COMPONENT: OVERFLOW CONTROL PUMPS (2)

COMPONENT FUNCTION:

To remove overflow water from the pressure seal tank of the slag hopper.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Pumps shall be designed specifically for fine particle slurry service and shall be capable of pumping floating fines of a slag hopper in a concentration up to 10% by weight, mean particle size - 60 mesh. Pump shall be capable of pumping such a mix at 140°F at 430 GPM each against a 70 ft. minimum head. Pump design shall be capable of passing a 1.5" spherical mass and shall be Model #4R122, type R, abrasive resistant rubber-lined pump as manufactured by the Worthington Pump Co., Mountainside, New Jersey, or a pump or equal design capability.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Pumps to have 20 bhp drives directly coupled to 1200 RPM motors or belted direct.

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SLAG & ASH HANDLING SYSTEM NO. 2.12.2-9

COMPONENT: HOPPER OVERFLOW TANK WITH PRESSURE LEG

COMPONENT FUNCTION:

To provide a 5 psi pressure leg and an active reservoir to accumulate slag hopper overflow water.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Tank to be approximately 6 ft. x 6 ft. x 20 ft. deep with a minimum of 500 cubic feet capacity between level controlling positions. Tank to have attached external pressure leg built of 4" schedule 80 pipe with cleanout entries. Bottom of tank to be triangular shaped for horizontal vee-shape transition of 4" pipe for pump suction line. Tank to be constructed of plate steel (A36 type) and shall be reinforced to AISC standards to take dead, water and ash loads plus pumping shocks. Tank to have cleanout provisions, level control and suction openings, skimmer plate and emergency overflow design features.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Source:

Slag hopper supplier
Local fabricator

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FLUE GAS EMISSION NO. 2.12.5-1

COMPONENT: STACK

COMPONENT FUNCTION:

The stack will dissipate the flue gas from the MHD unit and independently fired Radiant Boiler.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

The free standing 210 foot stack (50 feet above the tallest structure) will be constructed of Corten and have a castable refractory liner. The stack inside diameter is 6 feet. The breeching dimensions are 6' x 10'. A sampling platform will be installed eight diameters downstream of the breeching and will be designed to accommodate "EPA" method 5 sampling train. Two sampling ports are required and will be located at 90° of each other. The platform will be designed to accommodate temporary housing that can be installed in the platform so that sampling can be done during inclement weather. This platform will be designed to accommodate six people plus approximately 2,000 pounds of equipment. In addition, another platform will be installed 2 diameters downstream

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

1. Platforms:

   a. Lighting for each platform
   b. 4 outlets/sampling point, 100 amps total, 110 volts
   c. Service water, 20 GPM
   d. Service Air

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COMPONENT DESCRIPTION, Continued

of the sampling ports. This platform will service a DuPont SO_2-NO_x analyzer. Provision for a hoist capable of lifting a 500 pound load to each of the platforms is required.

Estimated Weight - 625,000 lbs.

MISCELLANEOUS REQUIREMENTS, Continued

2. Stack Operating Conditions:

   a. Maximum temperature - 335°F
   b. Maximum gas flow - 160,000 ACFM
   c. SO_2 - 600 ppm; SO_3 - 6 ppm
   d. No fly ash in the flue gas
   e. Self drafting stack
   f. Seismic Class - 3
   g. Maximum wind loading - 30 psf

3. Stack Safety Equipment:

   a. Aircraft warning lights in compliance with FAA regulations
   b. Stack grounding
   c. Caged ladders from the ground to the sampling platforms in compliance with OSHA requirements

4. Two capacity analyzers of the Lear Seigler type and the required platforms shall be installed, one on each stack inlet duct.

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: STACK GAS CLEANUP NO. 2.12.5-2

COMPONENT: IONIZER/ELECTROSTATIC PRECIPITATOR

COMPONENT FUNCTION:

To remove entrained seed and fly ash from stack gas emissions.

Stack Gas Characteristics

Volume - 140,000 ACFM
Velocity - 4.8 ft/sec.
Dust type - fly ash
high resistivity
Dust loading - 3.5 gr/SCF fly ash; 0.011 gr/SCF seed

Performance

Migration velocity - 3 in/sec.
Collection efficiency -
> 98.5% (fly ash)
> 90% (seed)
Particulate emission -
~ 0.075 lb/MBTU (fly ash)

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Two stage precipitator - one ionizer field, four collecting fields.

Treatment Time - 6 seconds

Collecting surface - 9 ft. long plates, 32 ft. high, 320 $ft.^2$/1000 ACFM specific collection area

Hopper - pyramidal, electrical resistance heated

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Transformers

(2) 50 kV, 150 MA, 10 kVA
(1) 50 kV, 500 MA, 35 kVA
(1) 105 kV, 150 MA, 20 kVA

Major Interfaces

Seed Collectors
Baghouse Filter
Sand Dryer

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COMPONENT DESCRIPTION, Continued

Rappers and Vibrators:

Collecting System	- flail hammers
Emitting System	- electromagnetic, single blow
Hoppers	- electromagnetic, single blow

Overall size - 76'L x 16'W x 54'H

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COLD BLOWDOWN AIR NO. 2.12.6.3-1

COMPONENT: HOT GAS DUCT

COMPONENT FUNCTION:

Transport hot air (600°F) from the primary compressor to the high temperature air heater cold blowdown air manifold.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

24 inch OD, schedule 20, carbon steel pipe per ASTM A-106 GR B and 6 inch thickness of "Micro-Lok 650" (Johns-Manville) fiberglass metal jacketed insulation.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

None

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FLUE GAS NO. 2.12.6.3-2

COMPONENT: HOT GAS DUCT

COMPONENT FUNCTION:

Transport hot flue gas (400°F) from the expansion turbine to the stack.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

24 inch OD, schedule 20, carbon steel pipe per ASTM A-106 Gr B and 6 inch thickness of "Micro-Lok 650" (Johns-Manville) fiberglass metal jacketed insulation.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

None

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FLUE GAS NO. 2.12.6.3-3

COMPONENT: HOT GAS DUCT

COMPONENT FUNCTION:

Transport hot flue gas (930°F) from the high temperature air heater flue gas manifold to the expansion turbine.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

24 inch OD, schedule 40, low alloy steel per ASTM A-335-P22 and 6 inch thickness of mineral wool insulation with a metal jacket.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

None

REV. NO. 0

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FLUE GAS

NO. 2.12.6.3-4

COMPONENT: HOT GAS DUCT

COMPONENT FUNCTION:

Transport hot flue gas (960°F) from the high temperature air heater flue gas manifold to the attemperator.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

10 inch OD, schedule 40, low alloy steel per ASTM A-335-P22 and 6 inch thickness of mineral wool insulation with a metal jacket.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

None

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COMPONENT SPECIFICATION

SUB-SYSTEM: ATOMIZING AIR NO. 2.12.6.3-5

COMPONENT: HOT GAS DUCT

COMPONENT FUNCTION:

Transport hot air (416°F) from the attemperator to the booster compressor and from the booster compressor to the high temperature air heater atomizing air manifold.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

4 inch OD, schedule 40, carbon steel pipe per ASTM A-106 GR B and 2 inch thickness of "Micro-Lok 650" (Johns-Manville) fiberglass metal jacketed insulation.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

None

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: DILUTION AIR NO. 2.12.6.3-6

COMPONENT: HOT GAS DUCT

COMPONENT FUNCTION:

Transport hot air (600°F) from the primary compressor to the mixing valve.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

8 inch OD, schedule 40, carbon steel pipe per ASTM A-106 GR B and 4 inch thickness of "Micro-Lok 650" (Johns-Manville) fiberglass metal jacketed insulation.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

None

REV. NO. 0
REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COMBUSTION AIR NO. 2.12.6.3-7

COMPONENT: HOT GAS DUCT

COMPONENT FUNCTION:

Transport hot air (400 to 600°F) from the compressor to the attemperator and from the attemperator to the high temperature air heater combustion air manifold.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

24 inch OD, schedule 40, carbon steel pipe per ASTM A-106 GR B and 6 inch thickness of "Micro-Lok 650" (Johns-Manville) fiberglass metal jacketed insulation.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

None

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CONDENSATE AND FEEDWATER NO. 2.12.7.1-1

COMPONENT: CONDENSATE PUMPS

COMPONENT FUNCTION:

Pump condensate from the condensate hotwell through the demineralizer to the suction of the condensate booster pumps.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Vertical Centrifugal Condensate Pumps:

No. Required-	2
Rating -	850 GPM (105% of Total Flow)
Discharge Pressure -	150 psig
Minimum Flow -	200 GPM
Fluid -	Water, 135°F
Driver -	Motor, Directly Coupled
Suction -	Submerged

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power: Motor Drivers - 100 HP Motors - 460V/60HZ/3Ø
TEFC, Class B Insulation
1.05 SF, 40 C Ambient

Accessories:
- Inlet Strainer
- Motor Ammeters
- Valves - Isolation on Inlet, Motor Operated and Check Valves at the Discharge
- Minimum Flow Loop to the Condenser
- OSHA Safety Coupling Guards
- Flexible Coupling "FAST", "FALK", or Equivalent

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SUB-SYSTEM: CONDENSATE AND FEEDWATER NO. 2.12.7.1-2

COMPONENT: CONDENSATE BOOSTER PUMPS

COMPONENT FUNCTION:

Pump condensate from the demineralizers through the gland seal condenser, economizer, LP FW heater and into the deaerating heater.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Horizontal Single Stage Centrifugal Pumps:

No. Required -	2
Rating -	850 GPM (105% of Total Flow)
Discharge Pressure -	185 psig
Minimum Flow -	200 GPM
Fluid -	Water, 135°F
Driver -	Horizontal Motor, Directly Coupled
Suction -	100 psig (minimum)

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power: Motor Driver - 60 HP Motors - 460V/60HZ/3Ø
Frame 365 TS
TEFC, Class B Insulation
1.05 SF, 40 C Ambient

Accessories: Inlet Isolation Valves
Motor Operated Discharge Valves and Check Valves
Minimum Flow Loop to Condenser
OSHA Safety Coupling Guard
Flexible Coupling - "FALK", "FAST" or Equivalent

REV. NO. 0

REV. DATE 2/5/78

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CONDENSATE AND FEEDWATER NO. 2.12.7.1-3

COMPONENT: EMERGENCY MAKE-UP PUMPS

COMPONENT FUNCTION:

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(2) Horizontal, radially split, single stage, volute centrifugal pumps, each complete with mechanical seal, all metal flexible coupling, coupling guard, baseplate and 460 volt, 3 phase, 60 hertz, open drip proof induction motor for operation at 7000'. Each pump to have a capacity of 1000 GPM at a total head of 363' at a speed of 3550 RPM. Pump to have ductile or cast iron casing, stainless steel impeller, casing wearing ring and shaft sleeve. Pumps to be Worthington 6" x 4" x 10" D1011 or equal with 150 HP motors.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor controls by others.
From condensate storage tank to deaerator.

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CONDENSATE AND FEEDWATER NO. 2.12.7.1-4

COMPONENT: DEAERATOR

COMPONENT FUNCTION:

Hest the condensate to the saturation temperature of the supply steam and mechanically remove all non-condensable gases from the water.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Utility Cycle Tray Deaerating Heater
Stainless Steel Internals
Direct Contact Tray Heater
Heater Storage for 10,000 gallons
First Stage Heater shall contain spring-loaded spray valves and a stainless steel vent condenser.

Design Points:

	Combined Cycle	Bottoming Only
Extr. Stream:	39,700 lb/hr at 145.5 psia and 640 F	21,300 lb/hr at 145.5 psia and 640 F
Htr. Drips:	None	30,350 lb/hr at 368 F (340 Btu/lbm)
Condensate Flow:	372,200 lb/hr at 251 F	401,000 lb/hr at 280 F

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Accessories: High Capacity Pressure Relief Valve
Vacuum Breaker Valve
Water Inlet Regulating Valve
Water Float Control Valve

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REV. DATE 2/2/78

COMPONENT DESCRIPTION, Continued

Deaerator Guaranteed:

a. Heat water to extraction pressure saturation temperature
b. Reduce oxygen content of water to 0.005 cc/l
c. Reduce free carbon dioxide to zero

MISCELLANEOUS REQUIREMENTS, Continued

Overflow Valve
Steam Pressure Reducing Valve
Dial Pressure Gauge
Thermometer
Float Switches - High and Low

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CONDENSATE AND FEEDWATER NO. 2.12.7.1-5

COMPONENT: CLOSED FEEDWATER HEATERS

COMPONENT FUNCTION:

Add heat to the condensate/feedwater using turbine extraction steam in order to improve the cycle efficiency. Single string of 100% size heaters used.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Shell and U-tube heat exchangers. Carbon Steel Shell - 90-10 Cu-Ni Tubes (3/4" O.D.), Stainless Steel Tube Sheets, HEI-TEMA Exchangers.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

All heaters supplied with drain and alternate drain connections.
All heaters supplied with two independent level controllers and an independent level switch
Heaters used during "Bottoming Only" operation.

REV. NO. ________

REV. DATE 2/1/78

COMPONENT DESCRIPTION, Continued

FW HEATER SUMMARY

Performance Fluid	LP Heater Shell Steam	LP Heater Tubes Condensate	HP Heater Shell Steam	HP Heater Tubes Feedwater
Cond. - FW Flow (#/hr)	---	401,000	---	462,000
Steam Condensed (#/hr)	30,190	---	30,350	---
Temp. In (°F)	428	183	886	358
Temp. Out (°F)	173	280	368	437
Pressure (PSIA)	53.5	150	370	990
Pressure Drop (PSID)	0.2	5	0.2	5
Heat Transfer (BTU/hr)	3.0×10^7	3.0×10^7	3.41×10^7	3.41×10^7
HT Area (ft^2)	3,700	---	6,300	---

COMPONENT SPECIFICATION

SUB-SYSTEM: CONDENSATE AND FEEDWATER NO. 2.12.7.1-6

COMPONENT: BOILER FEED PUMPS

COMPONENT FUNCTION:

Boost the feedwater pressure to final boiler operating pressure.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Horizontal Double Case Boiler Feed Pumps:

No. Required -	2
Rating -	1500 GPM at 7000 RPM
Discharge Pressure -	4000 psig with 900 psig suction
NPSH Required -	85' (approx.)
Minimum Flow -	500 GPM
Driver -	Motor, through hydraulic coupling and speed increasing gear
Fluid -	Water, 550°F
Type -	Double case construction with forged barrel and 4-5 chrome inner casing. Byron Jackson Type HDB or equal

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power: Motor Drivers - 2400 HP Motors, 6900V/60HZ/3Ø
Open Drip Proof Enclosure
Class B Insulation
1.0 SF, 40°C Ambient

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MISCELLANEOUS REQUIREMENTS, Continued

Accessories: Inlet Strainers and Isolation Valves
Discharge Motor Operated Valves and Check Valves
Minimum Flow Loop
OSHA Safety Coupling
Speed Increasing Gear - 4:1 (approx.)
Hydraulic Coupling with 4:1 Turndown and Capable of 2 second response to a 10% step increase in speed (maximum output speed 1750 RPM)

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CONDENSATE AND FEEDWATER NO. 2.12.7.1-7

COMPONENT: INTERMEDIATE PRESSURE BOILER FEED PUMPS

COMPONENT FUNCTION:

Pump the condensate from the deaerator storage tank through the IP FW heater, Economizer #1, Nozzle, Combustor #1, to the Boiler Feed Pump inlet.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Horizontal Multi-Stage Centrifugal Feed Pumps (Split Case)

No. Required -	2
Rating -	975 GPM (105% of Rated Flow)
Discharge Pressure -	975 psig
Suction Pressure -	140 psig
NPSH Required -	30' (approx.)
Minimum Flow -	200 GPM
Driver -	Motor, through a Hydraulic Coupling
Fluid -	Water, 380°F
Type -	Byron Jackson 6 stage DVMX or equal

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power: Motor Drives - 600 HP Motors, 6900V/60HZ/3Ø
DP Enclosure
Class B Insulation
1.0 SF, 40°C Ambient

REV. NO. 0

REV. DATE 2/5/78

MISCELLANEOUS REQUIREMENTS, Continued

Accessories: Inlet Strainers and Isolation Valves
Inlet Flow Measurement Device
Motor Operated Discharge Valve and Check Valves
Automatic Bypass to Deaerator Storage
OSHA Coupling Guard
Hydraulic Coupling capable of 4:1 speed turndown and 2 second response to a 10% step change (3550 RPM full rated speed)

COMPONENT SPECIFICATION

SUB-SYSTEM: STEAM CONDITIONING NO. 2.12.7.1-8

COMPONENT: DESUPERHEATING VALVES

COMPONENT FUNCTION:

During the bypass mode of operation, steam turbine-generator not running, the steam generated in the radiant boiler/superheater/reheater will be conditioned by means of desuperheating valve to reduce the steam enthalpy similar to the reduction due to expansion through the turbine.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

DESUPERHEATING VALVE SUMMARY

FUNCTION	STEAM FLOW (lb/hr)	STEAM PRESSURE (psia)	STEAM INITIAL ENTHALPY (BTU/1bm)	STEAM REDUCED ENTHALPY (BTU/1bm)	SPRAY WATER QUANTITY (GPM)	SPRAY WATER TEMP. (°F)	SPRAY WATER SUPPLY PRESSURE (psia)	NO. OF SPRAY VALVES	SIZE OF VALVES
Main Steam Desuperheater	480,000	630	1424	1252	240	380	975	1	10"
Reheat Desuperheater	480,000	50	1517	1175	380	190	125	4	12"

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Automatically Controlled Pneumatic Actuators
Accuracy of Control ± 1%
Noise Level - 90 dBA
Water Control Valve Supplied Separately
Manufacturer's - Yarway, Copes-Vulcan, Graham, or equal

REV. NO. 0

REV. DATE 12/3/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: STEAM CONDITIONING NO. 2.12.7.1-9

COMPONENT: PRESSURE REDUCING VALVES

COMPONENT FUNCTION:

Pressure Reducing Valves (PRV's) are required to reduce the steam pressure:

1. From main steam pressure of 3500 psia to 2400 psia turbine inlet pressure (PRV-1).

2. During bypass operation, from turbine throttle pressure to cold reheat pressure (PRV-2).

3. During bypass operation, from hot reheat pressure to 50 psia for dumping to the condenser (PRV-3).

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

PRESSURE REDUCING VALVE SUMMARY

STATION DESIGNATION	PRESSURE IN (psia)	PRESSURE OUT (psia)	TEMPERATURE (°F)	MASS FLOW (lb/hr)	NO. OF STAGES OF PRESSURE REDUCTION	NO. OF VALVES STAGE #1	SIZE OF VALVES STAGE #1	NO. OF VALVES STAGE #2	SIZE OF VALVES STAGE #2
PRV 1	3500	2400	1000	480,000	1	1	6"	---	---
PRV 2	2400	630	950	480,000	2	1	6"	1	10"
PRV 3	570	50	1000	480,000	2	2	10"	4	12"

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

All valves supplied with pneumatic operators and controllers.
Noise suppression provisions on all valves to limit noise to 95 dBA.
PRV-1 body of forged CR-MO Alloy
Discharge velocities limited to 30,000 fpm
All valves supplied with transition diffusers to reduce steam velocity to 10,000 fpm.

REV. NO. 0

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COMPONENT SPECIFICATION

SUB-SYSTEM: CONDENSER CIRCULATING WATER NO 2.12.7.1-10

COMPONENT: EXPANSION SURGE TANK

COMPONENT FUNCTION:

To prevent large fluctuations in the condenser circulating water system.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

One (1) 60" diameter x 10' high surge tank fabricated of 1/4" carbon steel plate with 24" flanged connection 6" long in center of bottom, 4" vent nipple welded in center of top, and two (2) 3/4" nipples in side for gauge connections. Total approximate volume 196 cu. ft. (1466 gal.). Total weight approximately 2010 lbs.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Provision for nitrogen charge by others.

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CHEMICAL FEED SYSTEM NO. 2.12.7.1-11

COMPONENT: CHEMICAL PUMP AND TANK EQUIPMENT

COMPONENT FUNCTION:

Provide a hydrazine feed system to feed hydrazine to the IP Boiler Feed Pump Suction.

Provide an ammonia feed system to feed ammonia to:

1. Condensate Demineralizer Discharge
2. Circulating Water System

Provide one spare pump common to both systems.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Three (3) tanks each shall be 50 gallon capacity and of 16 gauge type 304 or 316 stainless steel with hinged lid.

Pumps shall be either Milton Ray or Pulsafeeder premium quality and shall be of the diaphragm, positive displacement, metering type with provisions for changing the stroke length from 0 to 100 percent by means of a micrometer adjuster while the pumps are operating. Each pump shall be designed to pump 2.1 gph at 250 psia. Pumps shall be mounted below the tanks.

The ammonia feed system will include two tanks. One ammonia solution tank will be used for strong ammonia solution, the other for weak ammonia solution. Each tank shall be piped and valves such that the operating pump can take suction from either by simply changing valve position. Each tank shall have a sealable lid (to prevent ammonia fume release), a

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Discharge piping, motor starters, and power source.

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COMPONENT DESCRIPTION, Continued

valved vent with connection suitable for piping to a discharge by the Purchaser, and two (2) valved fill connections near the top of the tank (one for dilution water and one for ammonia).

Each solution tank shall have a gauge glass installed in 1/2 gallon increments and covering a range of 1-50 gallons of pumpable liquid. The weak solution tank shall have a 1 gallon, sealed, vented, graduated metering cylinder mounted on it. This cylinder shall have 1/2 pint (minimum) graduations visible on four sides, 3/4 inch ammonia inlet connection and 1/2 inch valved discharge and vent connections.

A cylinder vent shall be located on ammonia inlet piping between the throttling valve and the cylinder. The cylinder shall also be complete with an installed throttling valve and shut-off valve in the cylinder discharge pipe. The cylinder shall be made from a translucent material suitable for contact with 28 percent aqua ammonia.

Provide two (2) drum pumps (one shelf spare), Model PP 8200-B-3/4-inch-OP, complete with two (2) Part No. 99-107 drum adapters and thirty (30) feet of Part No. 55-266 PVC hose 3/4-inch diameter (as manufactured by Serfilco, Division of Service Filtration Corporation, Chicago, Illinois, phone 312-273-3240) or Engineer approved equal.

The hydrazine feed system shall include one tank (with floating cover) and one pump.

The spare pump shall be installed and piped and valved such that it can be placed in service by changing valve positions only.

Provide one (1) by-pass pot feeder, 18 gallon capacity with a pressure rating of 200 psig and complete with angle leg supports, inlet, outlet and bottom drain valves and piping, fill valve suitable for either dry or wet chemical addition as manufactured by Neptune Chemical Co., Lansdale, Pa.

COMPONENT SPECIFICATION

SUB-SYSTEM: WATER SAMPLING AND MONITORING SYSTEM NO. 2.12.7.1-12

COMPONENT: WATER SAMPLING AND MONITORING EQUIPMENT

COMPONENT FUNCTION:

To continuously monitor those parameters which are critical from an alarm, problem prevention, or problem solving standpoint.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

One sample panel complete with manual sample sink, window type annunciator, sample temperature and pressure control system, and the following:

Four (4) specific conductivity monitoring systems
Five (5) cation conductivity monitoring systems
Four (4) pH monitoring systems
Two (2) sodium monitoring systems
Two (2) dissolved oxygen monitoring systems
One (1) turbidity monitoring system
One (1) silica monitoring system
One (1) hydrazine monitoring system
Four (4) one-pen recorders
Eight (8) two-pen recorders
One (1) three-pen recorder

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Installation of panel, including foundation, mounting, anchoring, wiring connections, sample source to panel piping and drains.

REV. NO. 0

REV. DATE 12/13/77

COMPONENT DESCRIPTION, Continued

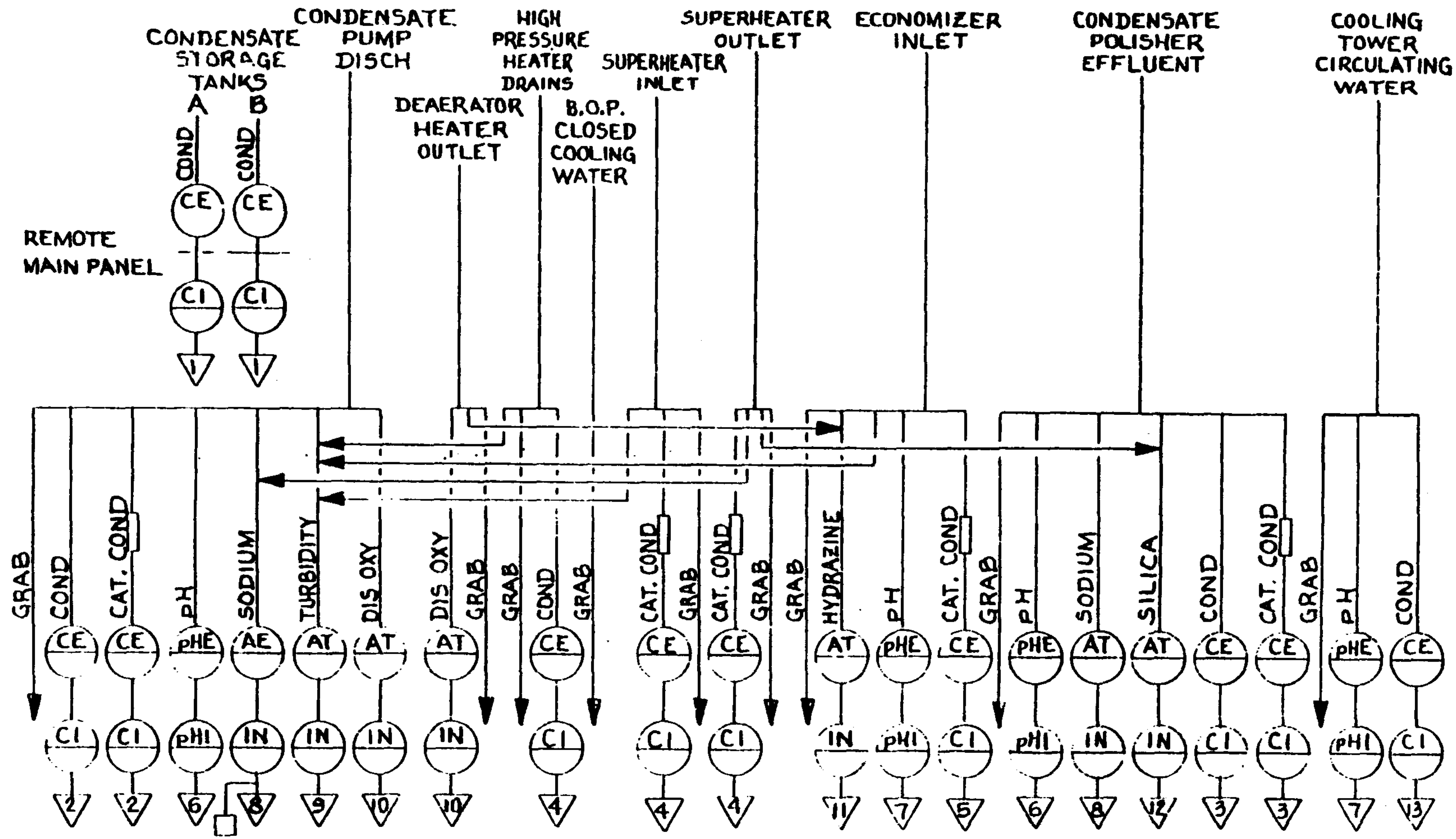
The following samples will be brought to the sample panel:

1. Cooling tower circulating water
2. Condensate pump discharge
3. Condensate polisher effluent superheater inlet
4. Deaerator heater outlet
5. Economizer inlet
6. Superheater outlet
7. High pressure heater drain
8. B.O.P. closed cooling water
9. Both condensate storage tanks

Figure 2-1 shows the required analysis for each sample.

The turbidimeter will be shared by these (3) samples; condensate pump discharge, high pressure heater drain, and steam, utilizing an automatic, adjustable duration sequence timer. The 2 pen recorder associated with turbidity will be a stepping type, with one pen indicating the sample being analyzed. The condensate pump discharge sodium analyzer will be manually shared with the steam sample and the condensate polisher effluent silica analyzer will be shared with the steam sample.

Each pH and conductivity cell shall be temperature compensated. Each sample brought to the panel shall have a manual sample outlet at the panel sink. The sample temperature control system shall automatically control all sample temperatures (including manual sample temperatures at 77° + or 2°F).



RECORDER DETAIL

1. 2PEN	7. 2PEN	13. 1PEN
2. 2PEN	8. 2PEN	
3. 2PEN	9. 2PEN	
4. 3PEN	10. 2PEN	
5. 1PEN	11. 1PEN	
6. 2PEN	12. 1PEN	

NOTES

1. SAMPLE COOLING PRESSURE REDUCTION, VALVING AND BLOWDOWN DETAILS NOT SHOWN
2. SAMPLE RECLAIM AND ANALYZER WASTE SYSTEMS NOT SHOWN
3. SHARED ANALYZER DETAILS NOT SHOWN

CE CONDUCTIVITY ELEMENT
CI CONDUCTIVITY INDICATOR
AT ANALYZER TRANSMITTER
IN ANALYZER INDICATOR
pHE pH ELEMENT
□ MAIN CONTROL ROOM ANNUNCIATOR POINT
pHI pH INDICATOR
▽ RECORDER
▯ CATION EXCHANGER

Figure 2-1. WATER SAMPLING & MONITORING SYSTEM GENERAL SKETCH

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CONDENSATE AND FEEDWATER NO. 2.12.7.1-13

COMPONENT: CONDENSATE STORAGE TANKS

COMPONENT FUNCTION:

To store 30,000 gallons of condensate.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Two (2) vertical cylindrical welded steel tanks for steam condensate. Tanks to be fabricated of 3/16" carbon steel plate, 16' inside dia. x 20' high to have a capacity of 30,000 gallons (each) to have an epoxy coating on the inside with the following nozzles and openings:

(1) 2" - 150# FF Pump Suction Nozzle
(1) 3" - 150# FF Drain Nozzle
(1) 3" - 150# FF Vent Nozzle
(2) 24" Manholes

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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COMPONENT SPECIFICATION

SUB-SYSTEM: RAW WATER MAKEUP AND STORAGE NO. 2.12.7.2-1

COMPONENT: DEMINERALIZED WATER STORAGE TANKS

COMPONENT FUNCTION:

To store 15,000 gallons of demineralized water.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Two (2) vertical cylindrical welded steel tanks for demineralized water. Tanks to be fabricated of 3/16" carbon steel plate 12' inside diameter x 17'-9" high to have a capacity of 15,000 gallons (each). To have an epoxy coating on the inside (to protect the metal from demineralized water) with the following nozzles and openings:

(1) 3" - 150# FF Pump Suction Nozzle
(1) 6" - 150# FF Drain Nozzle
(1) 6" - 150# FF Vent Nozzle
(2) 24" - Manholes

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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COMPONENT SPECIFICATION

SUB-SYSTEM: RAW WATER MAKEUP AND STORAGE NO. 2.12.7.2-2

COMPONENT: DEMINERALIZED WATER TRANSFER PUMPS

COMPONENT FUNCTION:

To transport water from the demineralized water storage tanks to the condensate storage tanks.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(2) Horizontal, radially split case, single stage, volute type centrifugal pumps, each complete with mechanical seal, all metal flexible coupling, coupling guard, baseplate and 460 volt, 3 phase, 60 hertz, open drip proof induction motor for operation at 7000'. Each pump to have a capacity of 100 GPM at a total head of 60' at a speed of 3500 RPM. Pumps to have all wetted parts of 316 stainless steel. Pumps to be Worthington 3" x 1-1/2" x 8" D1011 or equal with 3 HP motors. Total weight 313 lbs per unit.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor control by others.

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REV. DATE 12/13/77

COMPONENT SPECIFICATION

SUB-SYSTEM: RAW WATER, MAKE-UP AND STORAGE NO. 2.12.7.2-3

COMPONENT: BOILER MAKE-UP DEMINERALIZER EQUIPMENT

COMPONENT FUNCTION:

Demineralization of boiler make-up water. Will also, prior to start-up, provide make-up for the closed cooling water system.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

System to consist of two (2) demineralizer trains, each having a cation unit, anion unit, mixed bed unit, and each sharing a single forced draft decarbonator. Each ion exhcanger shall be sized for a normal flow of 45 GPM. Supply pressure to the cation units will be a minimum of 30 psig and a maximum of 50 psig. The vessels shall be designed for 100 psig ASME Code and shall bear the code stamp. The flow rate through the ion exhange units shall not exceed 8 GPM/ft^2 for the primary units nor 16 GPM/ft^2 for the mixed bed units. Each primary unit shall have a minimum of 30" of resin and each mixed bed shall have a minimum of 24" of cation resin and 24" of anion resin. Each primary unit shall be provided with the necessary valving for automatically segregating wastes.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Interconnecting wiring (panel and demineralizer). Installation of caustic and acid storage tanks. Piping and valving associated with acid and caustic feed systems. Piping and valving of raw water supply and demineralizer water discharge piping.

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COMPONENT DESCRIPTION, Continued

Regeneration shall be automatically initiated by preset throughput with back-up of ratio conductivity for the cation units, conductivity for the anion units, and conductivity and silica for the mixed bed units. Necessary controls and analyzers shall be provided.

The forced draft decarbonator shall be designed to reduce the carbon dioxide level of the water to 10 PPM (as CO_2) with a water temperature of 32°F. The decarbonator shall be designed to operate satisfactorily at 45 - 90 GPM and shall contain an integral storage tank with sufficient capacity to permit smooth operation of the inlet control valves. The decarbonator shall be provided with an installed spare blower.

Based on the 90 GPM flow rate, three (3) half capacity decarbonated water pumps shall be furnished, each capable of producing an excess pressure of at least 50 psig at the mixed bed outlet piping terminal.

An acid regeneration system shall be provided and shall include:

1. One (1) cation acid regeneration pump
2. One (1) mixed bed acid regeneration pump
3. One (1) spare acid regeneration pump
4. One (1) 300 gallon acid storage tank
5. All necessary valving, mixing tees, controls. etc.

A caustic regeneration system shall be provided and shall include:

1. One (1) anion caustic regeneration pump
2. One (1) mixed bed caustic regeneration pump
3. One (1) spare caustic regeneration pump
4. One (1) electric caustic heater with storage tank. Heater shall be designed to heat sufficient water for regeneration of both anion units in 6 hours.
5. One (1) 300 gallon caustic storage tank
6. All necessary valving, mixing tees, controls, etc.

COMPONENT DESCRIPTION, Continued

A low quality sump pH control system shall be provided as follows:

1. One (1) pH all assembly (rigid), suitable for insertion in the low quality sump
2. One (1) pH monitor, installed in a water tight (NEMA 4) enclosure, mounted on the acid-caustic pump skid.

A demineralizer control panel shall be provided to house and display all required controllers, timers, analyzers, recorders, etc.

All of the above equipment shall be skid mounted, with the exception of the acid and caustic tanks, and complete with all inlet, outlet, and interconnecting piping and valves.

2.14 STEAM TURBINE GENERATOR AND AUXILIARIES

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: STEAM TURBINE-GENERATOR NO. 2.14.1-1

COMPONENT: STEAM TURBINE-GENERATOR

COMPONENT FUNCTION:

A steam turbine-generator is used in the steam bottoming cycle or independent of the MHD generator to produce electrical power.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Turbine - 80MW TC-2F-20" LSB Reheat Turbine
Steam Conditions - 2400 psia/950°F/1000°F
Throttle Flow - 477,000 lbs/hr
Backpressure - 5" HgA (max.)
Extractions - 2 Closed Feedwater Heaters & 1 Deaerator
Speed - 3600 RPM

Generator - Hydrogen Cooled with Static Excitation System
Rating - 96,000 KVA
Terminal Voltage - 13.8 kV
Power Factor - 0.90
SCR - 0.58

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Major Interfaces - Turbine-Generator Foundation, Main Steam Piping, Reheat Steam Piping, Extraction Steam Piping, Feedwater Heater System, Condenser, and Bus Ducting.

Controls - Turbine-Generator will be capable of local start-up or by computer control. Control system will be compatible with utilities load dispatching.

Cooling Requirements - 800 GPM @ 85°F

Power - 300 HP total (none above 40 HP) @ 460/60/3 - 40 HP @ 120/240 VDC

Accessories - All standard accessories as supplied by the turbine-generator manufacturer.

REV. NO. 0

REV. DATE 11/29/77

COMPONENT SPECIFICATION

SUB-SYSTEM: STEAM TURBINE-GENERATOR NO. 2.14.1-2

COMPONENT: LUBE OIL PURIFICATION SYSTEM

COMPONENT FUNCTION:

A bearing lube oil purification and conditioning system is required to maintain turbine generator lube oil at the correct quality and purity. Purification system will be capable of both batch and bypass conditioning.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Rating - Bypass Mode 10-20%/hr. = 200-400 GPH
Batch Mode 20%/hr. = 400 GPH

Type - Skid mounted filtration unit with precipitation, filtration and storage compartments.

Quality of Conditioning - SAE-ARP Class 6 (NAS9) plus removal of all free water

General Requirements - ASTM STD, No. 118

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power - Circulating Pump - 5 HP
Transfer Pumps - 5 HP (2 required)

Major Interfaces - Lube Oil Pumping Unit and Storage Tanks

Special Accessories - Provisions for sampling purification unit discharge

REV. NO. 0

REV. DATE 11/29/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CONDENSER NO. 2.14.2-1

COMPONENT: CONDENSER

COMPONENT FUNCTION:

A water-cooled surface condenser will be used to:

1) Condense the steam turbine exhaust flow.
2) Condense the steam bypassed from the superheater and hot reheat lines during MHD generator operation without the steam turbine in operation.
3) Act as a dump for feedwater heater and other miscellaneous drains and vents.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Design Point: Steam Turbine Exhaust Flow - 400,000 lbs/hr at 1020 BTU/lbm
Circulating Water Inlet Temperature - 85°F
Circulating Water Flow - 40,000 GPM
Operating Pressure - 2.5" HgA

Bypass Operation: Steam Flow - 600,000 lb/hr, h_{max} = 1175 BTU/lbm
Condenser Pressure = 20" HgA (max.)

Design Characteristics:

Number of Passes - 2	TTD - 5°F (min.)
Cleanliness Factor - 90%	Tubes - Admiralty Metal - 3/4" 18 BWG
Velocity - 7 fps	
Number of Tubes - 11,000	Tube Length - 21'
Total Surface Area - 45,700 ft^2	

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Accessories: Vacuum Breaker Valve
Air Removal Equipment
Provisions for Condenser Backwash
Spray Bars & Manifolds for Distribution of High Dump Flow

Major Interfaces: Condenser Neck welded to turbine exhaust hood (Rubber expansion joint fitted in condenser neck)

REV. NO. 0
REV. DATE 12/1/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CONDENSER

NO. 2.14.2-2

COMPONENT: VACUUM PUMPS

COMPONENT FUNCTION:

Vacuum pumps are used for air removal from the condenser/turbine system to establish a vacuum of 25" Hg or better for start-up and operation of the steam turbine.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

2-50 HP Motor Driven Vacuum Pumps Required
Allis-Chalmers Type 17S Vacuum Pumps or equivalent
Sized to evacuate 22,000 FT^2 Volume from atmospheric pressure to 5" HgA in 20 min.
Two pumps used in parallel for "hogging" operation. One pump used for "holding" with the second as a 100% back-up.
Single stage rotary pump - 690 RPM - 121" long x 32.5" wide - 8" Inlet, 6" Outlet

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Each Motor Drive - 50 HP
Major Interface - Condenser Shell
Special Accessories - Full Coupling Guards

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CONDENSER CIRCULATING WATER NO. 2.14.3.1-1

COMPONENT: CIRCULATING COOLING WATER PUMPS

COMPONENT FUNCTION:

To circulate condenser circulating water from the condenser to the cooling tower where the heat rejected in the condenser is rejected to the atmosphere.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(3) Horizontal, axially split case, single stage, volute type centrifugal pumps, each complete with mechanical seals, base-plate, all metal limited end float, flexible coupling, coupling guard and 4160 volt, 3 phase, 60 hertz, 1.0 service factor, open drip proof induction motor for operation at 7000'. Each pump to have a capacity of 30,000 gpm at a total head of 62' at a speed of 390 rpm. Pump to have cast iron casing, bronze impeller, casing, impeller wearing rings and shaft sleeve and fabricated steel base. Pumps to be Worthington 36LN39 or equal with 600 H.P. motors. Total weight 54,090# each.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor control by others.
From dry cooling tower to main turbine condensers.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COOLING WATER NO. 2.14.3.1-2

COMPONENT: CIRCULATING COOLING WATER BOOSTER PUMPS

COMPONENT FUNCTION:

To supply water from the condenser circulating water system to the following systems:

(1) Main Combustion Air
(2) Slag Quench Tank Cooling
(3) Valve Cooling
(4) Balance of Plant Cooling
(5) MHD Channel Cooling (Back Up)

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Three (3) Horizontal, radially split case, single stage, volute type centrifugal pumps, each complete with mechanical seal, all metal flexible coupling, coupling guard, baseplate and 460 volt 3 phase, 60 hertz, open drip proof induction motor for operation at 7000'. Each pump to have a capacity of 2500 gpm at a total head of 125' at a speed of 1770 rpm. Pump to have ductile or cast iron casing, stainless steel impeller, casing wearing ring and shaft sleeve. Pumps to be Worthington 10"x8"x13" D1011 or equal with 125 H.P. motors. Total weight 7300# each unit.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor control by others.
From condenser circulating water system to closed cycle cooling water system.

REV. NO. 0
REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COOLING WATER NO. 2.14.3.1-3

COMPONENT: BEARING COOLING WATER CIRCULATING PUMPS

COMPONENT FUNCTION:

To circulate bearing cooling water from balance of plant heat loads to heat exchangers.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(2) horizontal, radially split case, single stage, volute type centrifugal pumps, each complete with mechanical seal, all metal flexible coupling, coupling guard, baseplate, and 460 volt, 3 phase, 60 hertz open, drip proof induction motor for operation at 7000'. Each pump to have a capacity of 500 gpm at a total head of 165' at a speed of 1760 rpm. Pump to have ductile or cast iron casing, stainless steel impeller, casing wearing rings and shaft sleeve. Pumps to be Worthington 4"x3"x13" D1011 or equal with 40 H.P. motors. Total weight 980# each unit.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor control by others.

REV. NO. 0

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COMPONENT SPECIFICATION

SUB-SYSTEM: BEARING COOLING WATER NO. 2.14.3.1-4

COMPONENT: SURGE TANK

COMPONENT FUNCTION:

To provide surge protection for the bearing cooling water system.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

One (1) 18" Dia. x 8'-0" high surge tank fabricated of 1/4" carbon steel plate with 6" flanged connection 6" long in center of bottom, 1-1/2" vent nipple welded to center of top and two (2) 3/4" nipples in side for gauge connections. Total approximate volume 14 cu. ft. (105 gal.) Total weight approx. 425#.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: BEARING COOLING WATER NO. 2.14.3.1-5

COMPONENT: BEARING COOLING WATER HEAT EXCHANGERS

COMPONENT FUNCTION:

To reject bearing cooling water heat to the condenser circulating water.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(3) 50% capacity shell and tube heat exchangers, each consisting of two units with shells in parallel and tubes in series. Shell sides to handle a flow of water entering at 120°F, 125,000#/hr, leaving at 90°F. Tube sides to utilize cooling water entering at 85°F. Max. tube pressure drop - 5 psi per tube bundle. Maximum shell pressure drop - 5 psi. Tube and tube sheet material to be 90-10 CuNi. Shell and channels to be carbon steel. Units to be TEMA Type AEM, constructed in accordance with TEMA Design C, ASME Boiler and Pressure Vessel Code Section VIII, Div. I and ASME code stamped. Units to be Basco Size 14205 Model OP or equal. Shell side design pressure 150 psi. Tube side design pressure 150 psi. Total weight (two units) 6500#.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Relief valves, Isolation valves, and Interconnecting Piping by others.

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: DEMINERALIZED WATER SYSTEM NO. 2.14.3.1-6

COMPONENT: MHD CHANNEL COOLING SYSTEM MAKEUP PUMP

COMPONENT FUNCTION:

To boost supply pressure of makeup water to MHD channel cooling system.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(2) horizontal, radially split, single stage, volute type centrifugal pumps, each complete with all metal flexible coupling, coupling guard, baseplate and 460 volt, 3 phase, 60 hertz, open drip proof induction motor for operation at 7000'. Each pump to have a capacity of 100 GPM at a total head of 520', (50 GPM will be recirculated) at a speed of 3550 RPM. Pump to have all stainless steel wetted parts. Pumps to be Worthington 3" x 1-1/2" x 13" D1011, or equal, with 50 HP motors. Total weight 972 lbs. each unit.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor control by others
From vacuum deaerator to MHD channel cooling system.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: DEMINERALIZED WATER SYSTEM NO. 2.14.3.1-7

COMPONENT: VACUUM DEAERATOR

COMPONENT FUNCTION:

To deaerate cooling water required for MHD channel cooling system.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

One (1) vacuum deaerator to deaerate 50 GPM demineralized water to a residual oxygen content of 0.1 ppm. Deaerator to have 2 minutes storage and rubber lining where demineralized water is in contact with the deaerator. Unit to be complete with two stage vacuum pump and inlet valve with level control. Deaerator to be as manufactured by Permutit Co., or equal.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor control by others.
From demineralized storage tanks to MHD channel cooling system booster pumps.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CIRCULATING WATER — NO. 2.14.3.1-8

COMPONENT: MHD CHANNEL CIRCULATING PUMPS

COMPONENT FUNCTION:

Circulating water pumps are required to booster the MHD channel circulating water from a nominal system pressure of 150 psia to pressure of 220 psia into the MHD Generator and Nozzle cooling passages.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(2) horizontal, radially split case, single stage, volute type centrifugal pumps, each complete with mechanical seal, all metal flexible coupling guard, baseplate, and 460 volt, 3ϕ, 60 Hz motor.
Each pump sized for 1300 gpm with a discharge head of 500'.
Motors are 1800 RPM - 50 HP Horizontal Motors.
Operating Fluid - Circulating water at 170 F.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CIRCULATING WATER NO. 2.14.3.1-9

COMPONENT: MHD CHANNEL HEAT EXCHANGER (GCLR)

COMPONENT FUNCTION:

Primary heat rejection for the MHD Generator and Nozzle cooling water.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Shell-and-tube TEMA standard heat exchanger.
Water-to-water Heat Exchanger.

	Tube Side	Shell Side
Fluid:	Condensate	Cooling Water
Pressure:	150 psig	170 psig
Temp. In:	109 F	275 F
Temp. Out:	251 F	168 F
Flow:	372,000 lb/hr	504,900 lb/hr

Surface Area: 13,000 FT^2
Carbon Steel Shell
90-10 Cu-Nl (3/4" OD) Tubes

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Heater to be supplied with vent,relief valve, and instrumentation connections for use with automatic flow control valves.

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CIRCULATING WATER NO. 2.14.3.1-10

COMPONENT: MHD CHANNEL BACK-UP HEAT EXCHANGER

COMPONENT FUNCTION:

Cooling of the MHD channel and Nozzle circulating water during emergency operation when the MHD channel Heat Exchanger (GCLR) is out of service.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Shell-and-Tube TEMA Standard Heat Exchanger
Water-to-water-Exchanger
Suface Area: 3,500 FT^2
Carbon Steel Shell
90-10 CuNi (3/4" OD) Tubes

	Tube Side	Shell Side
Fluid:	Cooling Tower Circulating Water	Cooling Water
Pressure:	25 psig	120 psig
Temp. In:	95 F	275 F
Temp. Out:	115 F	168 F
Flow:	2,701,200 lb/hr	504,900 lb/hr

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Heater to be supplied with vent, relief valve, and instrumentation connections for use with automatic flow control valves.

REV. NO. 0

REV. DATE 2/2/78

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COOLING TOWER NO. 2.14.3.2

COMPONENT: COOLING TOWER

COMPONENT FUNCTION:

A cooling tower is required to dissipate the heat added to the circulating water system by the condenser, MHD generator heat exchanger, and other balance of plant heat exchanger equipment. A dry cooling tower is required since no loss of cooling water is allowed.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Design Conditions: 5.4×10^8 BTU/hr Heat Load
57,000 GPM - Circulating Water Flow
85°F - Water Discharge Temperature
65°F - Ambient Air Temperature

Marley Type Round "Dri Cooler" Cooling Tower - Mechanical Induced Draft 250' in Diameter x 65" to the Fan Deck, Fan Stack 18' High

Heat Transfer Surface: Admiralty Metal Tubes, 1-1/4" - 18 BWG
Aluminum Fins
Area - 3,900,000 ft^2

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

HP required - 3800 HP (19 cooling fans - 200 HP motors each - 460V/60Hz/3Ø)

Individual Fan Control
Automatic Temperature Control
Motors Sized for 5000 ft. Altitude

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2.15 ACCESSORY ELECTRICAL EQUIPMENT

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: ACCESSORY ELECTRICAL EQUIPMENT NO. 2.15.1

COMPONENT: STATION AUXILIARY TRANSFORMERS

COMPONENT FUNCTION:

Supply power for the station auxiliary loads.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

2 Transformers Type OA

Rated - 45 MVA
Oil Filled, 65°C rise
HV-67,000 volts, delta connected
LV-6900 Volts, wye connected with neutral bushing
BIL-HV 350 kV, LV 95 kV, neutral 95 kV

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Fault pressure relay
Neutral bushing CT

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: ACCESSORY ELECTRICAL EQUIPMENT NO. 2.15.2

COMPONENT: 6900 VOLT METAL CLAD SWITCHGEAR

COMPONENT FUNCTION:

Distribute the station service power.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

2 Line-ups of metal clad switchgear with power VAC circuit breakers rated 8.25 kV, 3000 amp syn. interrupting 41,000 amperes momentary each with:

2 - Incoming breakers, 2000 amp
1 - Generator breaker emergency
1 - Breaker for load shedding
* - Motor starting breakers over 1500 HP
* - Motor starting breakers under 1500 HP
2 - Sets potential transformers
1 - Set synchronizing equipment

* See Drawing E-2 for numbers required.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: ACCESSORY ELECTRICAL EQUIPMENT NO. 2.15.3

COMPONENT: LOAD CENTER UNIT SUBSTATIONS

COMPONENT FUNCTION:

To transform from 6900 V to 480 V for secondary distribution of electrical power, and to provide circuit breaker protection for the 480 V bus. Where loads are directly connected to the 480 V bus, circuit breaker protection is provided.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

These unit substation (example: GE AKD-6 Low Voltage Switchgear) consist of an incoming line section, a transformer section, and a low voltage switchgear section in a single packaged unit for indoor installation. For larger size transformers, an oil transformer is utilized (outdoor) and cabled to the indoor substation. Motor control centers are physically connected to the substation (direct fussing) where location/distance considerations permit.

Some unit substations (See Drawings E2 and E3) are doubly fed via two transformers and two main 480 V circuit breakers (interlocked) to provide continuity of service to the 480 V bus.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: ACCESSORY ELECTRICAL EQUIPMENT NO. 2.15.4

COMPONENT: MOTOR CONTROL CENTERS

COMPONENT FUNCTION:

To provide secondary distribution at 480 V and circuit breaker (or combination motor control unit) protection for motors and other loads.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

These motor control centers (example: GE 7700 Plus and 7700 Lines) consist of an incoming line section or a transition section (for direct fussing to a load center), and a circuit breaker/combination motor control section in a single packaged unit for indoor installation. Motor control centers are physically connected to load center unit substations (direct fussing) where location/distance considerations permit.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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COMPONENT SPECIFICATION

SUB-SYSTEM: ACCESSORY ELECTRICAL EQUIPMENT NO. 2.15.5

COMPONENT: UNINTERRUPTIBLE POWER SUPPLY (UPS)

COMPONENT FUNCTION:

Supply uninterrupted power (115 volts, a.c., 100 KVA) to the control and instrumentation system for up to 30 minutes following the loss of ac source power.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

UPS consists of:

1. Rectifier for converting three phase, 480 VAC to DC. Sized to supply one fully load inverter, one on-but-idle inverter, and to recharge the batteries within 8 hours.
2. Batteries capable of sustaining rated output from one inverter for 30 minutes following the loss of source power (480 VAC, 3 phase).
3. Dual inverters: each capable of supplying 100 KVA, 115 volts, a.c. to the load.
4. Two zero-break static switches for (1) switching to the on-but-idle inverter should the fully loaded inverter fail and (2) switching to the UPS input line (via a step down and regulation transformer) should both inverters fail.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power: 480V, 3 phase

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: ACCESSORY ELECTRICAL EQUIPMENT NO. 2.15.6

COMPONENT: STATION BATTERY AND CHARGER

COMPONENT FUNCTION:

To provide electrical power (DC) for an emergency shutdown via the DC Distribution Panel. The battery will be suitably sized to shut down the plant in an emergency. The charger will be capable of floating the battery in a fully charged condtion and restoring the battery to normal charge in a reasonable time (8 hours) following an emergency shutdown.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Station battery - 58 cells, 125 volts, 1500 ampere hours with rack, intercell connections, and standard accessories.

Battery charger - static type, 480 volts, 3 phase, 60 Hz input, 118-144 volt dc output, 200 ampere, with voltmeter, ammeter, and equalizing timer.

Distribution panel - 125 V dc, 600 amp bus, supplied with molded-case breakers to supply loads and emergency lighting.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: ACCESSORY ELECTRICAL EQUIPMENT NO. 2.15.7

COMPONENT: EMERGENCY DIESEL GENERATOR

COMPONENT FUNCTION:

The function of the diesel engine generator is to provide emergency electrical power following failure of both sources of utility power to the auxiliary power system. This is to reduce the probability of damage to equipment, permit an orderly shutdown, maintain start-up readiness, and maintain certain necessary equipment energized during the utility outage.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)
Power Output, net continuous (minimum) - 2200 KW
Power Factor - 80%
The diesel engine generator shall be capable of starting a 600 H.P., across the line start, squirrel cage induction motor, while carrying a load of 2000 KVA at 80% power factor. Voltage at the generator shall recover to 90% and frequency shall recover to 58 cycles within 2 seconds or less of starting the 600 HP motor.

The generator shall be rated to deliver the maximum power developed by the engine, at rated power factor without exceeding nameplate rating.
Phase - 3
Voltage - 6900
Max. Synchronous Speed - 1800 rpm
Fuel, Oil - No. 2

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)
The diesel-engine generator shall be a complete skid mounted indoor unit, with all necessary components requiring only setting in place, fuel connection, exhaust system assembly, connection of electrical cables for outgoing power, and connection of leads for remote starting, stopping, and potential for initiation of automatic starting.

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MISCELLANEOUS EQUIPMENT: (Continued)

The unit shall be arranged for local manual operation, remote initiation of starting and stopping, and automatic starting upon failure of potential from the purchaser's bus. The automatic starting cycle shall not exceed 10 seconds from the time of potential failure to assumption of load. The sensor used to detect power failure shall not operate due to voltage disturbances.

The unit shall be complete, up to but not including the generator circuit breaker.

A neutral reactor shall be provided to limit short circuit current to generator capability, or if necessary, to limit third harmonic current to acceptable values.

The governor shall be hydraulic or electro-hydraulic and shall be capable of isochronous operation when operating isolated, or stable speed droop parallel operation.

The unit shall be complete with the manufacturer's standard excitation system, including all accessories, meters, switches, etc. to make a complete operable system.

The lubrication system shall be complete integral system with oil pump, coolers, pressure indicator, etc.

The fuel oil system shall be complete including an integral fuel tank and connections. Connection to the integral tank from the day tank, transfer pumps, and bulk storage tanks, and unloading facilities will be provided by others. The integral tank shall be at ample capacity for 4 hours, full load operation.

The air intake system shall be integral with the engine, and shall be complete including air filter.

The exhaust system shall be complete including silencer, spark arrester, and ducts. The silencer and duct work will be for assembly by others.

The cooling system shall be a closed system with radiator. The radiator, motor driven fan, thermostats, temperature control, jacket water heaters, and all other components necessary for a complete system shall be furnished. Except that pipe connections and electrical connections from the radiator to the skids will be furnished by others.

An annunciator shall be furnished to indicate malfunctioning. All malfunctions recommended by the manufacturer shall be annunciated. The annunciator shall have a contact for remote indication provided by others.

MISCELLANEOUS REQUIREMENTS: (Continued)

All alarm, tripping devices, indicators and other devices necessary or recommended for satisfactory operation shall be provided.

A complete starting system shall be provided. The system shall be complete including battery, automatic regulated charger, starting relay, timer, and other components to make a complete system. The battery shall be capable of at least four successive starts under the most adverse conditions. The charger shall be capable of fully recharging a discharged battery in four hours or less.

A barring device shall be furnished for maintenance rotation.

Automatic synchronizing shall be provided to match speed and voltage, and close the generator breaker. Automatic synchronizing shall be initiated automatically when the unit reaches approximately rated speed and voltage.

SUB-SYSTEM: ACCESSORY ELECTRICAL EQUIPMENT NO.2.15.8-1

COMPONENT: POWER AND CONTROL WIRING - 6900 V CABLE

COMPONENT FUNCTION:

To electrically connect the metalclad switchgear (Spec. 2.15.2) to (a) the station auxiliary transformers, (b) the emergency diesel generator, (c) the various load centers, and (d) the various 6900 V motors.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

All cabling to be either single-conductor or three-conductor (depending upon size and therefore ease of pulling) rated at 8 KV for a grounded system with VULKENE^R insulation, FLAMENOL^R jacketed, and shielded or equivalent. Estimated cable runs, stated for 3 conductor cable, are:

Size	
4/0 AWG	20,000 ft
350 MCW	7,000 ft

Stress cones and termination equipment for both ends of each conductor.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: ACCESSORY ELECTRICAL EQUIPMENT NO. 2.15.8-2

COMPONENT: POWER AND CONTROL WIRING - CONTROL & INST. CABLES

COMPONENT FUNCTION:

To provide indications to the Central Control Room of (a) voltage on each of the 6900 V busses, (b) voltage on each of the 480 V load center busses, (c) currents transversing each feeder (source, motor and, load center) from the 6900 V metalclad switchgear, and (d) position of each circuit breaker in the 6900 V metalclad switchgear and each main breaker in a load center.

To provide control in the Central Control Room of each breaker in the 6900 V metalclad switchgear and each main breaker in a doubly fed load center.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

All cabling to be seven-conductor (size 14 AWG) control cable with VULKENE[R] insulation and FLAMENOL[R] jacket rated at 600 V. Estimated length of cable required is 16,000 ft.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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REV. DATE ________

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: ACCESSORY ELECTRICAL EQUIPMENT NO. 2.15.10

COMPONENT: AREA LIGHTING

COMPONENT FUNCTION:

To provide a minimum of 2 foot-candles general lighting to outdoor areas. (Local higher levels of illimination requires additional lighting fixtures - as necessary.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Roadway - 53 luminaires (M400 with lucalox LU250 lamps)
53 steel poles (30 foot)

Flood lighting - 44 luminaires (P1000 with lucalox LU1000 lamps)
- 52 luminaires (P400 with lucalox LU400 lamps)
- 37 steel poles (30 foot) (59 luminaires mounted to sides of buildings)

Distribution panelboards - 5 - 200 ampere panelboards with main breaker and branch breakers for lighting circuits

Contractors - 5 contractors with light sensitive control

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power - 90 kV, 480 V, 3 phase (each luminaire served line to neutral)

REV. NO. ________

REV. DATE ________

2.16 MISCELLANEOUS POWER PLANT EQUIPMENT

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: RAW WATER NO. 2.16.1-1

COMPONENT: POTABLE WATER STORAGE TANK

COMPONENT FUNCTION:

To store 5000 gallons of potable water at 100'.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

One (1) vertical cylindrical welded steel tank for potable water. Tank to be fabricated of 3/16" carbon steel plate, 10' inside dia. x 8'-6" high, to have a capacity of approx. 5000 gallons to have a non-toxic epoxy coating on the inside with the following nozzles and openings:

(1) 1 1/2 - 150# Pump Suction Nozzle
(1) 2" - 150# Drain Nozzle
(1) 2" - 150# Vent Nozzle
(2) 24" - Manholes

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: RAW WATER

NO. 2.16.1-2

COMPONENT: RAW WATER PUMPS

COMPONENT FUNCTION:

To pump raw water from the raw water storage tanks to the raw water system.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(2) Horizontal, radially split case, single stage, volute type centrifugal pumps, each complete with all metal flexible coupling, coupling guard, baseplate and 460 volt, 3 phase, 60 Hertz, open drip proof induction motor for operation at 7000'. Each pump to have a capacity of 150 gpm at a total head of 110' at a speed of 3500 rpm. Pump to have ductile or cast iron casing, stainless steel impeller, casing wearing ring and shaft sleeve. Pumps to be Worthington 3"x1 1/2"x6" D1011 or equal with 7 1/2 HP motors. Total weight 243# each unit.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor control by others.
Fraw raw water storage tanks to raw water system.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: RAW WATER MAKE-UP AND STORAGE NO. 2.16.1-3

COMPONENT: POTABLE WATER CHLORINATION EQUIPMENT

COMPONENT FUNCTION:

Chlorination of potable water.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

The chlorinator shall be the vacuum operated, solution feed type with a capacity range of 0.1 pounds per day of chlorine gas. Accuracy of chlorine feed shall be within ±4% of the set rate. A flowmeter having a 20 to 1 range shall be provided with the chlorinator to indicate the chlorine feed rate.

The unit shall mount directly on a chlorine cylinder by means of a yoke clamp connection.

A positive tight shut off valve shall be provided within the chlorinator to isolate gas under pressure from the control system should there be a loss of vacuum. An easily removable silver filter screen shall be included upstream of the inlet valve. A diaphragm operated pressure relief valve shall be provided to prevent the building up of pressure within the gas control system. An excess vacuum shut off valve which isolates the regulator and gas supply system from the ejector on loss of gas pressure shall be supplied. An indicator shall provide a visual signal when the chlorine gas supply is exhausted or interrupted.

The ejector shall be provided with a ball check and a diaphragm operated back check valve as well as an emergency drain to protect against flooding of the chlorinator regulator.

The chlorinator shall be Fischer & Porter Series 70C1710 or equal.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Booster pump wiring, piping installation. Chlorinator installation and assembly. One (1) 100 lb. chlorine gas cylinder.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: RAW WATER MAKEUP AND STORAGE NO. 2.16.1-4

COMPONENT: HIGH QUALITY SUMP PUMP

COMPONENT FUNCTION:

To pump water from the high quality sump to the slag pond.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(2) Vertical volute type sump pumps, each complete with enclosed water lubricated lineshaft, foundation plate, flexible coupling, coupling guard and 460 volt, 3 phase, 60 hertz vertical solid shaft induction motor for operation at 7000'. Each pump to have a capacity of 50 GPM at a total head of 60' at a speed of 1750 RPM. Pump to have cast iron casing, bronze impeller and trim. Total length below foundation plate 8'-0". Pumps to be Gould's 1-1/4" x 1-1/2" x 8", Model 3171, bronze fitted or equal with 3 HP motors. Total weight 652# per unit.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor control, float control and alternator by others.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: RAW WATER MAKEUP AND STORAGE NO. 2.16.1-5

COMPONENT: LOW QUALITY SUMP PUMP

COMPONENT FUNCTION:

To pump water from the low quality sump to the evaporation pond.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(2) Vertical volute type sump pumps, each complete with enclosed water lubricated lineshaft, steel foundation plate, flexible coupling, coupling guard and 460 volt, 3 phase, 60 hertz, vertical solid shaft induction motor for operation at 7000'. Each pump to have a capacity of 50 GPM at a total head of 60' at a speed of 1750 RPM. Pump to be all 316 stainless steel. Total length below foundation plate 8'-0". Pumps to be Gould's 1-1/4" x 1-1/2" x 8", Model 3171, all 316 stainless steel, or equal with 3 HP motors. Total weight 652# per unit.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor control, float control and alternator by others

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: RAW WATER MAKEUP AND STORAGE NO. 2.16.1-6

COMPONENT: RAW WATER STORAGE TANKS

COMPONENT FUNCTION:

To store 250,000 gallons of raw water, 125,000 gallons of which is dedicated to fire service.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Two (2) vertical cylindrical welded steel tanks for raw water. Tanks to be fabricated of 3/16" carbon steel plate, 40" inside diameter x 26'-6" high, to have a capacity of 250,000 gallons (each), to have non-toxic coating on the inside with the following nozzles and openings:

(1) 4" - 150# FF Pump Suction Nozzle with 13'-3" standpipe to provide fire protection
(1) 8" - 150# FF Drain Nozzle
(1) 12" - 150# FF Vent Nozzle
(2) 24" - Manholes
(1) 8" - Diameter Fire Pump Suction Nozzle

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

REV. DATE 12/14/77

COMPONENT SPECIFICATION

SUB-SYSTEM: RAW WATER NO. 2.16.1-7

COMPONENT: WELL PUMPS

COMPONENT FUNCTION:

To pump water from wells to raw water storage tanks.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(3) submersible well pumps each complete with multi-stage bowl assembly, 460 volt, 3 phase, 60 hertz submersible motor. 500' of 4" column pipe, 4" column check valve, 520' of #6 cable and surface plate with discharge elbow. Each pump to have a capacity of 150 GPM at a total head of 520' (exclusive of column and check valve losses) at 3500 RPM. Pumps to have cast iron bowls, bronze impellers and carbon steel column pipe. Pumps to be Worthington Model 6-M-912 Stage or equal with 30 HP motors. Approximate weight each - 6040 lbs.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor control by others
From wells to raw water storage tanks

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FUEL OIL NO. 2.16.2-1

COMPONENT: FUEL OIL UNLOADING PUMPS

COMPONENT FUNCTION:

To transfer fuel from truck or rail to fuel oil storage.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Two (2) external gear type, internal bearing rotary pumps, each to be complete with all metal flexible coupling, coupling guard, baseplate and 460 volt 3 phase, 60 Hertz, Class I, Group D, explosion proof gear motor (with AGMA Class II gears) for operation at 7000'. Each pump to have a capacity of 500 gpm at a net pressure of 30 psi pumping #2 fuel oil. Pump to have cast steel casing and be equipped with mechanical seal. Pumps to be Worthington 6 GRHM or equal with 20 H.P. gear motors. Total weight 3075# each unit.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Relief valve and bypass piping by others.
Motor control by others.
From oil unloading station to fuel oil storage tanks.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FUEL OIL — NO. 2.16.2-2

COMPONENT: FUEL OIL STRAINERS

COMPONENT FUNCTION:

To provide pump protection from foreign object damage.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Two (2) 6" duplex fuel oil strainers. Each strainer to be capable of a flow of 500 gpm with a pressure drop not to exceed 2.5 psi. Strainer body to be cast steel with 150# ANSI flanged connections. Baskets to be stainless steel - 80 mesh. Strainers to be Hayward No. 50 or equal. Weight each 1250#.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FUEL OIL NO. 2.16.2-3

COMPONENT: FUEL OIL STORAGE TANKS

COMPONENT FUNCTION:

To store an approximately two week supply of fuel oil.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Two (2) vertical cylindrical welded steel floating roof tanks for fuel oil. Tanks to be fabricated of 1/4" carbon steel plate, 80' inside dia. x 20'-0" high, to have a capacity of 750,000 gallons (each) with the following nozzles and openings.

(2) 3" - 150# FF Pump Suction Nozzles
(2) 4" - 150# FF Drain Nozzles
(2) 24" - Manholes

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FUEL OIL NO. 2.16.2-4

COMPONENT: HIGH TEMPERATURE AIR HEATER FUEL OIL PUMPS

COMPONENT FUNCTION:

To provide fuel oil to the following systems:

(1) High Temperature Air Heaters
(2) Coal Dryer
(3) Radiant Boiler

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Two (2) external gear type, internal bearing rotary pumps, each to be complete with all metal flexible coupling, coupling guard, baseplate, relief valve with bypass piping and 460 volt, 3 phase, 60 Hertz, Class I, Groupd D, explosion proof induction motor for operation at 7000'. Each pump to have a capacity of 50 gpm at a net pressure of 200 psi pumping #2 fuel oil. Pump to have cast steel casing and be equipped with mechanical seal. Pumps to be Worthington 2 GRWM or equal with 5 H.P. motors. Total weight 566# each unit.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor control by others.
From fuel oil storage tanks to high temperature air heater and/or coal dryer. Provisions for recirculation to storage tank by others.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FUEL OIL SYSTEM NO. 2.16.2-5

COMPONENT: ACCUMULATOR

COMPONENT FUNCTION:

Surge protection of fuel oil system.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

One (1) bladder type accumulator, 275 psi design pressure, 5 gallon capacity with Buna N Aromatic Resistant Bladder, 3", 150# fluid connection, and nitrogen charging valve. Accumulator to be Greer Model 275-K-5-FS-2 or equal. Weight per unit 42#.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Provision for nitrogen charging

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FUEL OIL NO. 2.16.2-6

COMPONENT: FUEL OIL TRANSFER PUMPS

COMPONENT FUNCTION:

To pump fuel oil from the fuel oil storage tanks to the diesel engine generators.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Two (2) external gear type, internal bearing rotary pumps each to be complete with all metal flexible coupling, coupling guard, baseplate, relief valve with bypass piping and 460 volt, 3 phase, 60 hertz, Class I, Group D, explosion proof induction motor for operation at 7000'. Each pump to have a capacity of 50 gpm at a net pressure of 20 psi pumping #2 fuel oil. Pump to have cast steel casing and be equipped with mechanical seal. Pumps to be Worthington 2 GRWM or equal with 2 H.P. motors. Total weight 466# each unit.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor control by others.
From fuel oil storage tanks to diesel engine generator day tanks.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FUEL OIL NO. 2.16.2-7

COMPONENT: DIESEL GENERATOR DAY TANKS

COMPONENT FUNCTION:

To provide a 24 hour fuel supply for the diesel engine generators in each of two (2) 100% tanks.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Two (2) vertical cylindrical welded steel day tanks for #2 fuel oil. Each tank to be fabricated of 3/16" carbon plate, 10' inside dia. x 11' high, to have a capacity of approx. 6000 gallons (each) with the following nozzles and openings:

(1) 2" - 150# FF Pump Suction Nozzle
(1) 4" - 150# FF Drain Nozzle
(1) 4" - 150# FF Vent Nozzle
(2) 24" - Manholes
(1) 2" - 150# FF Dir. Return Nozzle

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Insulation and lagging. for -40 F ambient outdoor environment.

REV. NO. 0
REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FUEL OIL NO. 2.16.2-8

COMPONENT: DIESEL GENERATOR DAY TANK SUCTION HEATER

COMPONENT FUNCTION:

To heat fuel oil as required from fuel oil storage tanks to diesel generator.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

(2) Flanged immersion heater to heat 5 gpm of #2 fuel oil from minus 20 F to 0 F for an approximate heat load of 26,000 BTU/hr or 7621 watts for 460 volts, 3 phase 60 hertz. Unit to have 3" - 150# flange and steel sheath. Unit to be Chromalox Cat. No. 3095E-2 or equal. Approximate weight each 24#.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Control by others.
Enclosing shell by others.
Isolation valve by others.

Total installed price each - $290.00.

REV. NO. ________

REV. DATE ________

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: COMPRESSED AIR NO. 2.16.3

COMPONENT: PLANT AIR AND INSTRUMENT AIR

COMPONENT FUNCTION:

To provide compressed air to the plant and instrument air systems.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

One (1) Compressed Air System to serve both plant and instrument air requirements. Systems to be supplied by two (2) 100% capacity two stage, double acting, water cooled, non lubricated reciprocating air compressors. Each direct coupled to 460 volt, 3 phase, 60 Hertz, open drip proof induction motor suitable for operation at 7000' complete with 3 step capacity control, dry type air filter (for outdoor use), integral shell and tube type intercooler, and separate aftercooler. Capacity of each compressor to be at least 1300 ACFM, at a discharge pressure of 125 psig, at an elevation of 7000'. Compressors to discharge to one ASME code receiver. 66" dia. x 18', equipped with drain trap and relief valve. Receiver to supply approximately 600 SCFM to the service air system and approximately 400 SCFM to the instrument air system. Instrument air system to be equipped with dual tower desiccant type air dryer, interconnecting piping, valves and mounting base. Dryer to be capable of producing air with a dew point of minus 40°F with 460 volt electric regeneration for a 16 hour NEMA cycle. Dryer to be complete with prefilter and afterfilter. Pipe, valves, and fittings to be selected so that pressure loss does not exceed 5 psi per 1000' of pipe.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Motor starters by others.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FIRE PROTECTION NO. 2.16.4-1

COMPONENT: FIRE PUMPS AND ASSOCIATED CONTROLLERS

COMPONENT FUNCTION:

Fire Pumps: Supply fire water to yard and interior fire protection system piping and fire protection systems.

Pressure Maintenance (Jockey) Pumps: Provide fire service piping system pressure.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

1. Furnish two horizontal split case, double suction, single stage fire pumps. These pumps shall be designed to deliver 1000 GPM at a total net head of 125 psi. The pumps shall conform to the requirements of NFPA 20 and be listed by UL or approved by FM. One pump shall be suitable for electric drive while one shall be suitable for diesel engine drive. The pumps shall be manufactured by Worthinton Corporation or equal. These pumps and drivers shall be mounted on a fabricated steel baseplate, direct connected through a flexible coupling.

2. The electric pump's driver shall be an open drip proof motor wound for operation on 3 phase, 60 cycle, 480 volt power.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

REV. DATE 12/16/77

COMPONENT DESCRIPTION, Continued

3. The electric motor controller shall conform to the requirements of NFPA 20 and be specifically approved for fire pump service. All control equipment shall be mounted in a dripproof, mositure resistant housing and shall be labelled "Fire Pump Controller". The control equipment shall be complete assembled, wired, and factory tested. The starter shall be of the across-the-line type. The controller shall automatically start the pump on a drop in system pressure to 115 psig. The circuit breaker shall be rated for 30,000 amps interrupting capacity at 480 volts.

4. The diesel driver shall be similar or equal to a model NT-280, 1F open self-contained power unit as manufactured by Cummings Diesel. The engine and its accessories shall meet all the requirements of the National Fire Protection Association as forth in NFPA Pamphlet #20. The engine shall be specifically approved for fire pump service and shall be listed by Underwriter's Laboratories and/or approved by Factory Mutual Corporation. It shall operate at a rated speed not to exceed 1800 RPM and shall be capable of developing sufficient HP to drive the pump with reserve power as required. The engine shall be arranged for automatic operation, and be equipped with all accessories required for reliable operation, including batteries, battery charger, flexible exhaust connector, heat exchanger cooling water piping, and fuel system.

5. The diesel engine controller shall conform to the requirements of NFPA 20 and be specifically approved for fire pump service. The panel shall be mounted in a dust and moisture resistant dripproof enclosure and shall be labelled "Fire Pump Controller". The control panel shall be assembled, wired, and factory tested. The controller shall automatically start the pump on a drop in system pressure to 105 psig.

COMPONENT DESCRIPTION, Continued

6. Furnish one pressure maintenance (jockey) pump. The pump shall be capable of delivering 30 GPM at a total net head of 125 psi. The pump shall be close coupled to an open dripproof motor. The pump shall be similar and equal to a standard fitted unit as manufactured by Worthington Corporation ot equal. A relief valve shall be provided to prevent excess discharge pressures. The pumps shall operate automatically by utilizing a controller capable of automatically starting and stopping the pump through the use of a pressure switch. The controller shall contain an across-the-line starter with a fusible disconnect switch, adjustable pressure switch, and a "Hand-Off-Automatic" selector switch and start pushbutton in cover. The motor and controller shall be suitable for operation on 3 phase, 60 cycle, 480 volt power.

7. Furnish those fittings required by an described in NFPA 20. In addition, provide one 4" pressure relief valve model 50B-4KG as manufactured by Cla-Val Co. or equal. Also furnish one 4" flow meter system as manufactured by Aeroquip, or equal.

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FIRE PROTECTION NO. 2.16.4-2

COMPONENT: WET PIPE SPRINKLER SYSTEM

COMPONENT FUNCTION:

Provide automatic sprinkler protection and fire hose station supply for the following locations:

1. Ground floor of the Administration and Control Building
2. Mezzanine Level and Ground Floor Lube Oil Piping located in the Turbine-Generator Building
3. Area Protection for the Mill and Feeders located in the MHD Building
4. 100% coverage of the Maintenance Building
5. 100% coverage of the Compressor Building

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Sprinkler systems in accordance with NFPA Standard No. 13-1976 shall provide coverage for the areas described above and shall be designed for ordinary hazard (pipe schedule)occupancy using the maximum of 100 sq. ft. coverage. These systems shall also supply hose stations (equipment furnished under separate contract) designed to provide 100% coverage of protected areas. Design density shall be 0.2.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

REV. DATE 12/16/77

COMPONENT FUNCTION, Continued

6. Coal Pulverizing Area and Compressor-Turbine Area in the Coal-Sand-Seed Building
7. Complete coverage for the Fuel Oil Pump House
8. Diesel Driven Fire Pump and Fuel Oil Tank Area coverage in the Fire Pump House

COMPONENT DESCRIPTION, Continued

Sprinklers shall be rated at either 165°F, 212°F, or 286°F (as dictated by the hazard) and shall be brass upright mounted sprinkler heads. In addition to sprinkler piping and sprinkler heads, each system shall be provided with a water flow alarm indicator Model F620 as manufactured by Grinnell Fire Protection Systems Company, Inc., or equal. Pressure indicator and system OS&Y control valve. Those valves which are not accessible from the gound level shall also be provided with a chain operator.

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FIRE PROTECTION NO. 2.16.4-3

COMPONENT: FIRE HOSE STATIONS

COMPONENT FUNCTION:

Provide manual fire fighting water spray coverage.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

A total of sixteen (16) fire hose stations shall be provided. Fire hose stations shall be complete units and shall be in accordance with NFPA Standard No. 14-1976.

Angle valves shall be 1-1/2" male and female 300# cast brass, Elkhart No. U25 or equal for hose reel service. Hose shall be 75' long, 1-1/2", light-weight synthetic wrap, single jacket, rubber-lined, 300 psi test, National Standard thread, B.F. Goodrich 300AP, Elk-Lite or equal. Fire hose nozzles shall be "adjustable non-shock nozzle" Model L-205EB, 1-1/2" while fire hose reels shall be Model No. 30 with No. 7 reel both as manufactured by Elkhart, or equal.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

REV. DATE 12/16/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FIRE PROTECTION NO. 2.16.4-4

COMPONENT: WATER SPRAY SYSTEM

COMPONENT FUNCTION:

Provide water spray protection for the two (2) main and auxiliary transformers.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

System shall be designed in accordance with NFPA Standard Nos. 13-1976 and 15-1977.

An independent hydraulically designed system shall be provided for each of the four plant transformers, and each shall deliver 0.25 GPM per sq. ft. of projected area of rectangular prism envelope for the transformer and its components, and not less than 0.15 GPM per sq. ft. on the exposed non-absorbing surface area of the exposure. The deluge valves furnished shall be automatically operated by a electric signal from electric rate-compensated heat detectors. A manual pull box shall also be furnished with each valve which will also fully open the valve independently of the electric heat-compensated heat detector. Deluge valves shall be Multimatic as manufactured by Grinnell Fire Protection Systems Company, Inc., or equal. All systems shall be complete with all operating trim including guages, test trim and alarms.
Detectors shall be Detect-A-Fire Model No. 27121-0 rated at 190°F, and control panel with 12 amp/hr battery back-up shall be Model No. P/N30-191040-XXX all as manufactured by Fenwal, or equal.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

REV. DATE 12/16/77

SUB-SYSTEM: FIRE PROTECTION NO. 2.16.4-5

COMPONENT: PRE-ACTION SPRINKLER SYSTEMS

COMPONENT FUNCTION:

Provide sprinkler protection for the entire coal handling system's conveyors, including the emergency reclaim hopper, and also the silo building, coal unloading and transfer buildings.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Pre-action sprinkler systems shall be of the hydraulically designed type to provide protection on both the top and bottom belt areas, including the structural parts in the idler rolls supporting the belt. Also protected shall be drive rolls, take-up rolls, power units and hydraulic units. Design density shall be 0.25 GPM. Sprinkler coverage shall also extend throughout the coal silo structure, emergency reclaim hopper area, transfer building and coal unloading shed. System shall be design in accordance with NFPA Standard Nos. 13-1976 and 15-1977.

Sprinklers shall be standard type upright units with 1/2" orifice and either 286°F rated fusible line or 250°F upright quartzoid bulbs.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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COMPONENT DESCRIPTION, Continued

All deluge valves furnished shall be automatically operated by an electric signal from electric rate-compensated detectors. A manual pull box shall be furnished with each valve which will also full open the valve indenepdently of the electric rate-compensated detectors. Deluge valves shall be Multimatic as manufactured by Grinnell Fire Protection Systems Company, Inc., or equal. All systems shall be complete with operated trim including gauges, test trim, and alarms.

All thermal (heat) type detectors shall be rate-compensated Detec-A-Fire, Model No. 27121-0 by Fenwal, Inc. or equal. Detectors shall have normally closed contacts and be rated at 190°F. Detector spacing shall not exceed 25' on centers.

All fixture fittings with suitable gaskets and hub covers required for mounting these detectors shall also be furnished as part of this contract. These fixture fittings shall be Model EAHC2701 as manufactured by Crouse-Hinds or equal.

Control panels with built-in 12 amp/hr battery back-up for these systems shall be Model No. P/N30-19140-XXX as manufactured by Fenwal, Inc., or equal.

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FIRE PROTECTION NO. 2.16.4-6

COMPONENT: FUEL OIL STORAGE TANK SUB-SURFACE FOAM SYSTEM

COMPONENT FUNCTION:

Provide automatic internal fire protection for the fuel oil storage tanks.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Each of the two (2) outdoor fuel oil storage tanks shall be protected by a single balanced pressure proportioning foam system designed in accordance with NFPA Standard No. 11-1976.

Foam system components shall be located in the fuel oil pump house and shall consist of a diaphragm foam proportioning tank containing fluoroprotein liquid concentration (3%). Protection shall be sub-surface. Components provided shall include, but not necessarily be limited to the following: vertical diaphragm foam proportioning tank, automatic and manual valves. pressure gauges, strainer, rupture disc, high-back pressure foam generators, associated piping foam concentrate plus 100% reserve.

The foam system shall be as manufactured by Feecon Corporation, or equal.

System actuation shall be by way of electric rate-compensated heat detectors, All-Weather Detect-A-Fire detector Model No. 27120-20 and control panel associated with this system shall be Model P/N30-191040-XXX with built-in 12 amp/hr battery back-up, both as manufactured by Fenwal, Inc., or equal. Detectors shall be rated at 190°F.

In addition, two foam monitor nozzle stations shall be provided. These monitors shall be Model 229 (2-1/2") as manufactured by Elkhart Brass Manufacturing Co., Inc., or equal.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FIRE PROTECTION NO. 2.16.4-7

COMPONENT: COAL SILO FOAM SYSTEM

COMPONENT FUNCTION:

Provides protection to coal within silos.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Each of the coal silos shall be protected by a single automatic foam system designed in accordance with NFPA Standard No. 11-1976.

The foam system shall be located in a heated enclosure within the coal unloading buildings and shall consist of a balanced pressure protecting system containing Cobra Foam Liquid as manufactured by Feecon Fire Fighting Products, or equal. System components shall include, but not necessarily be limited to, the following: Liquid Foam Diaphragm Proportioning Tank, Automatic Valves, 0-30 minute Adjustable Timer, a Ratio Proportioner, Selector Valves, Pressure Gauges, Strainer, associated galvanized piping, foam concentrate plus 100% reserve foam. System shall be as manufactured by Feecon Fire Fighting Products, or equal.

Foam generator nozzles shall be located at the top of each one of the silos and shall be located within a bolted steel housing which will be accessible from the top of each silo. Actuation of this system shall be by way of methane sensors with standard industrial type sensor assembles located inside at the underside of the top of the silo. Remote monitor shall be Model 160 as manufactured by General Monitors, or equal.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FIRE PROTECTION NO. 2.16.4-8

COMPONENT: LOW PRESSURE CO_2 SYSTEM

COMPONENT FUNCTION:

Low pressure CO_2 system provides both automatic and manual protection to the following locations:

1. Lube Oil Conditioner, Pump and Reservoir Room No. 1; Filter and Unfiltered Oil Tanks Room No. 2, both located in the Turbine-Generator Building - Total flooding CO_2.
2. Pulverizers located in the MHD Building and Coal Sand Seed Building - Manual actuation.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

This system shall be of the low pressure type and shall be in accordance with NFPA Standard No. 12-1977.

System components shall include, but not necessarily be limited to, the following: low pressure, dual service (industrial use and fire protection) CO_2 storage units sized for largest purge requirement and largest single fire protection demand plus 100% reserve for fire service. Included shall be initial fill and gas required for all test purposes. Storage unit shall be provided with standard furnished control valves and piping to permit simultaneous fire service as well as turbine-generator purging. Components included shall also consist of "HEX" electric vaporizer and 480 volt electric heater for turbine-generator purging. All piping and associated

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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COMPONENT DESCRIPTION, Continued

fittings, hangers, pipe supports and valves from the low pressure CO_2 storage skid mounted package units to all units supplied and/or protected. System shall be as manufactured by Chemetron Fire Systems or equal.

The two lube oil storage room systems shall be actuated by electric rate-compensated heat detectors, Detect-A-Fire, Model 27121-0 as manufactured by Fenwal, Inc. or equal. Control as manufactured by Fenwal, Inc. or approved equal. Detectors shall be rated at 190°F.

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FIRE PROTECTION NO. 2.16.4-9

COMPONENT: HALON 1301 SYSTEM

COMPONENT FUNCTION:

Provide total flooding fire extinguishing systems for the following locations:

1. Cable Spreading and Logic Room
2. Control Room

both located in the Administration and Control Buildings.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

These systems shall be designed in accordance with NFPA Standard No. 12A-1977.

The system shall be designed for a minimum concentration of 5% and the maximum of 7% by volume. Gas quantities shall include largest demand plus 100% reserve for each system. Full discharge concentration tests shall be performed using Freon 122.

Each room shall be provided with the required quantity of photoelectric detectors wired in the cross-zone configuration for operation of system alarms and system discharge, as well as HVAC and fire damper shut-downs (when provided). The system shall be as manufactured by Fenwal, Inc., or equal. Photoelectric detectors shall be Model PSD-7100 as manufactured by Fenwal, Inc., or equal.

The Cable Spreading and Logic Room system's control panel shall be Model P/N30-191040-XXX complete with 12 amp back-up system, while a single-zone control unit Model 30-191024-001 with battery back-up shall be provided for the Control Room's system. Both panels shall be as manufactured by Fenwal, Inc., or equal.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

REV. DATE 12/16/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FIRE PROTECTION NO. 2.16.4-10

COMPONENT: PHOTOELECTRIC DETECTION SYSTEM

COMPONENT FUNCTION:

Provide alarm only function for the Inverter Building.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

All detectors furnished for this system shall be in accordance with NFPA Standard Nos. 72A-1975 and 72E-1974.

Photoelectric detectors shall be provided throughout this structure arranged to insure prompt detection of a fire within this location with normal ventilation system in service. Photoelectric detectors shall be Model PSD-7100, while the control panel associated with this system shall be a single zone unit Model 30-191024-001 with built-in 12 amp/hr battery back-up, both as manufactured by Fenwal, Inc., or equal.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

REV. DATE 12/16/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: FIRE PROTECTION NO. 2.16.4-11

COMPONENT: FIRE PROTECTION SUPERVISORY PANEL

COMPONENT FUNCTION:

Central panel for receipt of all fire protection system and detection system supervisory and alarm functions. All signals associated with the fire protection and detection systems shall be received at this remotely located panel (to be located within the main plant control room). Panel provides capability to monitor all fire protection systems at this location (in one central location) in order to monitor normal-trouble-alarm condition of each system, as well as the status of the electric and diesel driven fire pumps.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

This panel shall be designed and installed in accordance with NFPA Standard No. 72D-1975. The panel shall be a free-standing unit which monitors the operational and status Normal, Trouble, or Alarm for each fire protection system, detection system and all supervisory functions of the fire pumps as covered by their associated fire pump controller. Panel shall supervise circuits for break in the line or ground fault.

All indications on the panel shall be through one square inch engraved windows. A test acknowledge and reset push button shall be provided on the front of this panel.

Twelve spare sets of normal, trouble and alarm windows shall be provided on the panel for future use.

This panel shall be as manufactured by King-Fisher Company, or equal.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0

REV. DATE 12/16/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TURBINE ROOM NO. 2.16.5-1

COMPONENT: TURBINE HALL CRANE

COMPONENT FUNCTION:

The crane will be used to service equipment on the operating and ground floors of the Turbine Hall area and to provide hoisting capabilities for the installation and maintenance of a nominal 80 MW turbine-generator and other plant equipment.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

40 ton capacity cab and pendant station operated, top running, double girder traveling bridge crane. The crane will have a span of 55 feet; bottom of hook to grade life of 50 feet; main hoise rated 40 tons; auxiliary hoist rated 10 tons; speeds, travel, and operating at maximum rated loads, will be between the "slow" and "medium" speeds as recommended by CMAA; bridge and runway power conductors for 120 feet runway length; foot-walks and handrails; mercury vapor lighting fixtures; stepless controls with provisions to permit "load float control" for the main hook; and service classification, CMAA Class A-1. The crane will be in accordance with the applicable requirements of Crane Manufacturers Association of America (CMAA) Specification No. 70 and ANSI B30.2.0. Total crane weight will be approximately 48 tons.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power: 480 volt, 3-phase, 60 hertz supply

Major interfaces: Crane runway rails and runways stops by others.

REV. NO. 0

REV. DATE 12/13/77

COMPONENT SPECIFICATION

SUB-SYSTEM: TURBINE ROOM AND MISCELLANEOUS CRANE NO. 2.16.5-2

COMPONENT: MILL BAY CRANE

COMPONENT FUNCTION:

The crane will be used to service equipment in the Mill Bay Area of the plant and to provide hoisting capabilities and maintenance operations of the coal mills (pulverizers) and miscellaneous equipment.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

15 Ton capacity pendant station operated, underhung single girder bridge crane. The crane will have a span of 20 feet; bottom of hook to ground floor lift of 30 feet; hoist rated 15 tons; speeds, travel, and operating at maximum rated load, will be between the "slow" and "medium" speeds as recommended by CMAA; bridge and runway power conductors for 60 feet runway length; service classification, CMAA Class A-1. The crane will be in accordance with the applicable requirements of Crane Manufacturers Association of America (CMAA) Specification No. 74, ANSI B30.11 and/or B30.17. Total crane weight will be approximately 5.5 tons.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power: 480 volt, 3 phase, 60 hertz supply

Major Interfaces: Crane runway rails and runway stops by others.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TURBINE ROOM AND MISCELLANEOUS CRANES NO. 2.16.5-3

COMPONENT: MAINTENANCE BUILDING CRANE

COMPONENT FUNCTION:

The crane will be used to handle materials and equipment in the Maintenance Building including handling of the MHD channel and Diffuser.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

20 ton capacity pendant station operated, top running double beam bridge crane. The crane will have a span of 30 feet; bottom of hook to ground floor lift of 24 feet; hoist rated 20 tons; speeds, travel, and operating at a maximum rated load, will be between the "slow" and "medium" speeds as recommended by CMAA; bridge and runway power conductors for 100 feet runway length; service classification, CMAA Class A-1. The crane will be in accordance with the applicable requirements of Crane Manufacturers Association of America (CMAA) Specification No. 74, ANSI B30.11 and/or B30.17. Total crane weight will be approximately 6 tons.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power: 480 volt, 3 phase, 60 Hertz supply.

Major Interfaces: Crane runway rails and runway stops by others.

REV. NO. 0

REV. DATE 12/16/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CRYOGENIC SUPPORT NO. 2.16.6-1

COMPONENT: NITROGEN COOLING AND INERT BLANKET SUPPLY

COMPONENT FUNCTION:

To supply liquid nitrogen that provides 300 watts of refrigeration to the cryoplant, 616 watts of refrigeration to the magnet radiation shield and services the dual bed helium gas purification units. Also supplies gaseous nitrogen to blanket the coal storage.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

1 storage tank, 26' high by 10' diameter, containing 6,000 gallons of liquid nitrogen and weighing 20,700 pounds when empty is required for each day's use of 44 #/hr liquid nitrogen and 25 SCFM at 0.5 psig gaseous nitrogen. Associated with the tanks are fill stations and vaporizers (for converting the nitrogen from liquid to gas). One tank truck delivery is required for each day to refill this storage supply.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Instrumentation consisting of flow, temperature, pressure and tank level indicators. Major accessories include vent and relief valves, flow mixing valves and associated piping.

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: OXYGEN ENRICHMENT NO. 2.16.6-2

COMPONENT:

COMPONENT FUNCTION:

To increase the oxygen content of the combustor air steam downstream of the compressor discharge for a duration of 8 hours at a maximum enrichment of 10% or for longer periods at lesser enrichment content.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

4 storage tanks, 32' high by 10' diameter containing 11,300 gallons of liquid oxygen and weighing 47,000 pounds empty. Associated with the tanks are fill stations and vaporizers (for converting the oxygen from liquid to gas). Approximately 150 tons are required to provide 34,166 #/hr gaseous oxygen at 150 psig for an 8 hour period. Eight tank truck deliveries are required to refill this storage supply.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Instrumentation consists of flow, temperature, pressure and tank level indicators. Major accessories include vent and relief valves, flow mixing valves and associated piping.

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2.17 MHD CYCLE EQUIPMENT

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: GAS DIVERTING NO. 2.17.1-1

COMPONENT: GAS DIVERSION SYSTEM

COMPONENT FUNCTION:

To allow safe diversion of high temperature, low BTU gas flow from main gasifier-to-combustor pipeline during fast shutdown of plant. Equipment use allows safe flare-off of residual gas from gasifier bed(s).

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Total system flow rate 338,600 ACFH at 120 psia and 1800-1900°F, low BTU gas deficient of oxygen in pipeline. System requires 6" I.D. (minimum) refractory lined pipeline, 6" pneumatically-operated (N.C.) high temperature gate valve to allow gas to divert to flare stack, 150' free-standing refractory-lined flare stack with top mounted, high-temperature flame arrester, pilot, gas line and combustion safeguards. System to also incorporate inert or non-combustible purge glas flow to mix and cool gas leakage flow from high temperature gate valve on normally-closed mode. Change-over time for valves and for pilot ignition - approx. 10 seconds. Time of residual gas flow - nominal 23 seconds/maximum 90 seconds.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Sources: John Zink Co., Tulsa, Okla.
National Airoil Burner Co., Philadelphia, Pa.

REV. NO. 0

REV. DATE 12/8/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: AIR COMPRESSORS NO. 2.17.5-1

COMPONENT: MAIN AIR COMPRESSORS

COMPONENT FUNCTION:

Main air compressors are required to deliver air to the HTAH and combustors.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Type - Multi-stage centrifugal compressors (Tandem Hi-Lo Compressors)

Number - 3
Inlet Pressure - 12.2 psia
Discharge Pressure - 98 psia
Inlet Temperature - 80°F
Rating - 35,000 SCFM
RPM - 8340
BHP - 6240
Size - 12' (long) x 6' (wide)
Inlet Diam. - 42"
Discharge Diam. - 16"

Weights - 100,000 lbs (Total)
35,000 lbs (Heaviest During Construction)
14,000 lbs (Heaviest Main.)
Driver - Constant Speed Motor
Casings - Horizontally Split

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Special Accessories:
1) Inlet Guide Vane Control
2) Complete Lubrication System/Seal Oil System
3) 1800/8340 Gearbox
4) Intercoolers to Limit Discharge Temperatures to 550°F
5) Provisions for Air Preheat
6) Surge Control - Inlet Flow Measurement, Discharge Pressure Transmitter, Blow-off Valve

REV. NO. 0
REV. DATE 12/2/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: AIR COMPRESSORS NO. 2.17.5-2

COMPONENT: MOTOR DRIVES - MAIN AIR COMPRESSORS

COMPONENT FUNCTION:

Drive the three main air compressors.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Type K - Horizontal Induction Squirrel-Cage Motors - NEMA Standards

No. Required - 3
Rating - 7000 HP
Voltage - 6900
Phase - 3 phase
Cycles - 60 Hertz
Speed - 1800 RPM
Enclosure - Open Dripproof
Insulation - Class B
Temp. Rise - 80°C By Resistance
Max. Ambient - 40°C

Altitude - 7000 ft.
Space Heater - in motor frame
Overtemperature Protection - Required
Frame Size - 8400 (Nominal)
Bearings - Sleeve (Forced Lubrication)
Duty - Continuous
Service Factor - 1.0

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Major Interfaces - Compressor Gearbox. Special Accessories/ Modifications

A. High Altitude Service
B. Complete Factory Tests - Report Submitted
C. Oversize Conduit Boxes
D. Temperature Indicating and Detecting Equipment
    1. For Bearings
    2. For Windings

REV. NO. 0

REV. DATE 12/2/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: OXIDIZER PREHEATER NO. 2.17.5-3

COMPONENT: FLUE GAS EXPANDER - COMBUSTOR COMPRESSOR

COMPONENT FUNCTION:

The combustion compressor supplies compressed air to the HTAH combustor. The compressor is driven by a gas expander using HTAH off flue gas as a power source.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

The gas expander/compressor/start-up motor will be a tandem three module assembly with the compressor shaft driven from either end.

Gas Expander	Compressor	Motor Driver
LM1500 Power Turbine	Multistage Centrifugal	Horizontal Type K
Rating-14,700 Shaft HP	Inlet Conditions-75°F/ 12.2 psia	Rating-2400 HP
Inlet Conditions-925°F/ 115 psia	Discharge Pressure-98 psia	Speed-1800 RPM
Flue Gas Flow-282,000#/hr	Air Flow-230,000 lb/hr	Voltage-6900/60/3
Nominal RPM-5330	Speeed-5330 RPM	Frame-8400 Type
Exhaust Conditions- 400°F/15.2 psia	Driver Power-10,000 HP	
(Clark DJ Power Turbine an acceptable equal)	Inlet Guide Vane Control	

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Special Requirements - The compressor will operate at variable speed with the gas expander driver and with inlet guide vane control during constant speed start-up.

Major Interfaces - Flue gas exhaust and combustor inlet.

Accessories - Common forced lube oil system
Special motor voltage rating
1800/5330 speed increasing gear

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: OXIDIZER PREHEATER NO. 2.17.5-4

COMPONENT: ATOMIZING AIR BOOSTER BLOWER

COMPONENT FUNCTION:

The booster compressor raises a percentage of the combustor compressor discharge to 150 psia for use as atomizing air in the HTAH.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Blower Type - Single Stage Centrifugal Booster, Horizontal Case
Inlet Conditions - 400°F/130 psia
Discharge Pressure - 150 psia
Flow - 18,000 lb/hr
BHP - 78 HP
RPM - 8400

Driver - Horizontal Motor Type K, TEFC
Motor Rating - 100 HP
Voltage - 460/60/3
Frame - 405TS
RPM - 1800

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Major interfaces - Combustor Air Discharge and HTAH Atomizing Connection
Accessories - Compressor and Motor Manufacturer's standard No special accessories required.

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REV. DATE 2/5/78

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: OXIDIZER PREHEATER — NO. 2.17.5-5

COMPONENT: LOW PRESSURE AIR HEATER

COMPONENT FUNCTION:

In order to prevent inlet icing on the compressor inlets and to supply adequate discharge temperature from the main air and combustor air compressors, a low pressure inlet air heater is required. Sized for 100% compressor flows.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Type - Plate Type Air-to-Air Heater Exchanger
High Temperature Fluid -
High Temperature Fluid Range - 400°F in, 225-250°F out
Low Temperature Fluid - 12.2 psia Air
Low Temperature Fluid Range - 10°F in, 75°F out
Heat Load - 1.4×10^7 BTU/hr
Heater Surface Area - 3000 ft^2
Plate Material - 316 Stainless
Nominal Heat Transfer Coefficient - 20 BTU/hr ft^2 °F

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Major Interfaces - Compressor Inlet Ducts and Gas Expander Discharge
Special Accessories - Automatic Bypass Duct Control

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REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: OXIDIZER PREHEATER NO. 2.17.5-6

COMPONENT: RECIRCULATION FAN

COMPONENT FUNCTION:

Partial NO_x and combustor flame temperature control will be accomplished by recirculation of a percentage of HTAH flue gas with the combustor compressor discharge.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Fan - Low Speed Pressure Blower Fan Design (by Buffalo Forge or equal)
Inlet Temperature/Operating Temperature - 600 F
Discharge Pressure - 135 psia
Pressure Ratio - 1.14
Air Flow - 52,210 lb/hr
Driver - Constant Speed Horizontal Motor
Rating - 350 HP
Frame Size - 8188 Series

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Special Accessories - Gear Drive
Power Requirements - 460V/60 Hz/3Ø
Major Interfaces - HTAH Flue Gas Discharge and Combustor Compressor Discharge

REV. NO. 1
REV. DATE 2/5/78

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: OXIDIZER PREHEATER NO. 2.17.5-7

COMPONENT: RECIRCULATION FAN PRECOOLER

COMPONENT FUNCTION:

Cool the intake flow to the recirculation fan to a maximum temperature of 600 F.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Design Conditions:

Shell Flow: HTAH Flue Gas
Enthalpy In: 339 Btu/lbm
Enthalpy Out: 225 Btu/lbm
Mass Flow: 52,210 lb/hr
Pressure: 106 psig

Tube Flow: Circulating Water
Temp. In: 95 F
Temp. Out: 20 F
Flow: 435 gpm (nominal)
Pressure: 50 psig

Description: Water-to-gas shell and tube heat exchanger sized for a heat load of 4.35×10^6 Btu/hr (nominal). Inlet gas is HTAH flue gas at 950 F which must be reduced to 600 F prior to entering the recirculating fan inlet. Equivalent heat transfer area of 400 ft^2 at h = 18-20 Btu/hr ft^2 F.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Heater to be supplied with automatic water control valves and associated instrumentation.

REV. NO. 0

REV. DATE 2/1/78

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: OXIDIZER PREHEATER NO. 2.17.5-8

COMPONENT: CYCLONES

COMPONENT FUNCTION:

HTAH flue gas particulate clean-up prior to expansion through the gas turbine.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Standard cyclone collectors (2) will be used to remove 99% of the flue gas particulate. (Assumes particulate sizes will be greater than 10 microns when air heaters are fired on oil). Cyclones are designed for 282,300 lb/hr of flue gas at 930 F and 118 psia. (Q = 20,500 ACFM). Cyclones are commercially available and sized for minimum pressure drop. (Max. Internal Velocity = 50 fps)

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

No cooling or Power Requirements.
Interfaces with the HTAH exhaust manifold and gas expander inlet.
Typical Manufacturer: Joy MFG. Co., CE, Peabody, Research Cottrell or equal.

REV. NO. 0
REV. DATE 2/1/78

COMPONENT SPECIFICATION

SUB-SYSTEM: SEED (K_2CO_3) NO. 2.17.6-1

COMPONENT: SEED R.R. UNLOADING EQUIPMENT

COMPONENT FUNCTION:

Pneumatic system to unload granulated seed (potassium carbonate) from the bottom of 70-95 ton closed hopper railroad cars and convey material to a seed storage silo. System shall be a vacuum-pressure pneumatic type conveyor to protect product quality.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

System shall be capable of unloading closed railroad hopper cars through 5" pneumatic pipe at the minimum rate of 12 tons of product (density 82.5 lbs/ft^3) per hour. System to consist of portable car unloader, vacuum-pressure motivator power pack with positive displacement blower(s) on a common base incorporating receiver-surge bin filter and pressurizing blower and rotary air lock to discharge material through 5" dia. conveyor pipe to top of silo via a combination industrial cyclone/dust filter receiver with a minimum of 160 sq. ft. of cloth area. The top of silo receiver to have discharge weather shield, ladders, platforms, and access doors for servicing - unit to be CEA-Carter-Day model 12LRJ60 or equal with 8" pneumatically-operated bottom discharge knife or butterfly valve to allow silo pressurization (later).

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Unloader - 3 HP, motivator blower(s) - (2) 50 HP, motivator air lock - 1-1/2 HP, motivator pressure blower - 1-1/2 HP, top of silo filter blower - 3 HP, top of silo blower drive - 1/3 HP.

Recommended Source: CEA-Carter-Day Co., Minneapolis, Minn.
Union Conveyor Corp., Deerfield, Ill.

REV. NO. 0

REV. DATE 12/6/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SEED (K_2CO_3) NO. 2.17.6-2

COMPONENT: NEW MATERIAL STORAGE SILO

COMPONENT FUNCTION:

To provide seed (Potassium carbonate) storage surge capacity prior to delivery of seed to pulverization equipment.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

18' dia. x 44' high silo* with 45° unloading transition piece, silent-type pneumatic vibrators and basic or rotary valve unloader attached to bottom of transition. Silo design to be self-cleaning with epoxy coating on interior surfaces. Silo to be designed for a minimum of 12" w.g. pressure for inert gas sealing Silo material - 1/4" plate steel, reinforced as required.

*Silo dimensions can vary slightly to allow selection of "standard" manufactured size. Minimum useable volume must be 7,855 $ft.^3$.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Bin vent to be supplied as described in S-130. Silo to have safety ladder, platforms and railing at top to conform to OSHA requirements. Silo to be equipped with combination vacuum-pressure relief valve. Rotary valve - 1 HP. Recommended Source: Butler Manufacturing Co., Kansas City, MO. or local fabricator.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SEED (K_2CO_3) NO. 2.17.6-3

COMPONENT: IN-PROCESS MATERIAL STORAGE SILOS (3)

COMPONENT FUNCTION:

To provide storage surge capacity for:

1. Pulverized Seed Material
2. Flyash Residue Seed Material
3. Dry Soot Material

Units 1 & 2 to be located inside Silo Building; Unit 3 to be mounted outdoors on standover rotary unloader-trucking position.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Silos* to be approx. 7' dia. x 22' high with 60° unloading transitions and internally fabricated and fix mounted stationary diffusers to act as bridge and rathole breakers. (12) fluidizing flocones or air-activated flow assist plates to be mounted on each transition piece to assist material flow. Silo design to be self-cleaning with epoxy coating on interior surfaces. Silo to be designed for a minimum of 12" w.g. pressure for inert gas sealing. Silo material 1/4" plate steel, reinforced as required.

*Silo dimensions can vary slightly to allow selection of "standard" manufactured size. Minimum useable volume must be 720 $ft.^3$ per silo.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Silos to be equipped with combination cyclone/dust filter pneumatic receivers (CEA-Carter-Day model 12LRJ60 or equal) with 8" pneumatically-operated bottom discharge knife or butterfly valve to allow silo pressurization (later). Silos and pneumatic receivers to have safety ladders, platforms and railings to conform to OSHA requirements. Silos to be equipped with combination vacuum-pressure relief valves. Rotary valves - 1 HP.

Recommended Source: Butler Mfg. Co., Kansas City, MO.
CEA-Carter-Day, Minneapolis, Minn.
Local Fabricator.

REV. NO. 0

REV. DATE 12/6/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SEED NO. 2.17.6-4

COMPONENT: PULVERIZERS, PULVERIZER FEEDERS & HEATERS/DRYERS

COMPONENT FUNCTION:

To feed, temper-dry and pulverize seed or virgin potassium carbonate in dual pulverizing machines.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Pulverizing equipment will consist of (2) separate 5 tons/hr systems that can be operated individually, on an alternate basis or together to give a maximum pulverization capability of 10 tons/hr minimum total. Pulverizers will reduce 10-100 mesh size Anhydrous Potassium Carbonate as normally supplied by Diamond-Shamrock Co., Cleveland, Ohio in bulk, granulated form to 80% passing 200 mesh. Pulverizers shall be model #4 Pulverizers as manufactured by Mikropul Corp. furnished with air conveying pick-up hoppers. Dryers shall be modified Trane Co. #126-S unit heaters with approx. 150,000 BTU/HR output using 15 psig steam or a custom-designed air heat exchanger made from Turb-X Fintube sections as supplied by Escoa Fintube Corp., Pryor, Okla. Dryers shall be attached to the inlet feed section of each pulverizer with sufficient heat and temperature to vaporize 1% (by weight) of surface moisture on potassium carbonate granula material. Pulverizers to be fed by gravity by metered flow from (2) screw feeder conveyors (Sprout-Waldron, #9CS312, standard length units or equal). Pulverizer drives-(2) 75 HP, heaters-(2) 1/2 HP, screw feeders-(2) 2 HP.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Sources:

Pulverizers - #4th, Micropulverizer, R.H. See & Co. Scituate, Mass.
Dryers - Trane Co., LaCrosse, Wisc. or custom-designed, see above.
Screw Feeders - Sprout-Waldron, B.Brown Co., Pittsford, N.Y.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SEED

NO. 2.17.6-5

COMPONENT: SOOT MATERIAL & FLYASH UNLOADING SYSTEM

COMPONENT FUNCTION:

To collect soot and flyash materials from in-line equipment bottom discharges downstream of the plant radiant boiler, either:

1. During MHD operation pneumatically convey the material to the flyash/residue seed material storage bin for recycle/reionization use-1200#/hr., max. - with provisions to periodic hydraulic or dry disposal by collection and blowdown.
2. For direct operation (bottoming cycle) pneumatically convey material for either wet or dry disposal - 6,255#/hr., max. (It is expected that dry disposal by collection and conditioning soot/flyash before landfill will be the operationally more desirable method of disposal)

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Collection of materials at the rates listed above will be thru air lock-type medium pressure (nominal-10 psig) lockfeeder system similar to United Conveyor Nuva type feeders-(8) or more required. Transport of material will be via positive pressure-type pneumatics to the top of storage silos through 5" heavy wall conveyor line with in-line diverter/selector valves. Settings accumulation monitoring and sequencing will be via central, automated control furnished by pneumatics supplier. Pneumatic power by dual (100% standby) blowers with integral drying features. Up to (12) Nuva feeders to be supplied - each approx. 4 ft^3 working capacity Velocity in pneumatic conveyor lines to be 5,100 fpm minimum. In-line diverter valves, line elbows and all other high wear points of system to have errosion plates or double-thick wear sections with inspection posts to facilitate inspection. Power (2) 50 HP blower drives plus control pneumatic air.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Source: United Conveyor Corp., Deerfield, Ill.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SEED NO. 2.17.6-6

COMPONENT: REGENERATED SEED COLLECTION SYSTEM

COMPONENT FUNCTION:

To convey 8,100 lbs/hr, max. from discharge of regeneration equipment (by others) to top of seed storage silo inlet. Equipment is used only during MHD operation.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Material from discharge is assumed to be 1/4" x 0" in granulated form. Collection of materials will be through air lock-type medium pressure (nominal 10 psig) lockfeeder system similar to United Conveyor Nuva type feeders (2) units each approx. 8 $ft.^3$ working capacity are required. Transport of material will be by pressure-type pneumatics with motive power provided by Soot Material & Flyash Unloading System blowers. Pneumatic lines to be 5" heavy wall type with wear-errosion plates or double-thick wear sections. Transport velocity 5,100 fpm, minimum. Control pneumatic air from plant instrument air system.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Source: United Conveyor Corp., Deerfield, Ill.

REV. NO. 0

REV. DATE 12/8/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SEED NO. 2.17.6-7

COMPONENT: INSTRUMENT AIR SYSTEM

COMPONENT FUNCTION:

To provide dried, instrument-quality air for use in material handling operations related to collection and movement of potassium carbonate, soot and related products. Air is used for vibrator power, railcard pressurization, to provide a clean fluidizing media, for miscellaneous small-demand conveying operations and as pneumatic operator power and other control needs.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

System delivery - 1,000 CFM of air compressed to 100 psig and dried to -35°F. System to consist of (2) 500 CFM reciprocating oil-free (teflon rings) head 2-stage compressors with aftercoolers separators, traps, skid mount, intake filters and silencers and common air receiver (4' dia. x 12' high) and all necessary wiring and piping interconnects feeding an electric-regenerated, column filter bed type air dryer. All pressure vessels and components to be ASME coded for 120 psig. Compressors to be Gardner-Denver, 13x8x5 MLA type or equal; dryer to be C.M. Kemp Oriad II type model #2246 or equal.

Compressor power - (2) 125 HP motors
Drier power - 19.8 KW

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Sources: Compressor System - Gardner-Denver Co.
Quincy, Ill.

Dryer - C.M. Kemp Co., Glen Burnie, MD.

REV. NO. 0

REV. DATE 12/8/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SEED NO. 2.17.6-8

COMPONENT: ROTARY UNLOADER

COMPONENT FUNCTION:

Rotary unloader is to be mounted beneath the dry soot material storage bin to condition dry material to facilitate truck loading operation with a minimum of dust nuisance.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Unit to be a 30" rotary unloader with hopper gate and rotary drum feeder mounted above unloader and under storage bin. Unit can be outdoors mounted if water feed lines and unit spray mechanisms are freeze-protected. Approximate desired conditioning rate - 40 tons per hour.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power - 5 HP, unloader; 1 HP, feeder
Water - 50 GPM, max.

Recommended Source: United Conveyor Corp., Deerfield, Ill.

REV. NO. 0

REV. DATE 12/8/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: SEED DIVERTING NO. 2.17.6-9

COMPONENT: SEED DIVERTING SYSTEM

COMPONENT FUNCTION:

To divert seed flow of Petrocarb seed injection system during fast shutdown of plant. This equipment allows clearing or purging of product from injection system pipelines; purging of pipelines allows system restart without line plugging.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

System will allow 30 second dump of potassium carbonate feed at maximum plant firing rate. System total diverting flow is 726 lb/hr air and 8,000-8,800 lb/hr of potassium carbonate. System to be constructed from (2) pressure-type United Conveyor Co. Nuva feeders (or equal) - 36" dia. #4-15538-30 - 30 C.F. - modified as required for pressure let-down use, (2) 8" motorized inlet valves, (8) 3/4" multiport or 3-way plug valves, manifolding and interconnecting piping and specialties. Control package to be designed for automatic, sequenced operation (later). Vents (2) to pulverized seed storage bin. Air-seed recovery mix to be pressure recovered (pneumatically) from feeder bottoms and convey to pulverized seed storage bin.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Recommended Source: United Conveyor Corp., Deerfield, Ill.

REV. NO. 0

REV. DATE 12/8/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: MISC. MHD CYCLE SUPPORT EQUIPMENT NO. 2.17.8-1

COMPONENT: MHD BUILDING AND MAGNET ASSEMBLY CRANE

COMPONENT FUNCTION:

The crane will be used to service equipment on the ground floor and to provide hoisting capabilities for assembly, installation and maintenance of the magnet and related equipment.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

350 ton capacity cab operated, top running, double girder traveling bridge crane. The crane will have a span of 50 feet; bottom of hook to grade lift of approximately 70 feet; two (2) main hoists, each rated 175 tons; two (2) auxiliary hoists, each rated 25 tons; speeds, travel, and operating at maximum rated loads, will be between the "slow" and "medium" speeds as recommended by CMAA; bridge and runway power conductors for 188 feet runway length during construction; footwalks and handrails; mercury vapor lighting fixtures; stepless controls with provisions to permit "load float control" for the main hook; service classification, CMAA Class A-1. Seismic design considerations will require crane rail locks or tiedowns. The crane will be in accordance with the applicable requirements of Crane Manufacturers Association of America (CMAA), Specification No. 70 and ANSI B30.2.0. Total crane weight will be approximately 355 tons.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power: 480 volt, 3-phase, 60 hertz supply

Major interfaces: Crane runway rails and runway stops by others.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: MISC. MHD CYCLE SUPPORT EQUIPMENT NO. 2.17.8-2

COMPONENT: HTAH BUILDING CRANE

COMPONENT FUNCTION:

The crane will be used to service equipment on the support level and ground floor and to provide hoisting capabilities for the maintenance of the high temperature air heaters and miscellaneous equipment.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

30 ton capacity pendant station operated, top running, double girder bridge crane. The crane will have a span of 48 feet; bottom of hook to ground floor lift of 80 feet; hoist rated 30 tons; speeds, travel, and operating a maximum rated load, will be between the "slow" and "medium" speeds as recommended by CMAA; bridge and runway power conductors for 152 feet runway length; footwalks and handrails; service classification CMAA Class A-1. The crane will be in accordance with the applicable requirements of Crane Manufacturers Association of America (CMAA) Specification No. 70 and ANSI B30.2.0. Total crane weight will be approximately 34 tons.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power: 480 volt, 3-phase, 60 hertz supply

Major interfaces: Crane runway rails and runway stops by others.

REV. NO. 0

REV. DATE 12/13/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: MISC. MHD CYCLE SUPPORT EQUIPMENT NO. 2.17.8-3

COMPONENT: COMPRESSOR BUILDING CRANE

COMPONENT FUNCTION:

The crane will be used to service equipment on the ground floor of the compressor building and to provide hoisting capabilities for maintenance and service operations of the main compressors and related equipment.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

7-1/2 ton capacity pendant station operated, underhung single girder bridge crane. The crane will have a span of 24 feet; bottom of hook to ground floor lift of 24 feet; hoist rated 7-1/2 tons; speeds, travel and operating at maximum rated load, will be between the "slow" and "medium" speeds as recommended by CMAA; bridge and runway power conductors for 40 feet runway length; service classification, CMAA Class A-1. The crane will be in accordance with the applicable requirement of Crane Manufacturers Association of American (CMAA) Specification No. 70 ANSI B30.11 and/or B30.17. Total crane weight will be approximately 4 tons.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Power: 480 volt, 3 phase, 60 hertz supply

Major interfaces: Crane runway rails and runway stops by others.

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2.18 INSTRUMENTATION AND CONTROL (RESEARCH EQUIPMENT)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: INTERPLANT COMMUNICATION NO. 2.18.1.4-1

COMPONENT:

COMPONENT FUNCTION:

To provide telephone and audio communications between the Plant Control Areas and the Central Control Room.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

1. Handsets

Each handset shall consist of self-contained battery powered solid state transmitter, receiver, buzzer, and integral call button and talk button. Each handset shall be weatherproof with 6-foot, heavy duty, UL Type SJT, retractable cord set and plug with cord strain relief. It shall be capable of transmitting intelligible voice for a minimum distance of one mile. The element of microphone shall be dynamic with impedance of 25 ohm ± 20 percent at 1 KHz. Sensitivity shall be -90 db ± 3 db at 1 KHz, and a minimum frequency response of 300 to 8000 KHz. The receiver element shall be moving coil type with an impedance of 8 ohm ± 20 percent at 1 KHz, sensitivity of 110 db ± 20 percent at 1 KHz and frequency response from 20 to 6000 Hz. Fifteen such handsets will be provided.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Hazardous Areas

Telephones and remote intercom modules located in areas classified as hazardous shall be intrinsically self-safe and operate through conventional intrinsic safety barriers

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COMPONENT DESCRIPTION, Continued

2. Plugs and Jacks

Plugs and jacks shall be mating and locking watertight units specifically designed for low level sound-powered telephone circuits. Semiflush panel mounting jacks shall be factory installed in eacg plant control area. Factory installed jacks shall be supplied to panel or MCC vendor. All jacks shall have snap-on covers. Jacks shall be XL-3-14N and plugs shall be XL-3-50T as manufactured by Robins, Cannon equivalent, or equal. Jacks shown remote from panels shall be mounted in Crouse-Hinds, FD2 cast box, with DS/020G cover, Appleton equivalent, or equal. Mounting height shall be 4 feet unless noted otherwise.

3. Extension Cords

Entension cords shall be UL Type SJO with factory attached plug and jack on the ends. Twelve 25-foot and eight 50-foot extension cords shall be furnished.

4. Operator's Terminal

Two handsets shall be provided with an area selection module capable of interconnecting any plant control area handset to either handset.

Audio Intercom

An intercom (paging) capability shall be provided for audio communication between the central control room and the plant control areas for safety and security monitoring purposes. The system will consist of an Operators' Terminal with area selection capability, and remote terminal modules located in each plant control area. Each intercom module shall have separate in-volume, out-volume controls. Back-up emergency power capability will be provided as part of this system. Ten remote intercom modules and one operator terminal will be provided. The system will be provided as part of the Plant Safety and Security Monitoring System.

MISCELLANEOUS REQUIREMENTS, Continued

to prevent the possibility of external sources providing sufficient energy to cause ignition. Jacks in classified areas shall be connected to the signal lines through intrinsic safety barriers.

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: CCTV MONITORING SYSTEM NO. 2.18.1.4-2

COMPONENT:

COMPONENT FUNCTION:

The function of the CCTV Monitoring System is to provide the plant operating personnel continuous visual surveillance of selected areas within the plant from the central control room.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)
This system will consist of the following components:

- 1 - 16" Solid state video monitor having a minimum of 600 lines resolution with a minimum of 8 MHZ frequency response to be located in the Operators' Console in the Central Control Room
- 1 - Manual Video Switcher having the capability of handling up to 12 TV cameras
- 1 - Pan, tilt, zoom control unit to operate the TV cameras remotely from the control room
- 12 - TV cameras with low-light capability (useable picture with 2 foot candles of reflected illumination). Bandwidth will be a minimum of 6 MHZ with geometric distortion of less than 5%
- 12 - Zoom lens for each TV camera
- 5000 - Feet of co-axial television cable for connecting cameras to monitor

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

1. All television monitors must be housed in protective enclosures. Where housed outside enclosure, must be equal to NEMA IV with built-in thermostat, heater and blower.
2. Power for all cameras and monitors is 115 volt, 60 Hz.
3. This system should be integrated into the plant Safety and Security system.
4. Cameras must be located in reasonably lit areas and must be protected from direct or reflected sunlight entering the lenses.

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: ENVIRONMENTAL MONITORING SYSTEM NO. 2.18.1.4-3

COMPONENT:

COMPONENT FUNCTION:

The function of the environmental monitoring system is to provide a source of data to demonstrate compliance with applicable federal, state and local pollution control legislation concerning plant emissions and to assist in the operation of the plant to assure compliance.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

The following specifications cover the analyzers that are typical of those required to monitor power plant effluents

A. STACK, MHD GAS BREECH AND HTAH GAS BREECH

1. Stack Sampling System - provides samples for pollutant analyzers.

This system will consist of the following components.

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

1. In addition to monitoring the stack gas for pollution measurements, the stack Sampling System will provide samples to an O_2 analyzer for combustion analysis purposes.

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COMPONENT DESCRIPTION (Continued)

1. Heated sampling hose and associated temperature controller - Sampling hose, 200 to 300 feet in length, is used to maintain sample stream above the dew point of water to prevent condensation in the pipe. Condensation would result in pulsations, time delays, and sample averaging problems.

2. Stainless stack sampler probe and steam cleanable prefilter - The stainless probe protrudes far enough into the stack to obtain a valid sample. Preliminary filtering prevents settling of larger particles in sample line. Steam periodically used for cleaning filter.

3. Steam lines and controllers - To clean prefilter periodically, through backflush with steam.

4. Particulate filter - Located in analyzer house, sized to accommodate total analyzer flow required. Analyzers typically require about 1 liter/minute flow.

5. Refrigerated sample coolant chamber - Teflon coated coolant coils within a plastic or glass chamber are used to rapidly chill sample to condense water out. Sulfuric acid will form in the condensate because of SO_2, consequently glass or plastic piping required for drainage effluent.

6. Sample manifold chamber - Dried sample is routed to a manifold sized to minimize pressure fluctuations for distribution to the various analyzers.

7. Aspirator - Steam or compressed air operated aspirator is provided to function as the pump for drawing the sample air through the sampling system.

Analyzers presently commercially available for SO_x and NO_x exist which do not require withdrawing and conditioning of stack samples, however because of the developmental nature of the ETF, an oversize sampler system is recommended to allow analyzer additions to be included. Cost of a sampling system is $8,000.00.

2. <u>NITRIC OXIDE ANALYZERS</u> (Receivers Sample from Sampling System)

Analyzers based on the chemiluminescent properties of NO mixed with ozone and analyzers based on the UV absorption of NO_2, using 436 nm as the analytical frequency are typical of those used in stack monitoring with the latter being the most used system for NO measurements on stack effluents of power plants.

The UV absorption analyzer utilizes a once through pass of stack sample which would be extracted from the sampling system prior to the condenser/cooler by using a steam or air driven aspirator downstream of the analyzer. A UV light source is shown through the sample and the intensity of light passing through the sample at 436 nm is inversely proportional to the NO_2 concentrations.

COMPONENT DESCRIPTION (Continued)

The cost of a UV absorption analyzer is $15,000.00 and the Model 461 unit by Dupont utilizes a design similar to EPA recommended practices.

This system would be used to confirm that the current 0.7 lb/10^6 Btu federal limit (tentative 0.6 lb/10^6 Btu) is not exceeded for NO_x.

3. SULFUR OXIDE ANALYZER

A UV absorption analyzer is also commercially available for SO_x measurements and operates and would be installed similarly to the NO_x analyzer. Dupont manufactures a unit (Model 460) which is acceptable for a stack monitoring situation and would be used to confirm the federal sulfur oxide emission limit of 1.2 lbs/10^6 Btu. Cost of this unit is $16,000.00.

4. STACK PARTICULATE ANALYZER

An in-stack particulate analyzer of the double pass, transmitted light variety will be used to obtain a measure of the optical density of the gas. Optical density can then be related to the weight of the particulate being emitted per unit time which is used to derive the particulant weight per million Btu to confirm conformance with EPA regulations of less than 0.1 lbs/10^6 Btu.

The analyzer contains a stack mounted light source and detector port on one side and a mirror port on the other side of the stack. The optical ports are air purged to maintain cleanliness. The analyzer electronics are located in the analyzer house and cabling is routed to the light source and detector. The emission rate will be monitored and integrated by the plant computer for daily reporting purposes. Hardwiring will connect the analyzer output to the plant computer. Automatic calibration checks are included in the system design.

Present plans include two monitors; one monitor will be used for the main gas breech from the MHD channel and one from the gas breech from the high temperature air heaters.

Sampling and laboratory analysis will be required to obtain a correlation between the analyzer output and the particulate count in lbs/Btu.

The cost of this system is $5.6 thousand per particulate analyzer. Dynatron, Inc. has a Model 1100 opacity monitor which meets EPA specs for this type of analyzer.

B. WATER EMISSION ANALYZERS

1. Sewage Treatment

The following outputs will be monitored:

COMPONENT DESCRIPTION: (Continued)

Residual Chlorine - Measured by continuous analysis through mixing of water sample with potassium iodide and measuring the electrical conductivity of the resultant solution. Wallace and Tiernan is a manufacturer of such analyzers and cost is $8,000.00 per unit.

pH - Measured by amperimetric method. These monitors are $2,000.00 typically and are manufactured by Beckman, Uniloc, etc.

Suspended Solids - Turbidometer type analyzers which measure the optical transmittance of a continuous sample stream, are available from Hack, Biospherics, etc., and cost $7,000.00.

Total Oxygen Demand - Analyzers which monitor the total oxygen demand of treated wastewater will be used. These systems cost $18,000.00 and are manufactured by Envirotech, Beckman, etc.

2. Pump, Turbine Bearing, Cooling Systems, Boiler Return Condensate

Oil in Water Monitors - Analyzers which monitor the magnitude of oil presence in water through use of the UV absorption method are manufactured by Teledyne Corp. Cost is $15,000.00 per unit.

pH Monitors - previously described

Dissolved Oxygen - Measured difference in electric potential between a cathode and anode due to oxygen saturation of a stable electrolyte in which they are immersed. Oxygen is continuously separated from the water and passed to the electrolyte by means of a Teflon membrance located at the tip of the probe which is immersed in the flowing water sample. Various manufacturers including Delta Scientific, Ionics and Rexnord produce these analyzers. Cost is about $1200. for a probe and analyzer.

C. Final Plant Effluent Conduit - pH, Residual Chlorine, Oil in Water, Heavy Metals

D. Metal Cleaning Wastes from Boiler, Superheater, Reheater Tubes - To be defined

E. Demineralizer Wastes - To be defined

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: WEATHER MONITORING SYSTEM NO. 2.18.1.4-4

COMPONENT:

COMPONENT FUNCTION:

The weather monitoring system provides a source of current data to plant personnel to make decisions in shceduling activities that could be affected by the weather. The system also provides data to the plant computer for making calculations requiring current or daily weather conditions.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

Weather instruments will be mast-mounted in a location that is not affected by surrounding superstructures. Temperature sensor will be mounted in a manner where it is protected from the wind. A "tipping bucket" will be used to measure precipitation. All instruments will provide 4-20 MADC signals into 1200R for transmission back to the central control room. Specifically, the following instruments will be provided:

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

1. Weather instruments must be located in an area where they cannot be affected by the surrounding superstructures, i.e., cooling tower, stack, hot pipes. Tenative location is on a mast mounted to the roof of the Administrative Building.

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COMPONENT DESCRIPTION, Continued

Variable	Sensor	Range
Wind Speed	Cup Aenometer	0-100 MPH
Wind Direction	Potentiometer	0-540 Degrees
Temperature	RTD (Wind protected)	-40°F to 120°F
Precipitation	Tipping Bucket (heated)	0-Infinity 0.01" resolution
Solar Radiation	Photovoltaic	0-Infinite Langleys

MISCELLANEOUS REQUIREMENTS, Continued

2. Instruments will be hardwired to display equipment and the plant computer located in the central control room.

3. A 54° wind direction resolution sub-system will be used to minimize resolution problems when wind is at the 0°/360° point (North). Logic circuitry in this system will determine ambiguity when wind moves from 360° to 0" such that a continuous signal is displayed and inputted into the computer.

2.50 TRANSMISSION PLANT

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.1-1

COMPONENT: TRANSFORMERS

COMPONENT FUNCTION:

Stepdown 230 kV to 69 kV

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

2 - Transformers OA/FA/FOA

Rating	60/80/100 MVA with 30°C avg. ambient
Temperature Rise	65°C
HV Winding	230 kV wye connected
BIL	750 kV line end 110 kV neutral end
LV Winding	69 kV wye connected
LV Winding BIL	350 kV

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

De-energized tap charger
Support for HV and LV arresters
Fault pressure relay
Gas detector relay
Neutral bushing CT on both neutrals

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.1-2

COMPONENT: 230 kV CIRCUIT BREAKER

COMPONENT FUNCTION:

Transformer 230 kV circuit breaker.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

2 - circuit breakers

Max. voltage	242 kV, 60 Hz
Current	1600 amperes
Interrupting Current	31,500 amperes symmetrical
Short Time Rating	40,000 amperes

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

9 Current Transformers
1 Bushing Potential Device
1 Kirk Lock
1 125V DC Operating Mechanism

REV. NO. 0
REV. DATE 12/14/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.1-3

COMPONENT: 230 kV SURGE ARRESTERS

COMPONENT FUNCTION:

Control surges on the 230 kV transformer

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

6 - surge arresters
Alugard station type
voltage - 192 kV

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0
REV. DATE 12/14/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.1-4

COMPONENT: 230 kV DISCONNECT SWITCH

COMPONENT FUNCTION:

Isolating switches for the 230 kV circuit breakers

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

4 - Disconnect switches, air break

Max. Voltage	242 kV, 60 Hz
Rating	1200 amperes
Momentary current	61000 amperes
BIL	900 kV
Mechanism	3 pole manual group operated

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Auxiliary switch
Kirk Lock

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.1-5

COMPONENT: 230 kV Substation

COMPONENT FUNCTION:

Connect the 230 kV equipment together with the stepdown transformer

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

2- 230 kV incoming line towers
4- 230 kV switch stands
2- 69 kV outgoing structures
1- Lot insulators, bus, connectors, hardware and anchor bolts

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.2-1

COMPONENT: 69 kV SUBSTATION

COMPONENT FUNCTION:

Connect the 69 kV equipment together in a breaker and a half scheme.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

1 Lot - Galvanized steel structure
6 - Circuits with breakers and 18 switches
2 Sets - PT's
2 Sets - Bus arresters
1 Lot - Insulators, bus connectors, hardware, and anchor bolts.

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT-STATION EQUIPMENT NO. 2.50.2-2

COMPONENT: 69 kV CIRCUIT BREAKERS

COMPONENT FUNCTION:

69 kV Switchyard Breakers

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

9 Circuit Breakers
- GE Type FKA oil blast
- Max. Voltage - 72.5 kV
- Current Rating - 1200 amperes
- Interrupting Rating - 19,000 amperes symmetrical
- Short time rating - 23,000 amperes
- Mechanism - 125V DC motor operated spring charged

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

9 Current Transformers
- Kirk Lock

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT-STATION EQUIPMENT NO. 2.50.2-3

COMPONENT: 69 KV SURGE ARRESTERS

COMPONENT FUNCTION:

Control Surges on the 69 kV system

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

12 - Surge Arresters
Alugard Station Type
Voltage - 60 kV

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

REV. NO. 0
REV. DATE 12/14/77

MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT-STATION EQUIPMENT NO. 2.50.2-4

COMPONENT: 69 kV DISCONNECT SWITCHES

COMPONENT FUNCTION:

Isolate the 69 kV Circuit Breakers

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

18 - Air Break Disconnect Switches

Mechanism	3 pole manual group operated
Max. Voltage	72.5 kV
Rating	1200 amperes
Momentary Current	61,000 amperes
BIL (Basic Insulation Level)	350 kV

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Auxiliary Switch
Kirk Lock

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT-STATION EQUIPMENT NO. 2.50.2-5

COMPONENT: 69 kV POTENTIAL TRANSFORMERS

COMPONENT FUNCTION:

Measure the 69 kV bus voltage.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

6 - Potential Transformers
Type ES-350
Voltage - 40,250 - 115/67.08 - 115/67.08
BIL - 350 KV

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT-STATION EQUIPMENT NO. 2.50.2-6

COMPONENT: PT FUSE

COMPONENT FUNCTION:

Protect the potential transformer

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

6 - Resistored Power Fuses

Outdoor vertical disconnect type
Voltage - 72.5 kV
Resistor - 1 amp, 250 ohms
Fuse Rating - 1/2 E

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT-STATION EQUIPMENT NO. 2.50.3

COMPONENT: TRANSFORMER

COMPONENT FUNCTION:

Generator Step up Transformer

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

1 Transformer

Rating - 96 MVA FOA
HV-72 kV, wye connected
LV-13.8 kV delta connected
BIL-350 kV, HV winding, 110 kV neutral
BIL-110 kV, LV winding

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Fault pressure relay
Neutral bushing CT
De-energized tap charger

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.6

COMPONENT: TELEMETERING CARRIER EQUIPMENT

COMPONENT FUNCTION:

To couple the data transmitters to the 230 kV line.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

4 - Type CT52 B1F12H2C Frequency Shift Carrier Equipment
4 - Analog Variable Frequency Telemeter Transmitter
4 - Analog Telemeter Transducers for watts and for var's for the plant output and the turbine generator output

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.7

COMPONENT: SWITCHGEAR BATTERY AND BATTERY CHARGER

COMPONENT FUNCTION:

Provide reliable control power for the switchyard.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

1 - Lead Calcium Battery
60 Cells
150 Ampere Hour Nominal Capacity

1 - Battery Charger
Input 240 V, 60 Hz, Single Phase
Output 130 Volts DC Nominal

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

Battery Rack
Charger Timer
Ground Alarm
Low Voltage Alarm AC and DC

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.8-1

COMPONENT: 230 kV LINE PRIMARY RELAYS

COMPONENT FUNCTION:

Provide circuit protection to both 230 kV lines by fault detection relays and carrier current equipment to operate both the near and remote circuit breakers for each line.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

2 Lots - of relays (one for each 230 kV line) to provide the following:
(General Electric or equal)

1 - SLY51B Phase Distance Relay
1 - SLYG51B Ground Distance Relay
1 - SLC51A Over Current Relay
1 - SLA41 Logic Relay
1 - SLAT51 Trip and Output Relay
1 - SSA50A
1 - Test Panel
1 - Mounting Rack

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION STATION NO. 2.50.8-2

COMPONENT: 230 kV LINE BACK-UP RELAYS

COMPONENT FUNCTION:

Provide back-up protection of the 230 kV transmission lines.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

2 Lots - of Back-Up Relays (1 for each 230 kV line) to provide the following:
(General Electric or equal)

1 - SLX12B Phase Distance Relay
1 - SLXG12C Ground Distance Relay
1 - SLA13F Logic Relay
1 - SSA12C Power Supply
1 - Test Panel
1 - Mounting Rack

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.8-3

COMPONENT: TRANSFER TRIP BREAKER FAILURE RELAY

COMPONENT FUNCTION:

Protect the 230 kV line from circuit breaker failure faults.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

2 Lots - of Back-Up Relays to protect against breaker failure consisting of:
(General Electric or equal)
1 - SBC11C Logic Relays
1 - Test Panel
1 - Mounting Rack

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.8-4

COMPONENT: PRIMARY RELAYING CARRIER CURRENT EQUIPMENT

COMPONENT FUNCTION:

To couple the line relay functions to the transmission lines.

COMPONENT DESCRIPTION:

(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

2 Lots - of carrier current equipment for the primary relaying consisting of:
(General Electric or equal)

1 - CS-26B1S1ZM1V Carrier Transmitter
1 - Receivers with voice modulator
1 - Type CX-5A Meter Analyzers
1 - Rack Cabinets
1 - Type CL03A16ZNL Wide Band Line Tuners

MISCELLANEOUS REQUIREMENTS:

(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.8-5

COMPONENT: CARRIER EQUIPMENT FOR TRANSFER TRIP

COMPONENT FUNCTION:

To couple the breaker failure relay signal to the transmission line.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

2 Lots - of frequency shift carrier transmitters and receivers for the back-up relaying consisting of: (General Electric or equal)

1 - Type CT61A1S1ZM2C Transmitters
2 - Type CR61A1S1ZC6D Receivers
1 - Mounting Cabinet
1 - Type CL12RS Line Tuner
1 - Type C103A1G2N1L Wide Bank Line Tuner

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.8-6

COMPONENT: COUPLING CAPACITOR POTENTIAL DEVICES

COMPONENT FUNCTION:

Provide carrier coupling to the 230 kV line and potential signal.
2 devices with carrier accessories.
4 devices without carrier.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

6 - Coupling Capacitor Voltage Transformers
Extra High CA
Type CD-51
230 kV
0.010 MF Capacitance
1050 kV BIL
(4) Catalog No. CD51A23ST6C (General Electric or equal)
(2) Catalog No. CD51A23SC6C (General Electric or equal)

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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MHD ENGINEERING TEST FACILITY

COMPONENT SPECIFICATION

SUB-SYSTEM: TRANSMISSION PLANT - STATION EQUIPMENT NO. 2.50.8-7

COMPONENT: LINE TRAP

COMPONENT FUNCTION:

Confine carrier signal to the power line.

COMPONENT DESCRIPTION:
(SIZE, WEIGHT, TYPE, PRINCIPAL FEATURES, RATING, ETC.)

2 - Line Traps Type CF05
0.53 mH inductance
800 Amperes Pedestal Mount
Wide Band Tuning
Cat. #CF05S08NW3 (General Electric or equal)

MISCELLANEOUS REQUIREMENTS:
(POWER, COOLING, MAJOR INTERFACES, ABNORMAL OPERATING CONDITIONS, SPECIAL ACCESSORIES, ETC.)

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PART 5 - DRAWINGS

This part contains the following diagrams and drawings:

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FLOW SHEET VALVE SYMBOLS

- ANGLE
- BALL
- BUTTERFLY
- CHECK
- DIAPHRAGM
- GATE
- GLOBE
- PLUG
- SAFETY
- SPECIAL THROTTLING
- 3-WAY
- 4-WAY
- CV TURBINE CONTROL VALVE
- SV TURBINE STOP VALVE
- CRV TURBINE COMBINED REHEAT VALVE

INSTRUMENTATION SYMBOLS

- LOCALLY MOUNTED INSTRUMENT
- CONTROL PANEL INSTRUMENT
- LOCAL GAUGE BOARD MOUNTED INSTRUMENT
- DATA LOGGER, OR COMPUTER ID NUMBER
- FLOW ORIFICE (FLANGED)
- FLOW ORIFICE (RESTRICTION)
- FLOW ORIFICE WITH FLOW SECTION
- FLOW NOZZLE (WELDED IN)
- FLOW NOZZLE (FLANGED)
- FLOW NOZZLE WITH FLOW SECTION
- FLOW SECTION WITH STRAIGHTENING VANES
- STRAIGHTENING VANES
- * INSTRUMENTS, SPECIALTY ITEMS FURNISHED WITH MAJOR EQUIPMENT
- RUPTURE DISC
- MULTI-WAY VALVE (AS REQUIRED)
- AIR FOIL TYPE FLOW ELEMENT
- DIAPHRAGM

LINE SYMBOLS

- PROCESS PIPING
- SECONDARY PROCESS PIPING
- PNEUMATIC SIGNAL LINE
- ELECTRICAL SIGNAL LINE
- CAPILLARY TUBING
- FLEXIBLE LINE OR HOSE
- TEMPORARY LINE
- PIPING BY OTHERS

PIPING AND EQUIPMENT SYMBOLS

- SCREWED JOINT
- SOCKET OR BUTTWELD JOINT
- MECHANICAL JOINT
- BELL & SPIGOT JOINT
- FLANGED JOINT
- UNION
- BLIND FLANGE
- PIPE CAP
- SCREWED CAP
- SCREWED PLUG
- SPECTACLE BLIND
- DAMPER (GUILLOTINE)
- BOOTLEG
- LINE SIZE CHANGE
- EXPANSION JOINT
- DAMPER (LOUVER)
- SPRAY NOZZLE
- FD FLOAT DRAINER
- TRAP (SEE TRAP LIST FOR TYPE)
- AIR VENT TRAP
- VSC VARIABLE SPEED COUPLING
- FHS FIRE HOSE STATION
- SAS SERVICE AIR STATION
- SWS SERVICE WATER STATION
- T TURBINE DRIVE
- EDUCTOR OR EJECTOR
- PIPE HANGER
- HEAT EXCHANGER
- F G FLOW GLASS
- FIRE HYDRANT
- FIRE HYDRANT WITH HOSE & HYDRANT HOUSE
- MIXER (AGITATOR)
- OPEN FUNNEL TO (NAME OF DRAIN)
- VENT STACK-DRIP PAN/ELL
- DUPLEX STRAINER
- INTAKE FILTER/SILENCER
- SINGLE STRAINER/FILTER
- SPRAY-TYPE STRAINER
- TEMPORARY STRAINER
- Y-TYPE STRAINER
- CLEANOUT TYPE STRAINER
- CENTRIFUGAL PUMP
- VERTICAL PUMP (DRY PIT)
- VERTICAL PUMP (WET PIT)
- OR VERTICAL PUMP (CAN)
- IN-LINE PUMP
- CHEMICAL PUMP
- SEPARATOR
- MECHANICAL VACUUM PUMP
- AIR COMPRESSOR (RECIPROCATING)
- AIR COMPRESSOR (CENTRIFUGAL)
- AIR BLOWERS
- FAN CENTRIFUGAL
- FAN AXIAL FLOW
- SUMP PUMP

OPERATOR SYMBOLS

- M POWER OPERATOR
- S SOLENOID
- MODULATING CONTROL VALVE OPERATOR
- LEVER
- MANUAL WRENCH
- SPRING
- CONTROL DRIVE (DESIGNATE TYPE E.P. ETC.)
- SELF CONTAINED BACK PRESSURE REGULATOR
- SELF CONTAINED PRESSURE REGULATOR

INSTRUMENT AND EQUIPMENT ABBREVIATIONS

A	ALARM POINT
AI	ANALYZER INDICATOR
AN	ANNUNCIATOR
AR	ANALYZER RECORDER
AS	AIR SUPPLY (INSTRUMENT AIR)
AT	ANALYZER TRANSMITTER
ADV	AUTOMATIC DRAIN VALVE
AOV	AIR OPERATED VALVE
CCV	CONDUCTIVITY CONTROL VALVE
CD	SIGNAL CONVERTER OR PNEUMATIC RELAY
CE	CONDUCTIVITY ELEMENT
CI	CONDUCTIVITY INDICATOR
CHC	CONDUCTIVITY HAND CONTROLLER
CR	CONDUCTIVITY RECORDER
CT	CONDUCTIVITY TRANSMITTER
DC	DENSITY CONTROLLER
DPI	DIFFERENTIAL PRESSURE INDICATOR
DPS	DIFFERENTIAL PRESSURE SWITCH
DPT	DIFFERENTIAL PRESSURE TRANSMITTER
DR	DENSITY RECORDER
DT	DENSITY TRANSMITTER
E	ELECTRIC
EH	ELECTRO-HYDRAULIC
EJ	EXPANSION JOINT
E/P	ELECTRIC TO PNEUMATIC CONVERTER
ER	ELECTRIC RELAY
FD	FLOAT DRAINER
FC	FLOW CONTROLLER
FCD	FLOW CONTROL DRIVE
FCV	FLOW CONTROL VALVE
FE	FLOW ELEMENT
FG	FLOW GLASS
FH	FLEXIBLE HOSE
FHC	FLOW HAND-AUTO CONTROLLER
FHS	FIRE HOSE STATION
FI	FLOW INDICATOR
FM	FLOW METER
FO	FLOW ORIFICE (RESTRICTION)
FQ	FLOW INTEGRATOR
FR	FLOW RECORDER
FRC	FLOW RECORDER CONTROLLER
FS	FLOW SWITCH
FT	FLOW TRANSMITTER
FX	FLOW TEST POINT (NO ELEMENT)
G	GEAR
H	HYDRAULIC
HCV	HAND CONTROL VALVE
IL	INDICATING LIGHT
IN	INDICATOR
LC	LEVEL CONTROLLER
LCD	LEVEL CONTROL DRIVE
LCV	LEVEL CONTROL VALVE
LG	LEVEL GLASS
LHC	LEVEL HAND CONTROLLER
LI	LEVEL INDICATOR
LMS	LIMIT SWITCH
LR	LEVEL RECORDER
LRC	LEVEL RECORDER CONTROLLER
LS	LEVEL SWITCH
LT	LEVEL TRANSMITTER
M	MOTOR
MI	MOTOR (POSITION) INDICATOR
MOD	MODULE (MULTIPLE LIGHTED PB)
MOV	MOTOR OPERATED VALVE
MT	MOTION (POSITION) TRANSMITTER
P	PNEUMATIC
PB	PUSHBUTTON
PBIL	PUSHBUTTON WITH INDICATING LIGHT
PC	PRESSURE CONTROLLER
PCD	PRESSURE CONTROL DRIVE
PCV	PRESSURE CONTROL VALVE
P/E	PNEUMATIC TO ELECTRIC CONVERTER
PF	PERMANENT STRAINER
PHC	PRESSURE HAND CONTROLLER
pHC	pH CONTROLLER
pHE	pH ELEMENT
pHI	pH INDICATOR
pHR	pH RECORDER
pHT	pH TRANSMITTER
PI	PRESSURE INDICATOR
PR	PRESSURE RECORDER
PRC	PRESSURE RECORDER CONTROLLER
PS	PRESSURE SWITCH
PSV	PRESSURE SAFETY VALVE
PT	PRESSURE TRANSMITTER
PX	PRESSURE TEST POINT
RE	RESISTOR
RHEO	RHEOSTAT
RD	RUPTURE DISC.
S	SOLENOID
SAS	SERVICE AIR STATION
SC	SAMPLE COOLER
SF	SPRAY TYPE STRAINER
SI	SPEED INDICATOR
SN	SAMPLE NOZZLE
ST	SPEED TRANSMITTER
SV	SOLENOID VALVE
SW	SWITCH (ELECTRICAL)
SWS	SERVICE WATER STATION
SX	SAMPLE TEST POINT
T	TRAP
TC	TEMPERATURE CONTROLLER
TCD	TEMPERATURE CONTROL DRIVE
TCV	TEMPERATURE CONTROL VALVE
TD	TURBINE DRIVE
TDV	TEST DEVICE
TE	TEMPERATURE ELEMENT
TF	TEMPORARY STRAINER
THC	TEMPERATURE HAND CONTROLLER
TI	TEMPERATURE INDICATOR
TR	TEMPERATURE RECORDER
TRC	TEMPERATURE RECORDER CONTROLLER
TS	TEMPERATURE SWITCH
TSW	TEST SWITCH
TT	TEMPERATURE TRANSMITTER
TW	TEMPERATURE WELL
TV	TELEVISION
TX	TEST WELL
UVS	FLAME SCANNER
V	VALVE
VSC	VARIABLE SPEED COUPLING
VSD	VARIABLE SPEED DRIVE
ZI	POSITION INDICATOR
ZSS	ZERO SPEED SWITCH
ZT	POSITION TRANSMITTER
ZS	ZERO POSITION SWITCH

PIPE LINE NUMBERING SYSTEM

6" ST 2005 ABA

- PIPE SPECIFICATION
- LINE NO.
- PLANT UNIT NUMBER
- SERVICE IN PIPE
- SIZE

SERVICE ABBREVIATIONS

AC	ACID CLEANING
AD	DRAINS TO ASH WATER SYSTEM
AS	AUXILIARY STEAM
AW	ASH WATER
BD	BOILER BLOWDOWN
BF	BOILER FEEDWATER
BO	BLOWOUT
BW	BEARING COOLING WATER
CA	CONVEYING AIR
CD	CO_2
CF	CONDENSATE CYCLE FLUSH
CH	CHEMICAL
CM	CONDENSATE MAKE-UP
CO	CONDENSATE
CW	CIRCULATING WATER
DL	DRAINS TO DAYLIGHT
DO	DIESEL OIL
DM	DOMESTIC WATER
DR	DRAINS TO CYCLE
DW	DEMINERALIZED WATER
ED	EQUIPMENT DRAIN
EW	EQUIPMENT COOLING WATER
EX	EXTRACTION STEAM
FA	FLY ASH
FD	FLOOR DRAIN
FG	FUEL GAS
FO	FUEL OIL
FP	FIRE PROTECTION WATER
FW	FEED WATER
HD	HEATER DRAINS
HC	HEATING CONDENSATE
HS	HEATING STEAM
HW	HOT WATER - DOMESTIC
HY	HYDROGEN
IO	IGNITOR OIL
LO	LUBE OIL
MM	MISCELLANEOUS MATERIAL
MS	MAIN STEAM
N	NITROGEN
NA	INSTRUMENT AIR
NB	DRAINS TO NEUTRALIZING BASIN
PW	POTABLE WATER
RB	DRAINS TO HOLDING BASIN
RD	ROOF DRAINS
RH	REHEAT (HOT & COLD)
RW	RAW WATER
SA	SERVICE AIR
SB	SOOT BLOWER AIR
SS	SANITARY SEWER
ST	STEAM (INCL. TRAPS)
SW	SERVICE WATER
SP	SPECIAL
TA	TRANSFER AIR
TW	TREATED WATER
VT	VENTS (INCL. RELIEF VALVES)
WA	WET ASH
WD	DRAINS TO WASTE DISPOSAL SUMP
YD	YARD DRAINS
XW	CHILLED WATER

EQUIPMENT NUMBERING SYSTEM

V ST 2005 1

- EQUIPMENT NUMBER
- LINE NUMBER
- PLANT UNIT NUMBER
- SERVICE IN PIPE
- EQUIPMENT IDENTIFICATION (SEE BELOW)

EJ	EXPANSION JOINT	H	PIPE HANGER
FH	FLEXIBLE HOSE	FD	FLOAT DRAINER
MOV	MOTOR OPERATED VALVE	PSV	PRESSURE SAFETY VALVE
PF	PERMANENT STRAINER	SV	SOLENOID VALVE
SF	SPRAY TYPE STRAINER	FO	FLOW ORIFICE
TF	TEMPORARY STRAINER		
T	TRAP		
V	VALVE		
AOV	AIR OPERATED VALVE (NOT MODULATING)		

Equipment numbering system above is for in-line piping components only. For equipment numbering system for pumps, tanks, etc., see P3 series drawings and project equipment nomenclature list.

ABBREVIATIONS

NC NORMALLY CLOSED

GENERAL NOTES

FLOW DIAGRAM INDEX

II-5-3

NO	REVISIONS	DATE	BY	CK'D	APP'D
A	ISSUED FOR CONCEPTUAL DESIGN	12 13 77	YW	GVZ	FW

REFERENCE DRAWINGS

PRINT RECORD

REVISION NO.	A
ISSUED	12/16/77
CUSTOMER	3 - 1/2
FIELD	
INTRA-COMPANY	5 - 1/2

Form 22200-84

Stearns-Roger

DRAWN		COORD CK	
STRUCT CK		APPROVED	JM 12/13/77
MECH CK		APPROVED	GVZ 12-13-77
ELECT CK		APPROVED	12/13/77

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

RECOMMENDED FOR APPROVAL
APPROVED
APPROVED

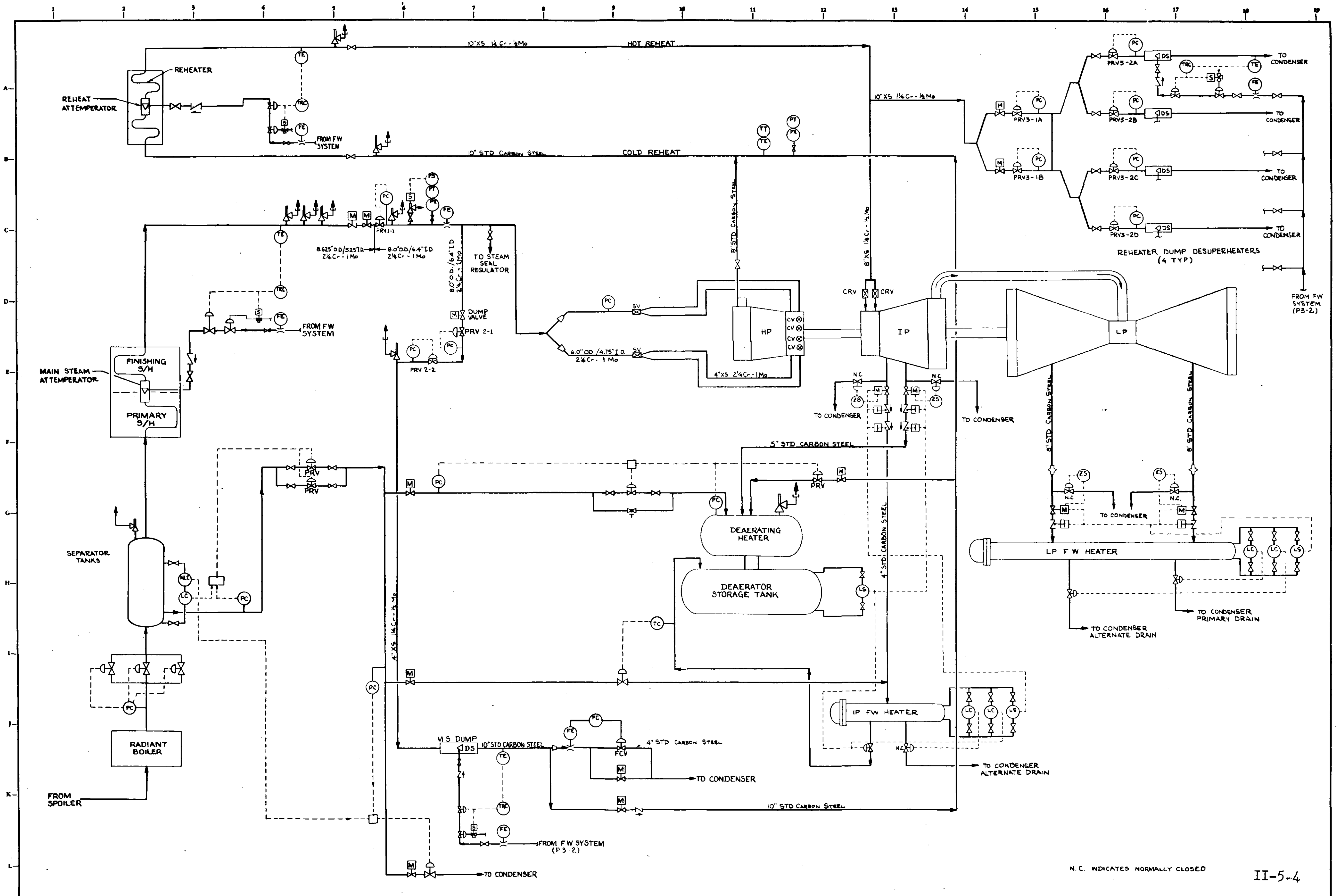
TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN

PIPING AND EQUIPMENT
SYMBOLS AND NOMENCLATURE

SCALE NONE | ORDER NO. C-19350 | M.L. NO

PRELIMINARY
FOR APPROVAL
APP FOR CONST

DWG NO L-22757
SHEET NO P1-1
REV A



II-5-4

NO.	REVISIONS	DATE	BY	CK'D	APP'D
A	FOR CUSTOMER COMMENTS	11/18/77	VW	JW	
B	REVISED PER CUSTOMER COMMENTS	12-9-77	VW		
C	ISSUED FOR CONCEPTUAL DESIGN	12-19-77	VW		
D	REMOVED "MHD PLANT - BOTTOMING PLANT" NOTE	1-31-78	VW		

REFERENCE DRAWINGS

PRINT RECORD

REVISION NO.	A	B	C	D
ISSUED	11/18/77		12/16/77	2/6/78
CUSTOMER	2-½	2-½	3-½	2-½
S-R FIELD				
ERDA (COMPANY)	7-½	7-½	5-½	5-½

Stearns-Roger

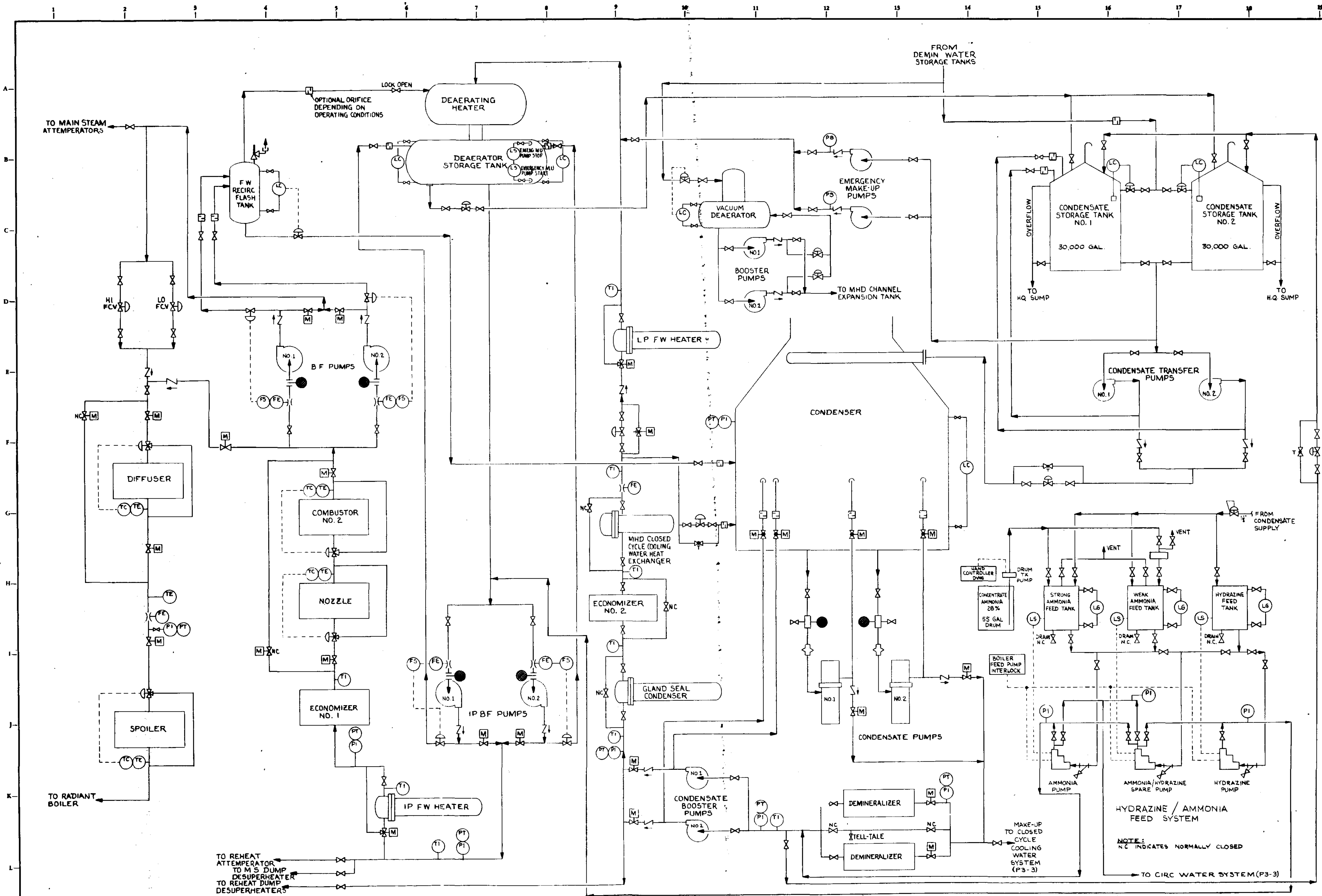
DRAWN: V WHITE 11/15/77 — APPROVED: JM 12/13/77
MECH. CK.: J WINBG 11/28/77 — APPROVED: 12-13-77

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
FLOW DIAGRAM
MAIN STEAM

SCALE: NONE — ORDER NO. C-19350

DWG. NO. L-22757
SHEET NO. P3-1
REV. D



NO.	REVISIONS	DATE	BY	CK'D	APP'D
A	FOR CUSTOMER COMMENT	11/28/77	YW	JW	
B	REVISED PER CUSTOMER COMMENT				
C	ISSUED FOR CONCEPTUAL DESIGN	12/13/77	YW		
D	REVISED IP & LP HEATER BYPASSES	1/31/78	YW		

REFERENCE DRAWINGS

PRINT RECORD

REVISION NO.	A	B	C	D
ISSUED	11/28/77		12/14/77	2/6/78
CUSTOMER	2-1/2	2-1/2	3-1/2	2-1/2
S.R. FIELD				
INTRA-COMPANY	7-1/2	7-1/2	5-1/2	5-1/2

Stearns-Roger

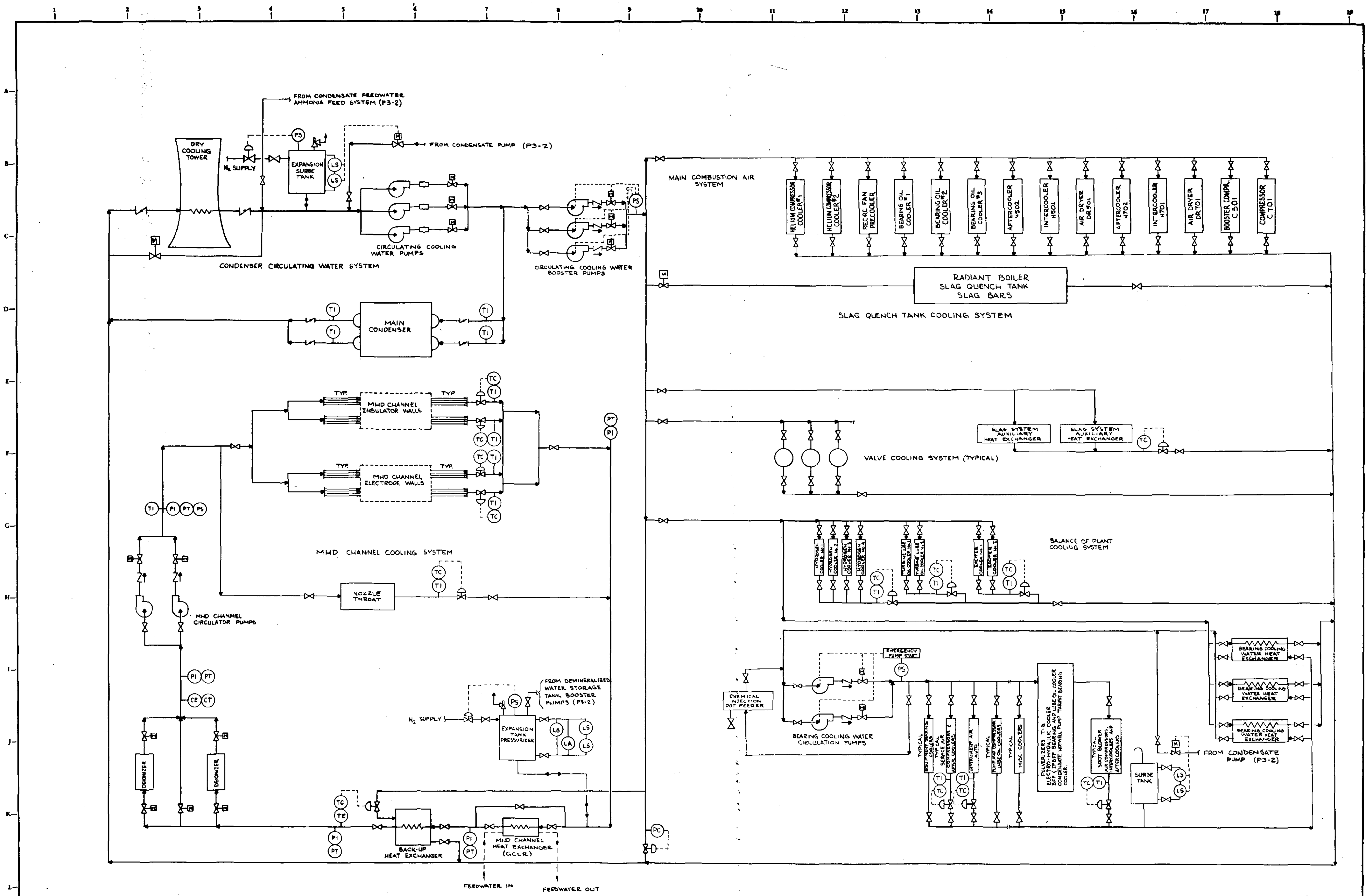
DRAWN	Y WHITE	11/17/77	COORD. CK.		
STRUCT. CK.			APPROVED		12/13/77
MECH. CK.	J WINTER	11/28/77	APPROVED		12/13/77
ELECT. CK.			APPROVED		

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
FLOW DIAGRAM
CONDENSATE AND FEEDWATER

SCALE NONE ORDER NO. C-19350

DWG. NO. L-22757
SHEET NO. P3-2
REV. D



II-5-6

NO.	REVISIONS	DATE	BY	CK'D	APP'D
A	FOR CUSTOMER COMMENT	11/18/77	G.S.	JW	
B	REVISED PER CUSTOMER COMMENTS	12-8-77	RVB		
C	ISSUED FOR CONCEPTUAL DESIGN	12/8/77	YW		
D	REVISED PER CUSTOMER COMMENTS	1/31/78	YW		

REFERENCE DRAWINGS

PRINT RECORD

REVISION NO.	A	B	C	D
ISSUED	11/28/77		12/14/77	2/6/78
CUSTOMER	2-1/2	2-1/2	3-1/2	2-1/2
S.R. FIELD				
	7-1/2	7-1/2	5-1/2	5-1/2

Stearns-Roger

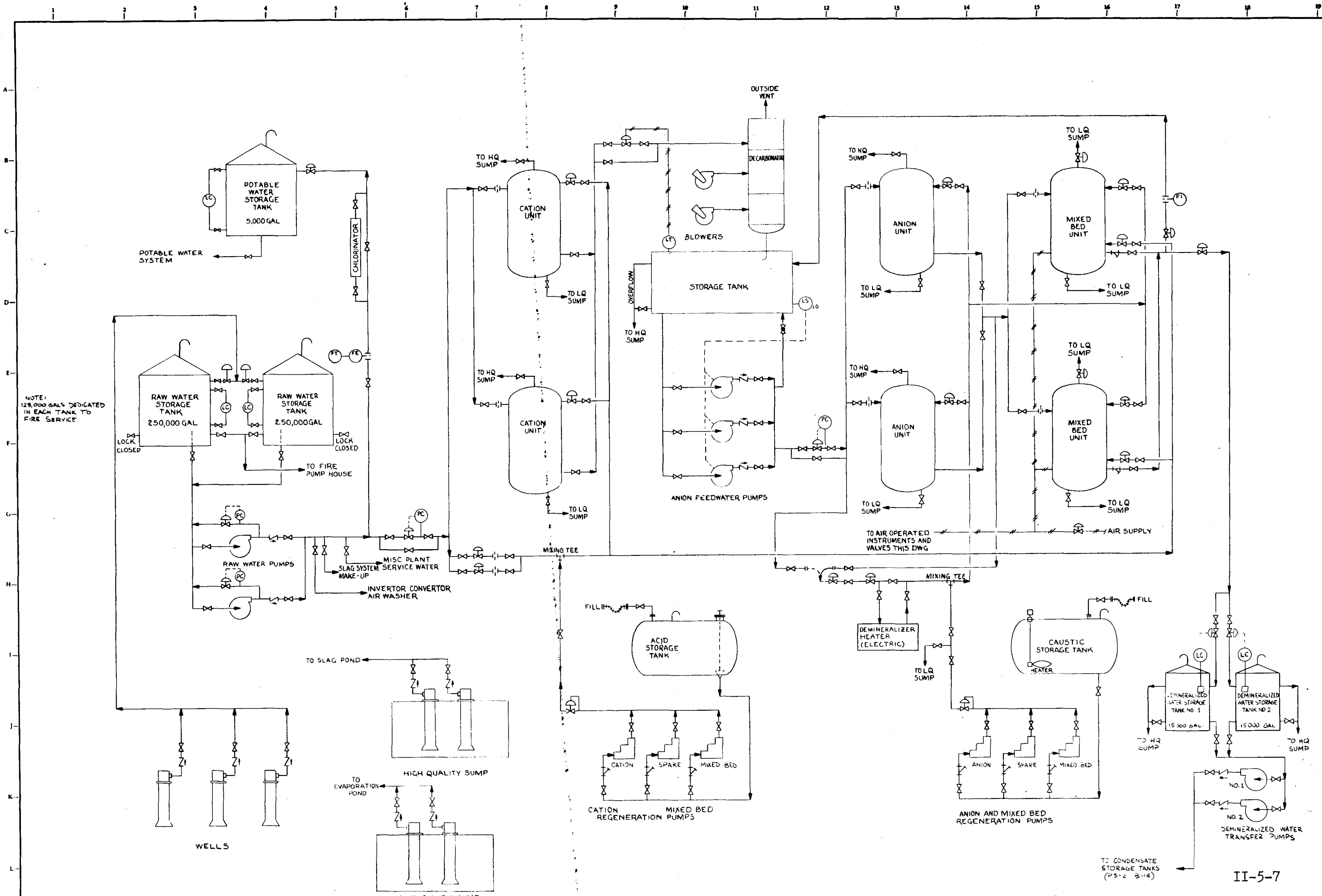
DRAWN G.S. 11/21/77 — APPROVED M 12/12/77
MECH. CK. J. WINTER 11/28/77

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
FLOW DIAGRAM
CLOSED CIRCULATING COOLING WATER SYSTEMS

SCALE NONE — ORDER NO. C-19350

DWG. NO. L-22757
SHEET NO. P3-3
REV. D



NO	REVISIONS	DATE	BY	CK'D	APP'D
A	FOR CUSTOMER COMMENT	11/28/77	YW	JW	
B	ISSUED FOR CONCEPTUAL DESIGN	12/13/77	YW		
C	REVISED PER CUSTOMER COMMENTS	1/31/78	YW		

REFERENCE DRAWINGS

PRINT RECORD

REVISION NO	A	B	C
ISSUES	11/28/77	12/14/77	2/6/78
CUSTOMER	2-1/2	3-1/2	2-1/2
S R FIELD			
INTRA-COMPANY	7-1/2	5-1/2	5-1/2

Stearns-Roger

DRAWN		11-15-77	COORD. CK.		
STRUCT. CK.			APPROVED		12-13-77
MECH. CK.	J Winter		APPROVED		12-13-77
ELECT. CK.			APPROVED		

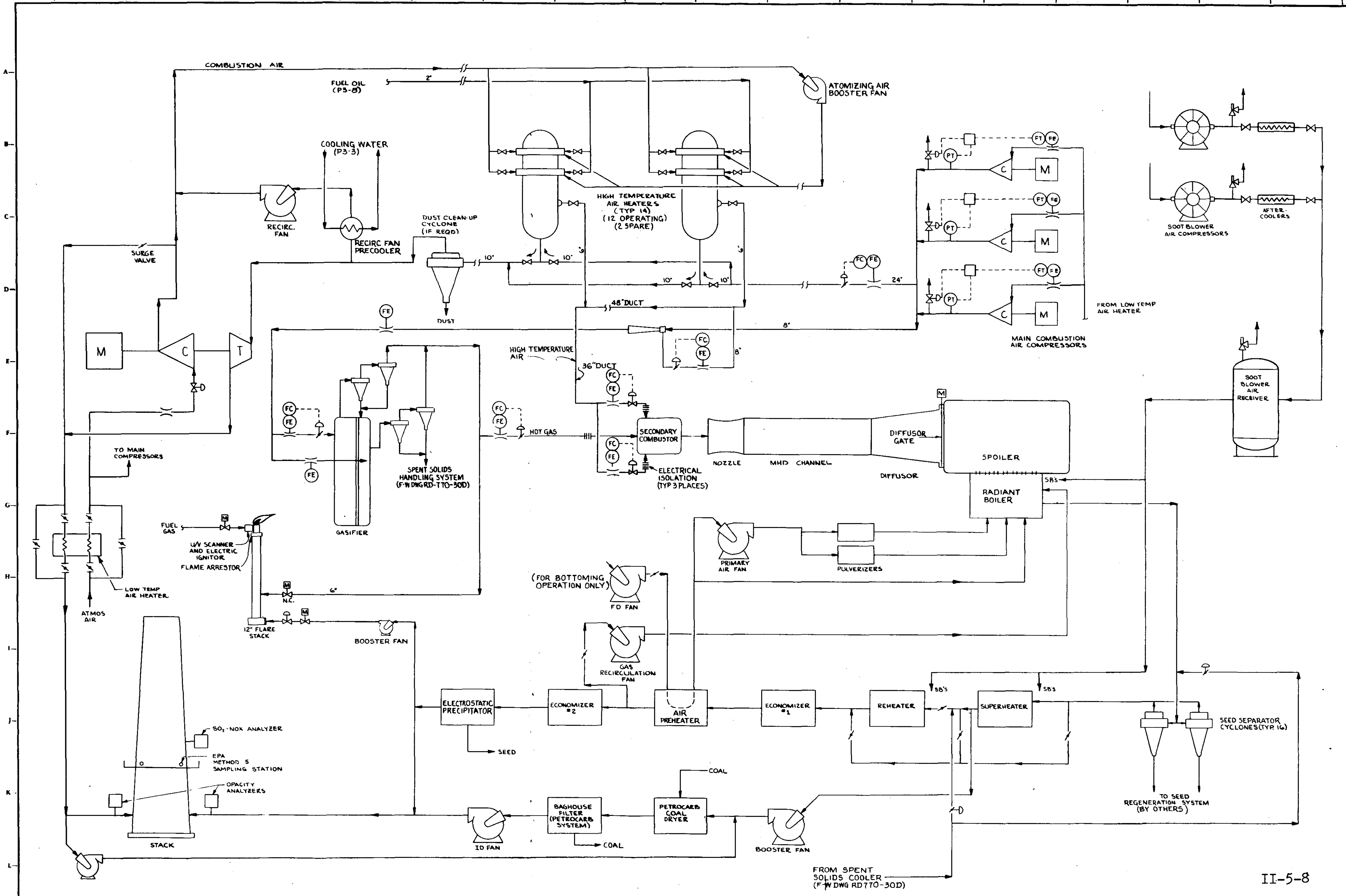
GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

RECOMMENDED FOR APPROVAL
APPROVED
APPROVED

TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
FLOW DIAGRAM
RAW WATER, MAKE-UP AND STORAGE

SCALE NONE | ORDER NO. C-19350 | M. L. NO.

PRELIMINARY
FOR APPROVAL
APP. FOR CONST.
DWG. NO. L-22757
SHEET NO. P3-4
REV. C



II-5-8

NO	REVISIONS	DATE	BY	CH'D	APP'D
A	FOR CUSTOMER COMMENTS	11/28/77	YW		
B	REVISED PER CUSTOMER COMMENTS	11/30/77	ELL		
C	ISSUED FOR CONCEPTUAL DESIGN	12/13/77	YW		
D	REVISED PER CUSTOMER COMMENTS	12/21/77	SWB		
E	REVISED PER CUSTOMER COMMENTS	2/6/78	YW		

REFERENCE DRAWINGS

PRINT RECORD

REVISION NO.	A	B	C	D	E
ISSUED	11/28/77		12/14/77		2/6/78
CUSTOMER	2-½		3-½	3-½	2-½
S R FIELD					
INTER-COMPANY	7-½		5-½	5-½	5-½

Stearns-Roger

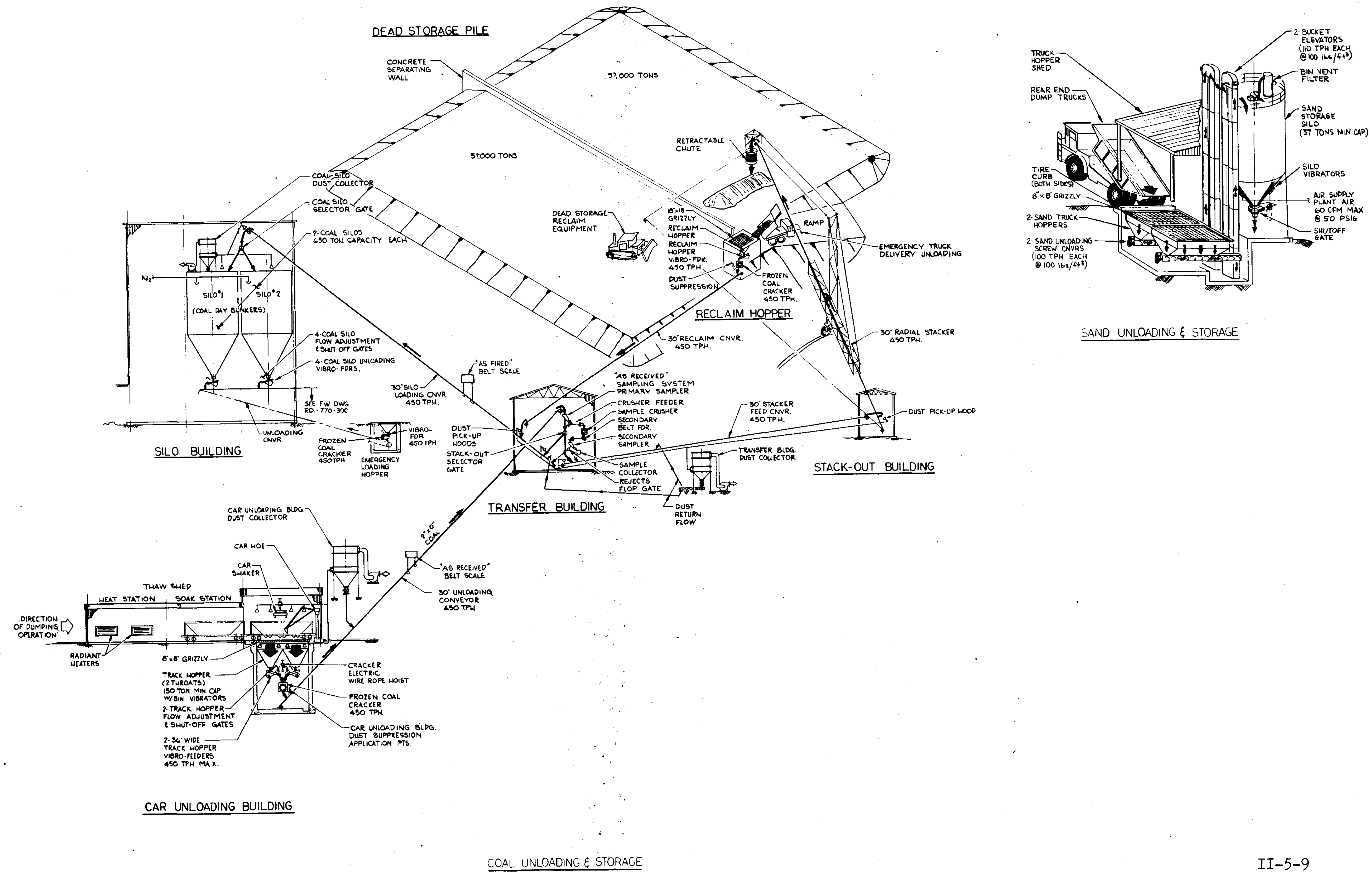
DRAWN 11-22-77

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
FLOW DIAGRAM
COMBUSTION AIR, HOT GAS, AND FLUE GAS

SCALE NONE ORDER NO. C-19350

DWG. NO. L-22757
SHEET NO. P3-5
REV. E



NO.	REVISIONS	DATE	BY	CK'D	APP'D
A	ISSUED FOR CONCEPT	11/9/77	RR		
B	REVISED PER CUSTOMER COMMENT	11/21/77	GS		
C	REVISED PER CUSTOMER COMMENT	12/6/77	RYB		
D	ISSUED FOR CONCEPTUAL DESIGN	12/13/77	YW		

REFERENCE DRAWINGS

PRINT RECORD

REVISION NO.	A	B	C	D
ISSUED	11/15/77	11/28/77		12/14/77
CUSTOMER	2-P	2-½	2-½	3-½
S.R. FIELD				
INTRA COMPANY	4-P	7-½	7-½	5-½

Stearns-Roger

DRAWN R. ROERIG 11/12/77 — COORD. CK.
STRUCT. CK. — APPROVED 11/15/77
MECH. CK. EGB 11/15/77 — APPROVED 11/15/77
ELECT. CK. — APPROVED 11/15/77

RECOMMENDED FOR APPROVAL
APPROVED
APPROVED

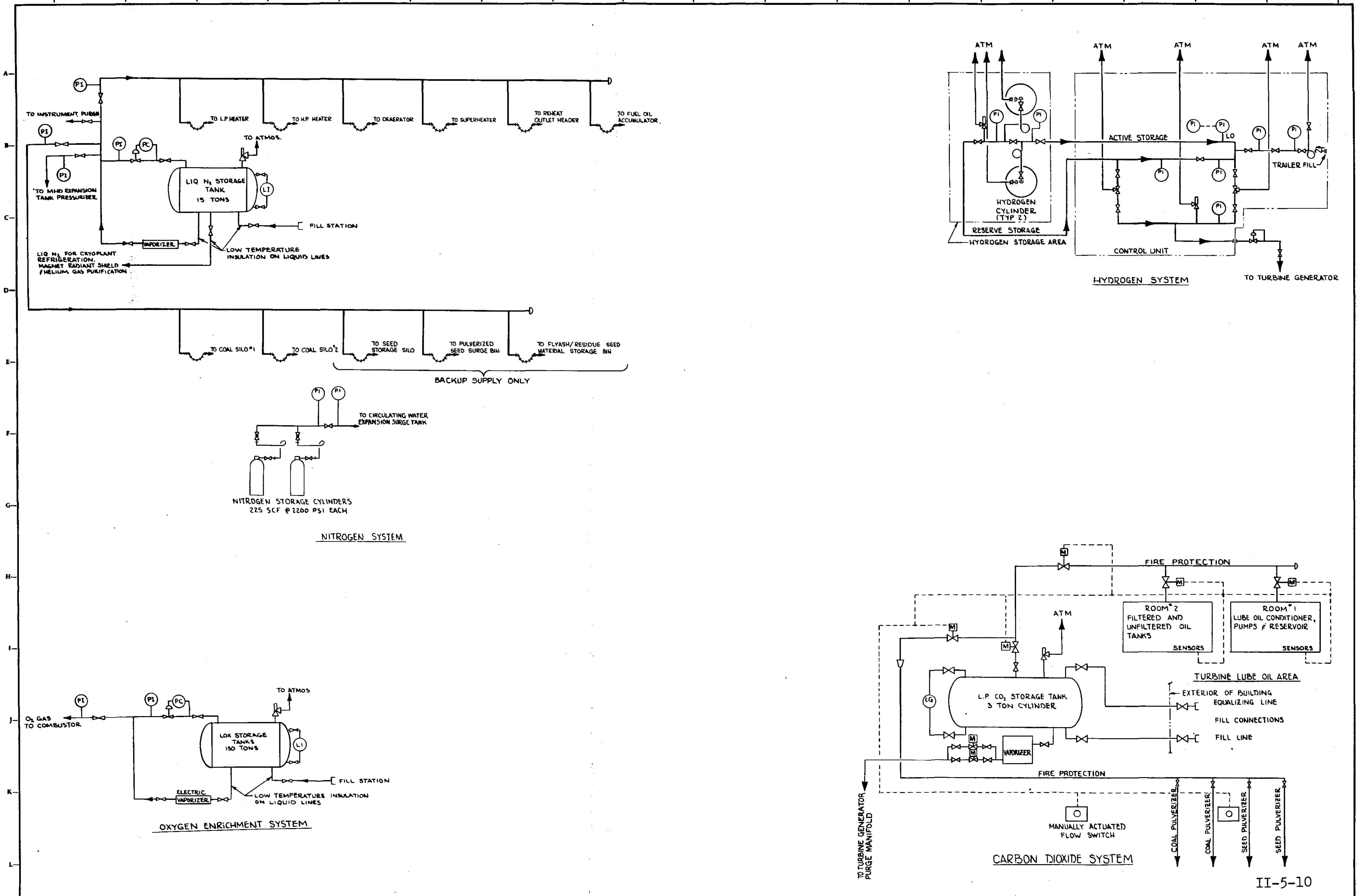
GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
FLOW DIAGRAM
COAL AND SAND UNLOADING AND STORAGE

SCALE NONE — ORDER NO. C-19350 — W.L. NO.

PRELIMINARY
FOR APPROVAL
APP. FOR CONST.
DWG. NO. L-22757
SHEET NO. P3-6
REV. D

Form 32200-34



II-5-10

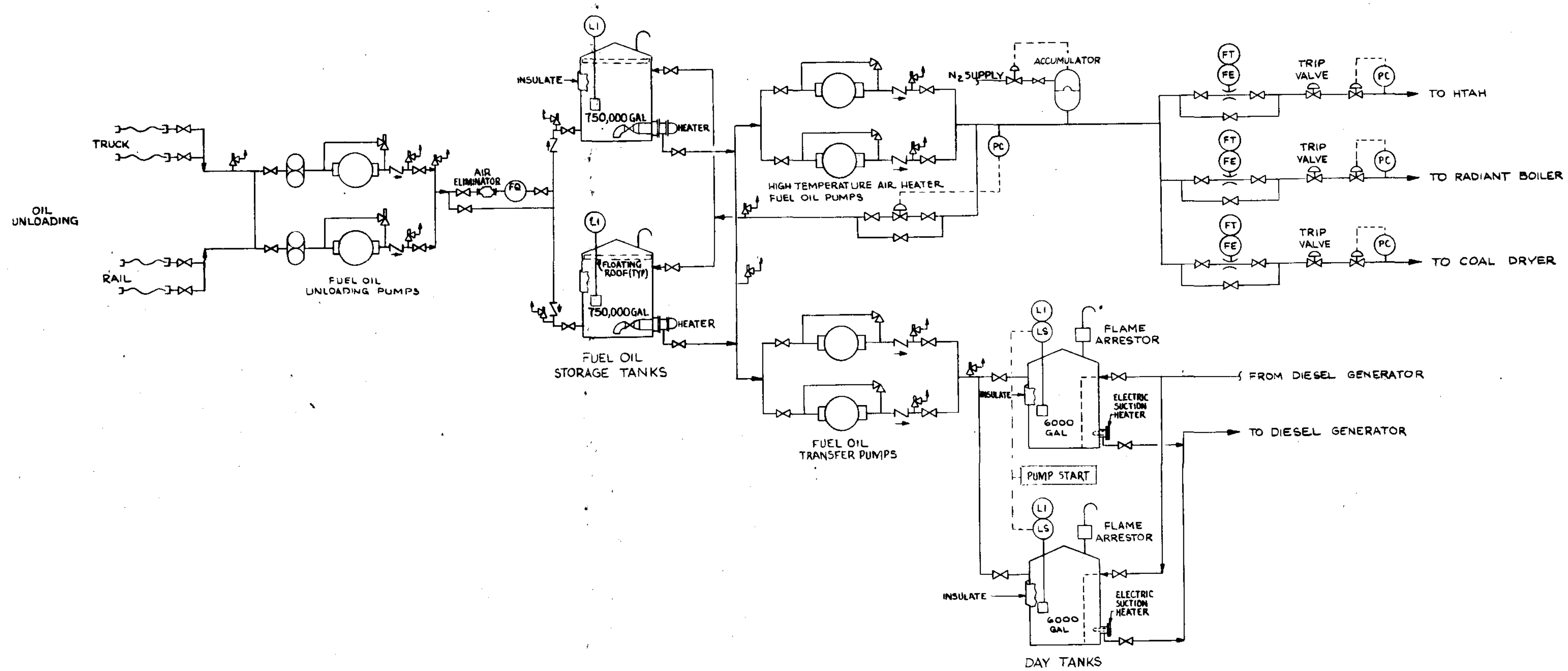
NO	REVISIONS	DATE	BY	CK'D	APP'D
A	ISSUED FOR CONCEPTUAL DESIGN	12/13/77	YW		
B	REVISED PER CUSTOMER COMMENT	12/22/77	RVB		
C	REVISED PER CUSTOMER COMMENTS	1/31/78	YW		

Stearns-Roger

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
FLOW DIAGRAM
MISCELLANEOUS GASES

SCALE NONE ORDER NO. C-19350
DWG. NO. L-22757
SHEET NO. P3-7
REV. C



II-5-11

NO	REVISIONS	DATE	BY	CK'D	APP'D
A	FOR CUSTOMER COMMENT	11/28/77	GS	JW	
B	REVISED PER CUSTOMER COMMENT	12-8-77	RVB		
C	ISSUED FOR CONCEPTUAL DESIGN	12/13/77	VW		
D	REVISED DAY TANKS SIZE	12/14/77	RVB		
E	REVISED PER CUSTOMER COMMENTS	2/2/78	YW		

REFERENCE DRAWINGS

PRINT RECORD

REVISION NO.	A	B	C	E
ISSUED	11/29/77		12/14/77	2/6/78
CUSTOMER	2-1/2	2-1/2	3-1/2	2-1/2
S.R. FIELD				
INITIAL COMPANY	7-1/2	7-1/2	5-1/2	5-1/2

Stearns-Roger

DRAWN G. S. 11/22/77 — COORD. CK. — APPROVED JM 12/13/77
MECH. CK. J Winter 11/28/77 — APPROVED V Zachau 12-13-77
STRUCT. CK. — ELECT. CK. — APPROVED

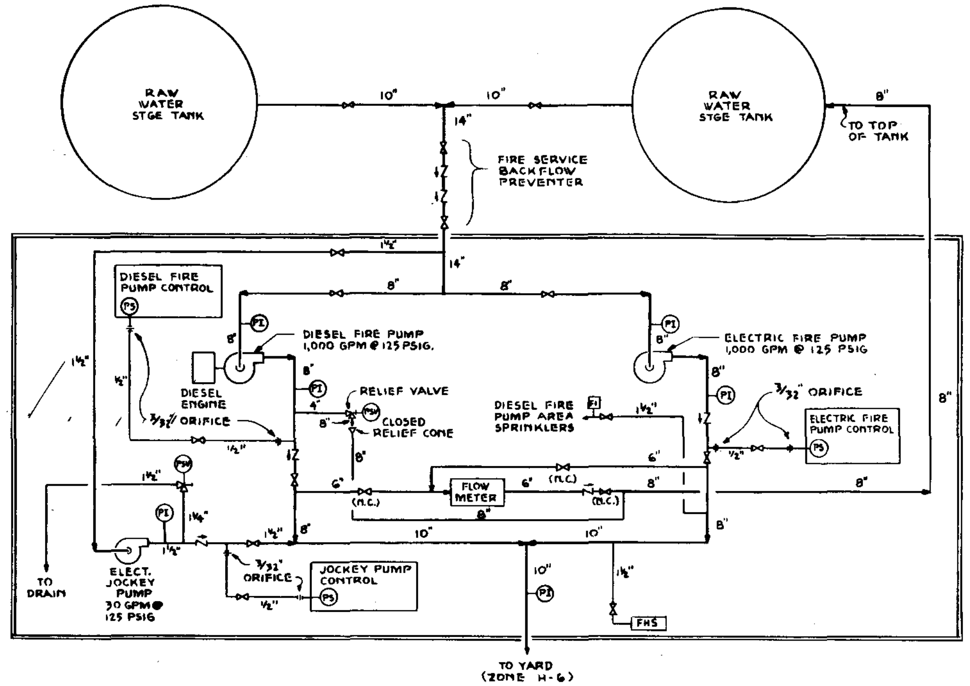
GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

RECOMMENDED FOR APPROVAL — APPROVED — APPROVED

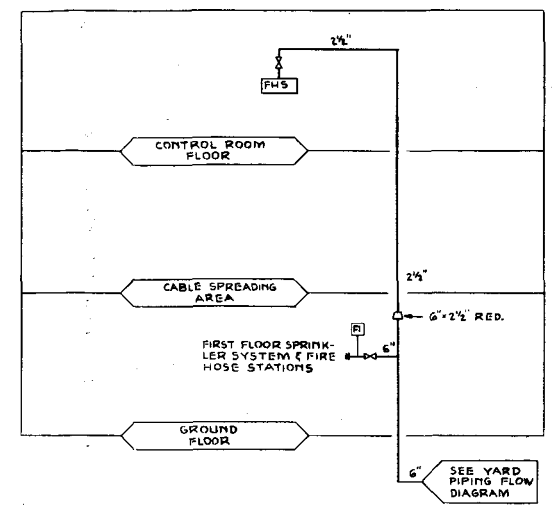
TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
FLOW DIAGRAM
FUEL OIL

SCALE NONE — ORDER NO. C-19350 — M.L. NO.

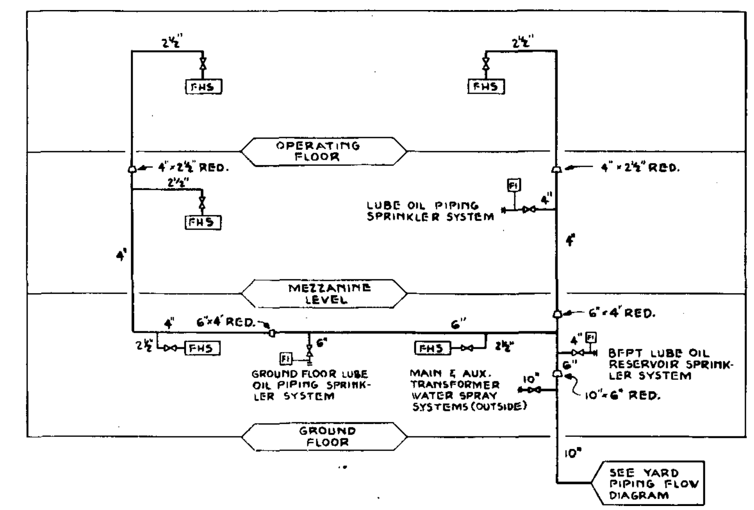
DWG. NO. L-22757
SHEET NO. P3-8
REV. E



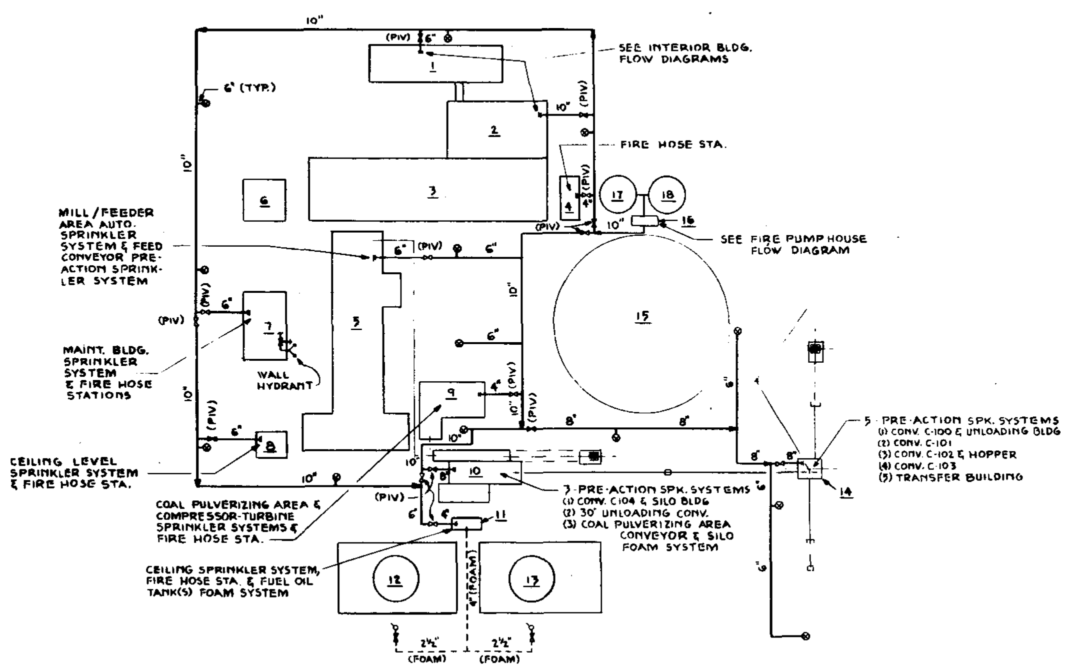
FIRE PUMP HOUSE - FLOW DIAGRAM



ADMINISTRATIVE & CONTROL BLDG. - FLOW DIAGRAM



TURBINE-GENERATOR BLDG. - FLOW DIAGRAM



YARD PIPING - FLOW DIAGRAM

BUILDING LEGEND

1. ADMINISTRATION & CONTROL BUILDING
2. TURBINE GENERATOR BUILDING
3. HEAT RECOVERY BUILDING
4. WATER TREATMENT BUILDING
5. MHD BUILDING
6. SWITCHYARD
7. MAINTENANCE BUILDING
8. COMPRESSOR BUILDING
9. COAL SAND SEED BUILDING
10. COAL SILO UNLOADING AREA
11. FUEL OIL PUMP HOUSE
12. FUEL OIL TANK - 750,000 GAL.
13. FUEL OIL TANK - 750,000 GAL.
14. TRANSFER BUILDING
15. COOLING TOWER
16. FIRE PUMP HOUSE
17. RAW WATER TANK - 250,000 GAL.
18. RAW WATER TANK - 250,000 GAL.

SYMBOL LEGEND

- (PSV) PRESSURE SAFETY VALVE
- (PS) PRESSURE SWITCH
- (PI) PRESSURE INDICATOR
- FIRE HYDRANT
- MONITOR NOZZLE
- FHS FIRE HOSE STATION
- (PIV) POST INDICATOR VALVE
- (N.C.) NORMALLY CLOSED
- FI FLOW INDICATOR

SPECIAL AGENT FIRE PROTECTION

AREA	LOCATION	TYPE PROTECTION
GENERAL	WHERE REQUIRED	FIRE HOSE STATIONS & FIRE EXTINGUISHERS
CABLE SPREADING & LOGIC ROOM	ADMINISTRATION & CONTROL BUILDING	AUTOMATIC TOTAL FLOODING HALON 1301
CONTROL ROOM	ADMINISTRATION & CONTROL BUILDING	AUTOMATIC TOTAL FLOODING HALON 1301
LUBE OIL CONDITIONER, PUMP & RESERVOIR RM. NO. 1	TURBINE-GENERATOR BUILDING	LOW PRESSURE CO_2 - SEE FLOW DIAGRAM (MISC. GASES) DWG. L-22757 SHEET P3-7
FILTERED & UNFILTERED OIL TANKS ROOM NO. 2	TURBINE-GENERATOR BUILDING	LOW PRESSURE CO_2 - SEE FLOW DIAGRAM (MISC. GASES) DWG. L-22757 SHEET P3-7
PULVERIZERS	MHD BUILDING & COAL SAND SEED BUILDING	LOW PRESSURE CO_2 - SEE FLOW DIAGRAM (MISC. GASES) DWG. L-22757 SHEET P3-7
FUEL OIL TANKS	YARD AREA	AUTOMATIC SUBSURFACE FOAM & HYDRANT SYSTEM
COAL SILOS	COAL UNLOADING AREA	AUTOMATIC FOAM SYSTEM

II-5-12

NO.	REVISIONS	DATE	BY
A	ISSUED FOR CONCEPTUAL DESIGN	12/13/77	YW

REFERENCE DRAWINGS

PRINT RECORD

Stearns-Roger

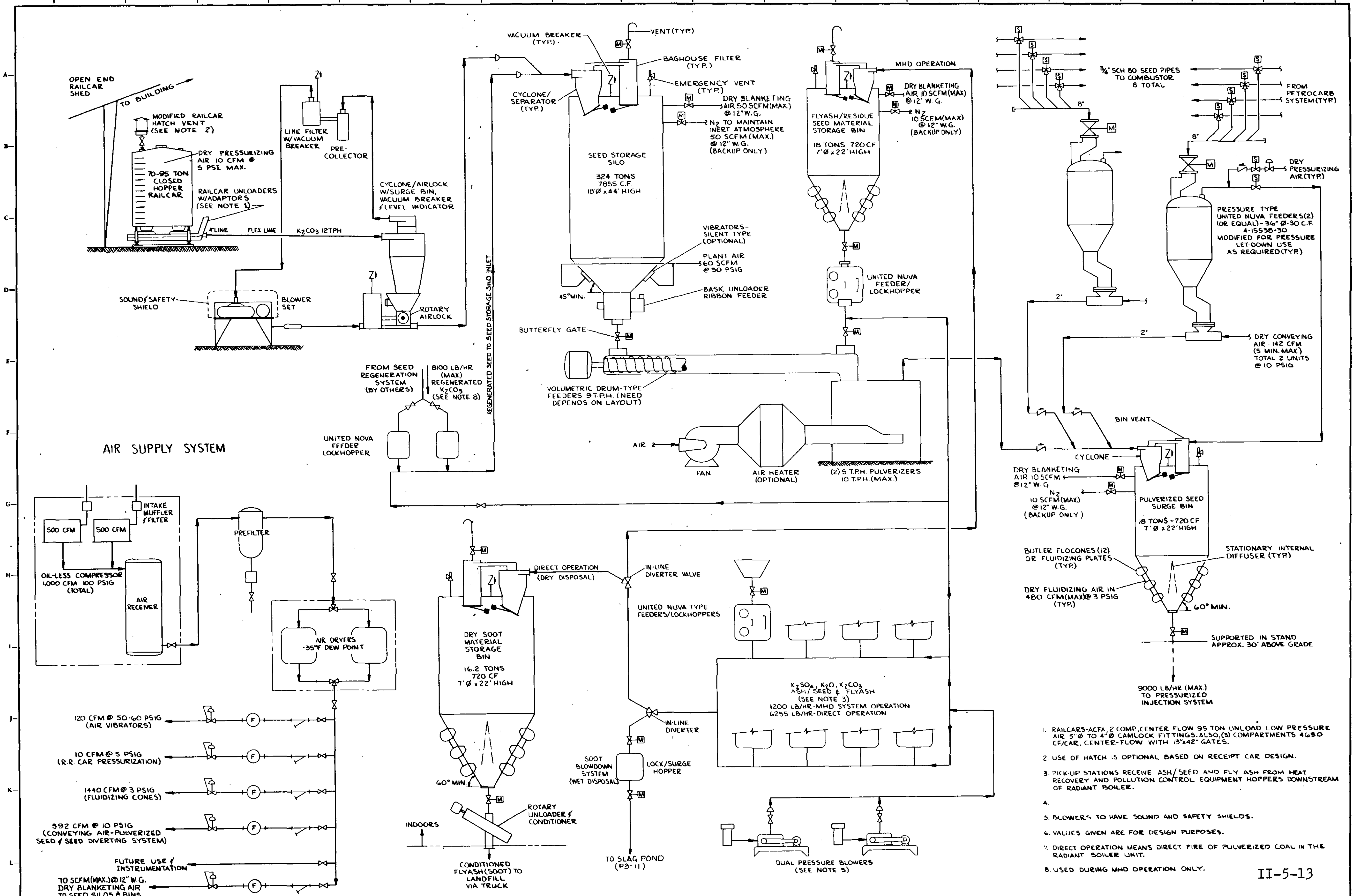
DRAWN P.D. CORCORAN 12-13-77

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
FLOW DIAGRAM
FIRE SERVICE

SCALE NONE | ORDER NO. C-19350

DWG. NO. L-22757
SHEET NO. P3-9
REV. A



1. RAILCARS-ACFX, 2 COMP. CENTER FLOW 95 TON UNLOAD LOW PRESSURE AIR 5"Ø TO 4"Ø CAMLOCK FITTINGS. ALSO, (3) COMPARTMENTS 4650 CF/CAR, CENTER-FLOW WITH 13"x42" GATES.
2. USE OF HATCH IS OPTIONAL BASED ON RECEIPT CAR DESIGN.
3. PICK UP STATIONS RECEIVE ASH/SEED AND FLY ASH FROM HEAT RECOVERY AND POLLUTION CONTROL EQUIPMENT HOPPERS DOWNSTREAM OF RADIANT BOILER.
4.
5. BLOWERS TO HAVE SOUND AND SAFETY SHIELDS.
6. VALUES GIVEN ARE FOR DESIGN PURPOSES.
7. DIRECT OPERATION MEANS DIRECT FIRE OF PULVERIZED COAL IN THE RADIANT BOILER UNIT.
8. USED DURING MHD OPERATION ONLY.

II-5-13

NO.	REVISIONS	DATE	BY	CK'D	APP'D
A	ISSUED FOR CUSTOMER COMMENT	12/9/77	RLL		
B	ISSUED FOR CONCEPTUAL DESIGN	12/13/77	YW		
C	REVISED NOTE 3 WAS SOOT MATL NOW ASH/SEED	12/21/77	RVB		
D	REVISED PER CUSTOMER COMMENTS	2/2/78	YW		

REFERENCE DRAWINGS

PRINT RECORD

REVISION NO	A	B	C	D
ISSUED	12/9/77	12/14/77		2/6/78
CUSTOMER	1	3-1/2	3-1/2	2-1/2
S.R. FIELD				
	4-1/2	5-1/2	5-1/2	5 1/2

1 COPY BY TELECOPYER

Stearns-Roger

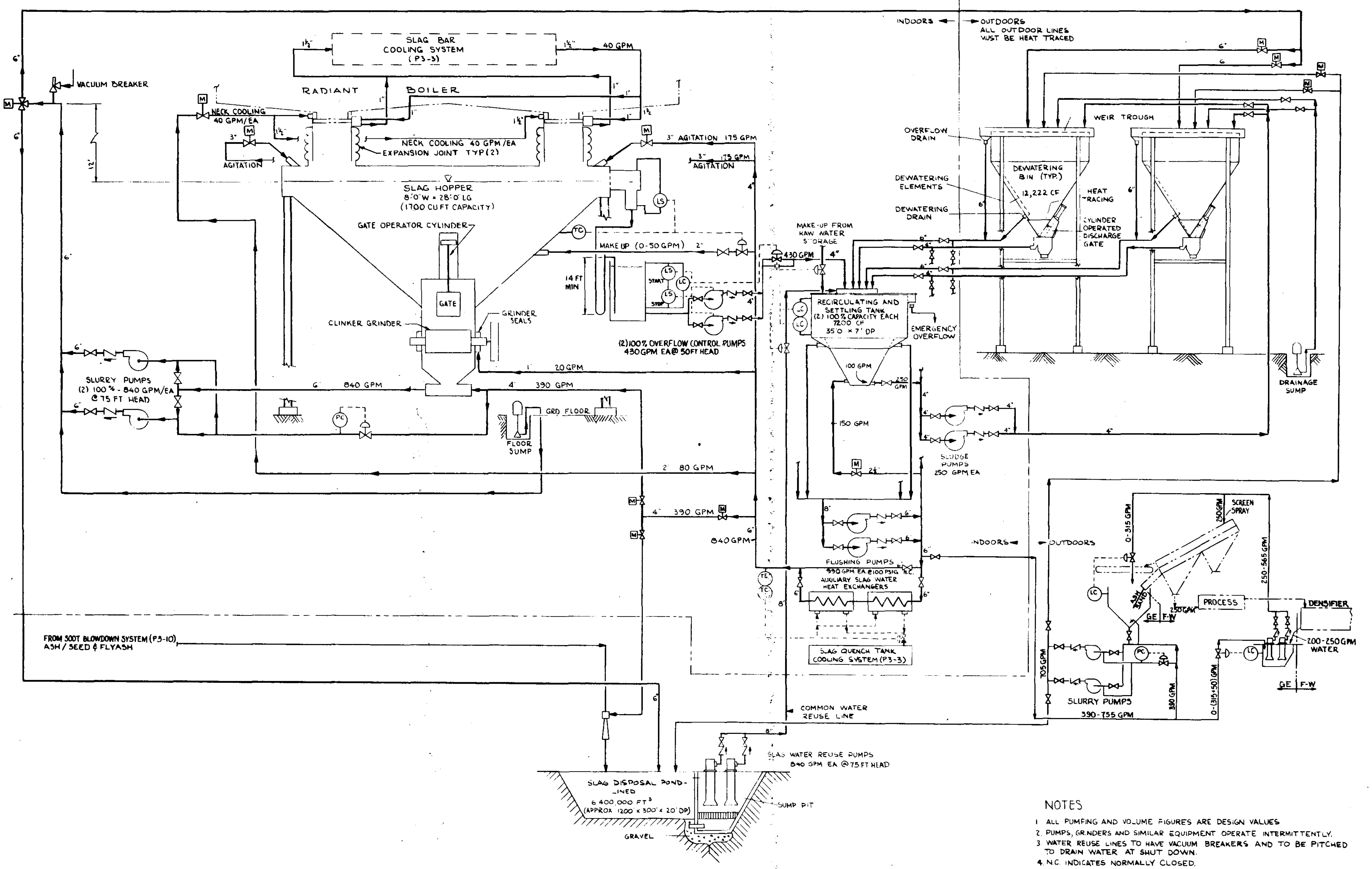
DRAWN RXX 12-2-77

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
FLOW DIAGRAM
SEED HANDLING

SCALE NONE — ORDER NO. C-19350

DWG. NO. L-22757
SHEET NO. P3-10
REV. D



NOTES

1. ALL PUMPING AND VOLUME FIGURES ARE DESIGN VALUES.
2. PUMPS, GRINDERS AND SIMILAR EQUIPMENT OPERATE INTERMITTENTLY.
3. WATER REUSE LINES TO HAVE VACUUM BREAKERS AND TO BE PITCHED TO DRAIN WATER AT SHUT DOWN.
4. N.C. INDICATES NORMALLY CLOSED.

II-5-14

NO	REVISIONS	DATE	BY	CK'D	APP'D
A	ISSUED FOR CUSTOMER COMMENT	11/18	GS		
B	REVISED PER CUSTOMER COMMENTS	11/22/77	YW		
C	REMOVED COMBUSTOR SLAG COLLECTION / REVISED	12/8/77	RVB		
–	RB SLAG COLLECTION - OMITTED NOTES 2/3	–			
D	ISSUED FOR CONCEPTUAL DESIGN	12/13/77	YW		
E	REVISED PER CUSTOMER COMMENTS	2/2/78	YW		

REFERENCE DRAWINGS

PRINT RECORD

REVISION NO.	A	B	C	D	E
ISSUED	11/18/77	11/28/77		12/14/77	2/6/78
CUSTOMER	1 *	2-½	1 *	3-½	2-½
S.R. FIELD					
INTRA Company	4-½	7-½	4-½	5-½	5-½

* 1 COPY BY TELECOPYER

Stearns-Roger

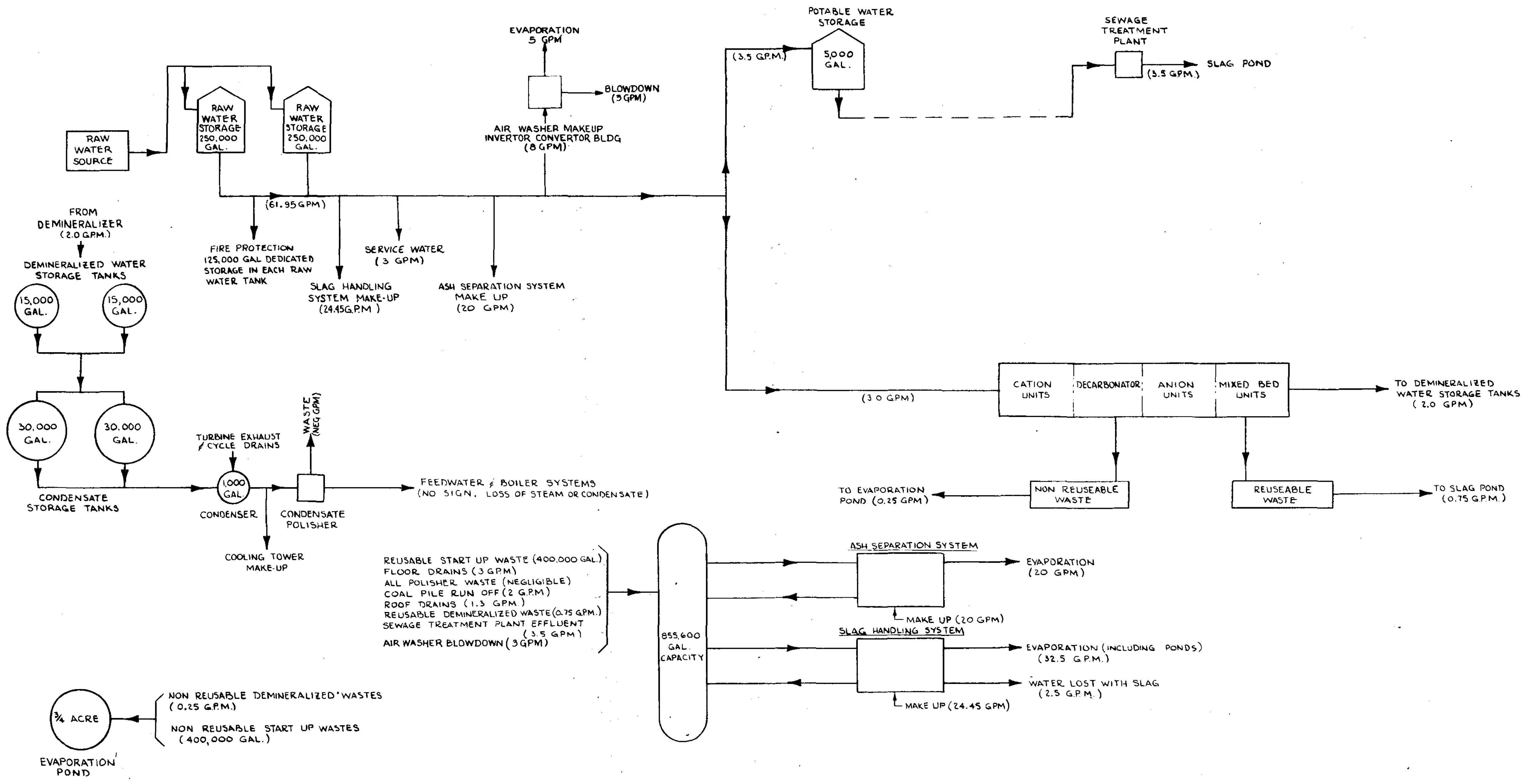
DRAWN G. SULZER 11/16/77 — MECH. CK. 11/18/77 — APPROVED 12-13-77

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
FLOW DIAGRAM
SLAG HANDLING

SCALE NONE — ORDER NO. C-19350

DWG. NO. L-22757 — SHEET NO. P3-11 — REV. E



II-5-15

NO	REVISIONS	DATE	BY	CK'D	APP'D
A	ISSUED FOR CONCEPTUAL DESIGN	12/13/77	VW		
B	REVISED PER CUSTOMER COMMENTS	12/26/77	VW		
C	REVISED PER CUSTOMER COMMENTS	2/1/78	VW		

REFERENCE DRAWINGS

PRINT RECORD

REVISION NO.	A	C
ISSUED	12/14/77	2/7/78
CUSTOMER	3-1/2	2-1/2
S R FIELD		
INTRA-COMPANY	5-1/2	5-1/2

Stearns-Roger

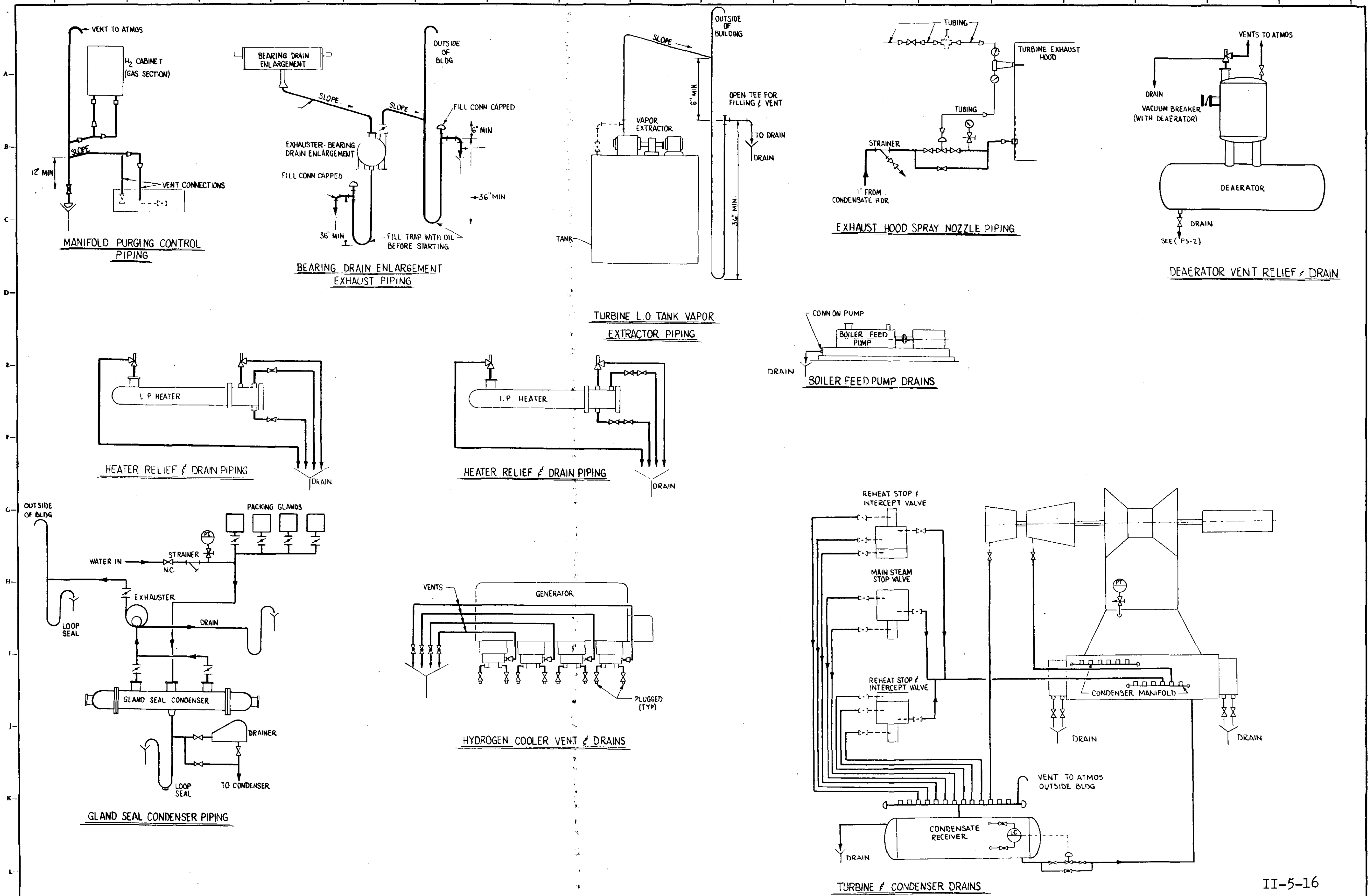
DRAWN RVB 12-6-77

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N Y

TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
WATER BALANCE

SCALE NONE ORDER NO. C-19350

DWG. NO. L-22757
SHEET NO. P3-12
REV. C



NO.	REVISIONS	DATE	BY	CK'D	APP'D
A	ISSUED FOR CONCEPTUAL DESIGN	12/16/77	VW		

REFERENCE DRAWINGS

PRINT RECORD

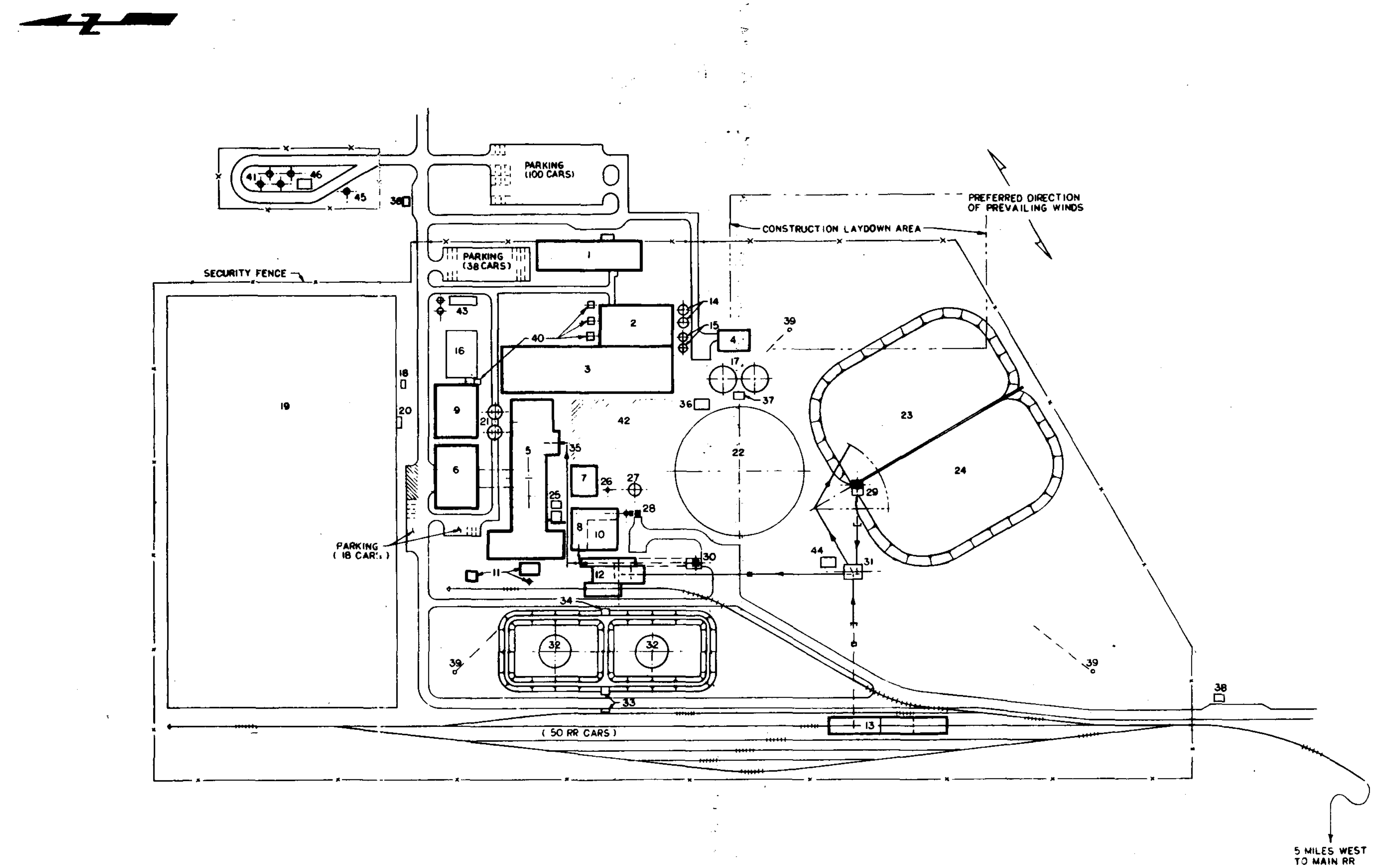
Stearns-Roger

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

TITLE
ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
FLOW DIAGRAM
TURBINE AUXILIARY SYSTEMS

SCALE NONE — ORDER NO. C-19350

DWG. NO. L-22757
SHEET NO. P3-13
REV. A



LEGEND

1 ADMINISTRATION BUILDING AND CONTROL ROOM
2 TURBINE BUILDING
3 HEAT RECOVERY BUILDING
4 WATER TREATMENT
5 MHD BUILDING INCLUDING HIGH TEMPERATURE AIR HEATERS AND RADIANT BOILER
6 MAINTENANCE BUILDING
7 CYROGENIC AREA
8 PULVERIZER/DRYER-INJECTION AREA INCLUDING BED MATERIAL DRYING AND SEPERATION
9 INVERTER BUILDING
10 COMPRESSOR AREA INCLUDING COMBUSTION AIR-AIR COMPRESSOR
11 COMBUSTION TEST FACILITY INCLUDING BLOCK HOUSE AND STACK
12 SILO BUILDING AND SEED UNLOADING
13 COAL UNLOADING AND THAWING
14 CONDENSATE TANKS
15 DEMINERALIZED WATER TANKS
16 SWITCH YARD
17 RAW WATER TANKS
18 SEWAGE TREATMENT
19 SLAG DISPOSAL POND
20 SLAG WATER REUSE PUMP PIT
21 SLAG DEWATERING BINS
22 DRY COOLING TOWER
23 COAL STORAGE (MONTANA ROSEBUD)
24 COAL STORAGE (ILLINOIS NO. 6)
25 SPENT SOLIDS COOLER
26 FLARE STACK
27 STACK
28 SAND UNLOADING STATION
29 COAL RECLAIM HOPPER
30 EMERGENCY COAL TRUCK HOPPER
31 COAL HANDLING TRANSFER BUILDING
32 FUEL OIL TANKS
33 FUEL OIL UNLOADING (TRUCK & RAIL)
34 FUEL OIL TRANSFER PUMPS
35 BELT CONVEYORS, COAL HANDLING
36 CIRCULATING WATER (CONDENSER) PUMP HOUSE
37 RAW WATER PUMP HOUSE
38 GUARD HOUSE (2 PLACES)
39 WELL (3 PLACES)
40 TRANSFORMERS
41 LOX TANKS
42 FLUE GAS CLEAN-UP AREA
43 DIESEL GENERATOR WITH FUEL OIL TANKS
44 COAL HANDLING CONTROL AND DUST SUPPRESSION BUILDING
45 LN_2 TANK
46 VAPORIZER BUILDING

NO.	REVISIONS	DATE	BY	CHK'D	APP'D
A	ISSUED FOR CONCEPTUAL DESIGN		R.Y.		
B	RELOCATED DIESEL GEN & FUEL OIL TANK ADD TRANSFORMERS AND MOVED ADM BLDG, PARKINGS, LOX TANKS, LN_2 TANK, GUARD HOUSE, STREETS, ADDED VAPORIZER BLDG	2/2-78	K.J.		

REFERENCE DRAWINGS

PRINT RECORD

ENG. RECORD

DRAWING STATUS

ERDA EF #77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
PLOT PLAN

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

SCALE 1"=100'-0"

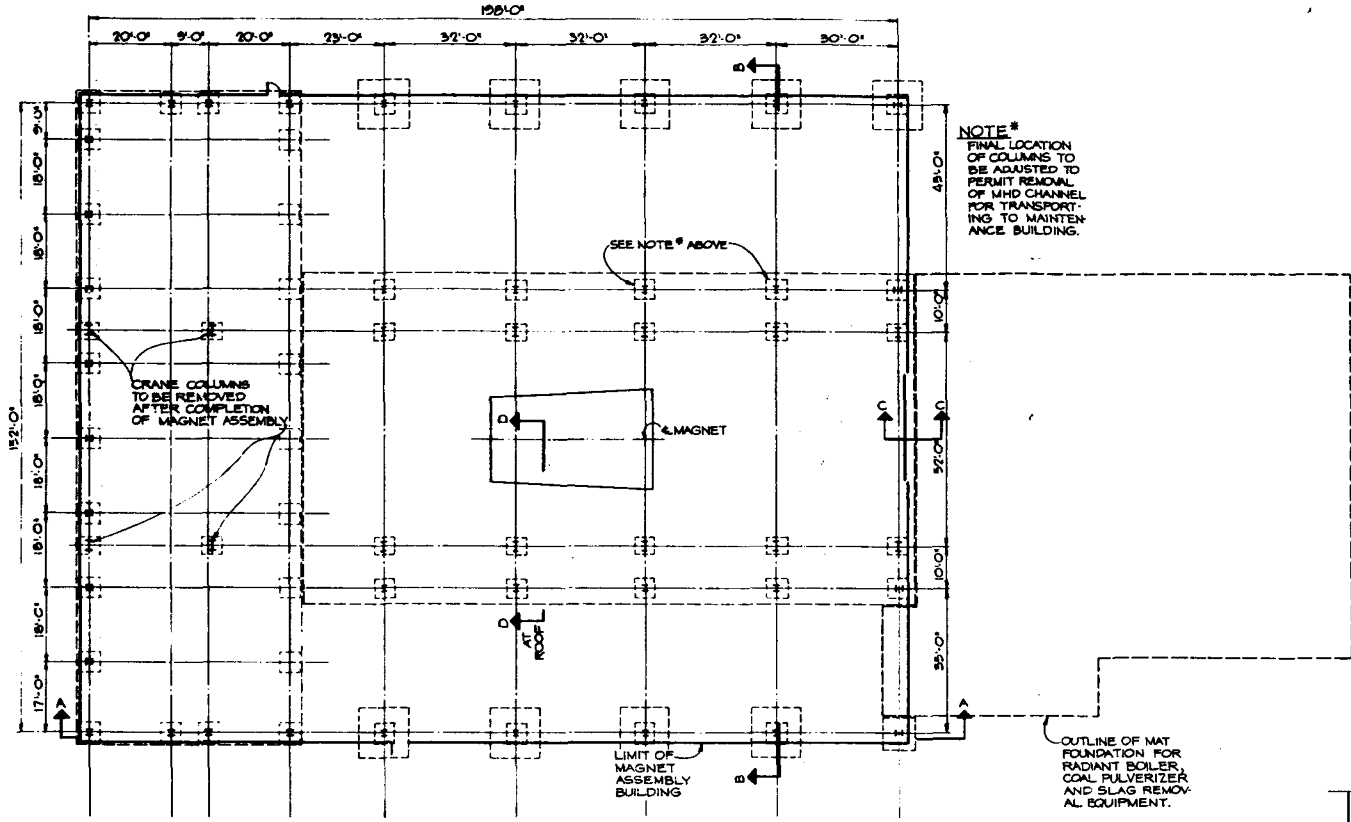
Stearns-Roger

ORDER NO. C-19350

DWG. NO. L-22757

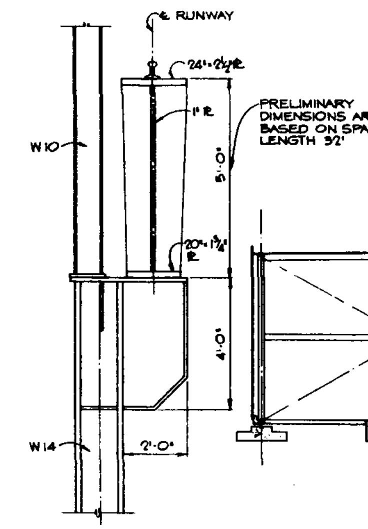
SHEET NO. Y1-1

REV. B



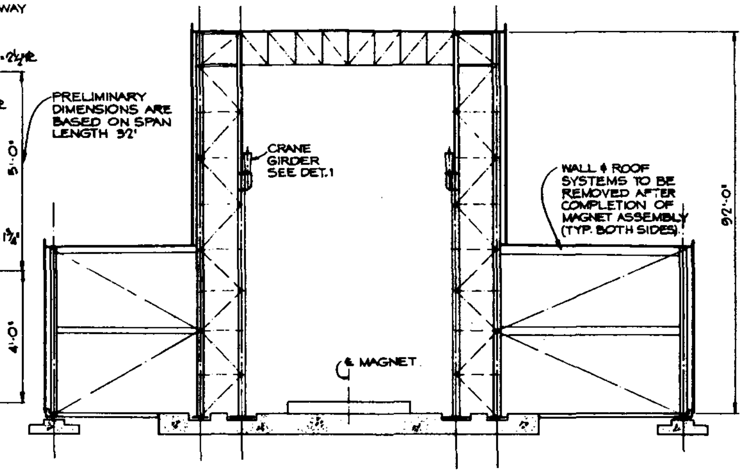
PLAN

1/16" = 1'-0"



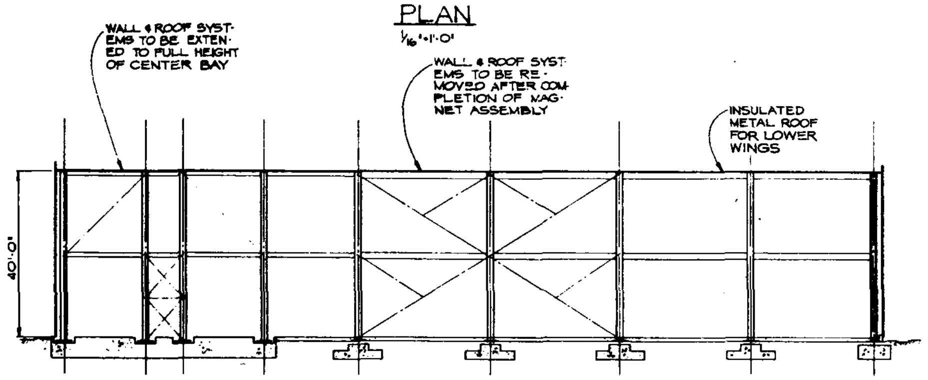
DETAIL 1

1/2" = 1'-0"



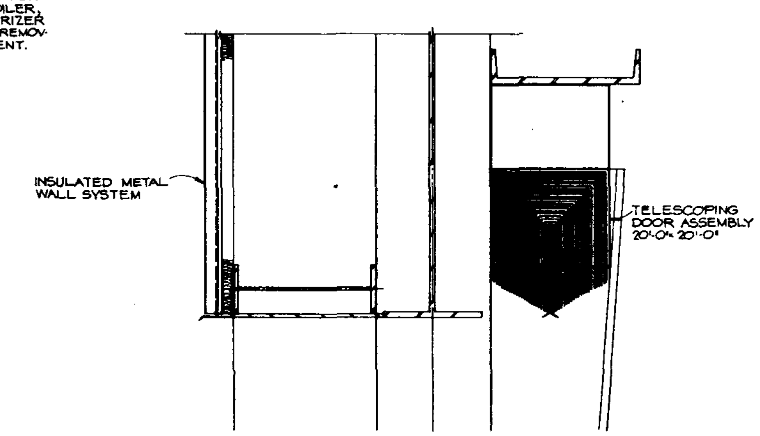
SECTION 'B-B'

1/16" = 1'-0"



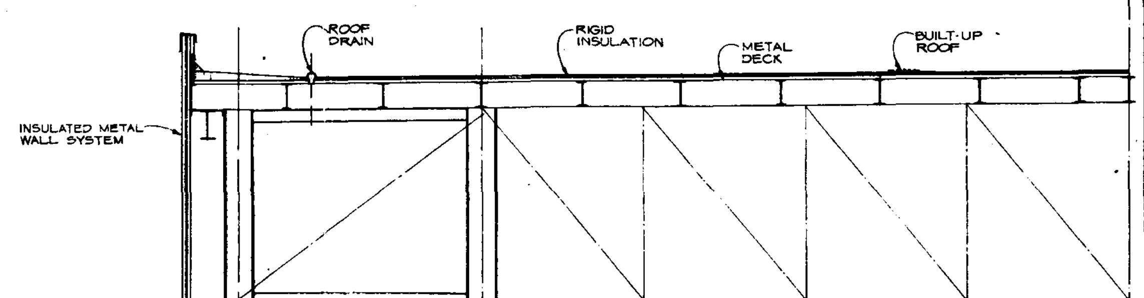
SECTION 'A-A'

1/16" = 1'-0"



SECTION 'C-C'

1/4" = 1'-0"



SECTION 'D-D'

3/8" = 1'-0"

BUILDING SCHEDULE

BUILDING	CONSTRUCTION				DIMENSIONS (FT.)			REMARKS
	FRAME	WALL	FLOOR	ROOF	L	W	H	
ADMINISTRATION AND CONTROL	STEEL	CONC. BLOCK	CONC.	STEEL DECK BUILT-UP ROOF	205	60	30	
AIR HEATER	STEEL	INS. METAL WALL	CONC.	STEEL DECK BUILT-UP ROOF	152	49	92	ONE BUILDING
MHD					149	72	92	
RADIANT BOILER					107	90	76	
INVERTOR	STEEL	*	CONC.	INS. MTL. ROOF	125	80	20	
SEED COLLECTION HEAT RECOVERY	STEEL	INS. METAL WALL	CONC.	STEEL DECK BUILT-UP ROOF	340	88	148	
TURBINE-GENERATOR	STEEL	*	CONC.	*	140	80	65	
MAINTENANCE	STEEL	*	CONC.	STL. DECK BUILT-UP ROOF	120	80	30	
PETROCARB:								
1. COMPRESSOR	STEEL	INS. METAL WALL	CONC.	INS. METAL ROOF	60	60	24	2 3 / 1 4
2. COAL INJECTION					60	30	80	
3. SEED INJECTION					20	20	80	
4. SAND INJECTION					70	20	80	
COAL UNLOADING	STEEL	INS. METAL WALL	CONC.	INS METAL ROOF	100	30	32	COAL HANDLING SYSTEM
THAWING SHED					132	30	26	
TRANSFER					34	28	50	
COAL SILO					100	36	120	
CONVEYOR SHED					110	14	30	
SEED UNLOADING					70	25	29	
CONVEYOR GALLERY	STEEL	*	STL. R.	*	750	8	16	WONDER BLDG.
WATER TREATMENT	STEEL	INS. METAL WALL	CONC.	STEEL DECK BUILT-UP ROOF	60	40	20	
COMBUSTION TEST	STEEL	*	CONC.	INS. METAL ROOF	40	20	20	
		BLOCK			20	20	15	
FUEL OIL PUMP	STEEL	INS. METAL WALL	CONC.	INS. METAL ROOF	15	15	12	
					15	10	12	
CIRCULATING WATER PUMP	STEEL	INS. METAL WALL	CONC.	INS. METAL ROOF	30	20	20	
RAW WATER PUMP	STEEL	INS. METAL WALL	CONC.	INS. METAL ROOF	20	15	15	
GUARD HOUSE	STEEL	*	CONC.	*	15	15	10	2 PLACES
CYROGENIE	STEEL	*	CONC.	*	60	50	40	
COAL HANDLING CONTROL	STEEL	INS. METAL WALL	CONC.	INS. METAL ROOF	30	20	25	

II-5-18

NO.	REVISIONS	DATE	BY	CHK'D	APP'D
A	ISSUED FOR CONCEPTUAL DESIGN	12-22-77	EAR	SCY	
B	REVISED BUILDING SCHEDULE	1-31-78	EAR	SCY	

REFERENCE DRAWINGS

PRINT RECORD: DATE ISSUED / REVISION NO. / FOR / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD: DRAWN EAR 11-28-77 / CHECKED / MECH. CK. / STRUCT. CK. / ELECT. CK. / PIPING CK. / APPROVED SCY 12-16-77 / APPROVED

DRAWING STATUS: PRELIMINARY / FOR COMMENTS AND/OR APPROVAL / APPROVED FOR CONSTRUCTION / REVISED & APPROVED FOR CONSTRUCTION

ERDA EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
STRUCTURAL
MAGNET ASSEMBLY BUILDING

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

SCALE AS NOTED

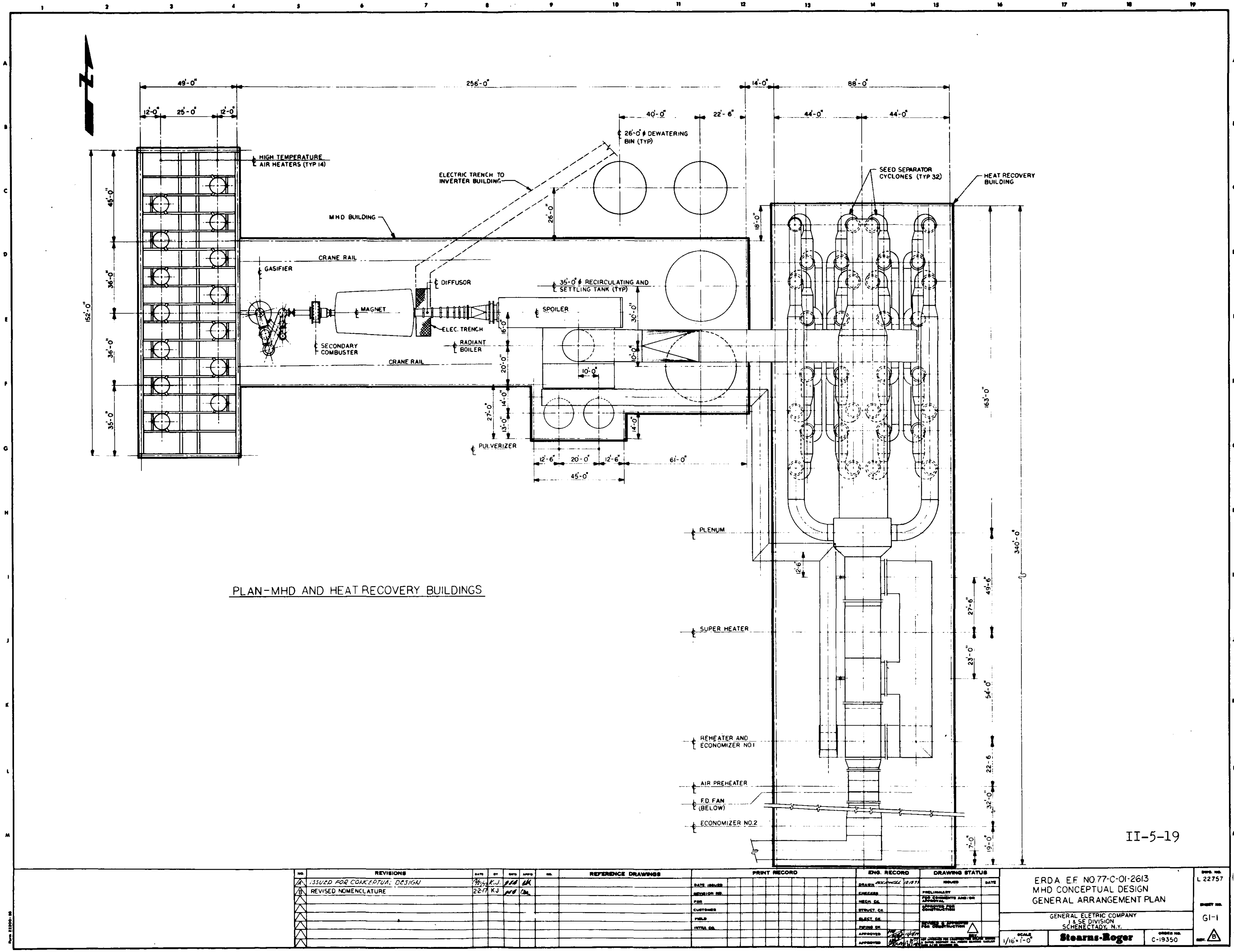
Stearns-Roger

ORDER NO. C-19350

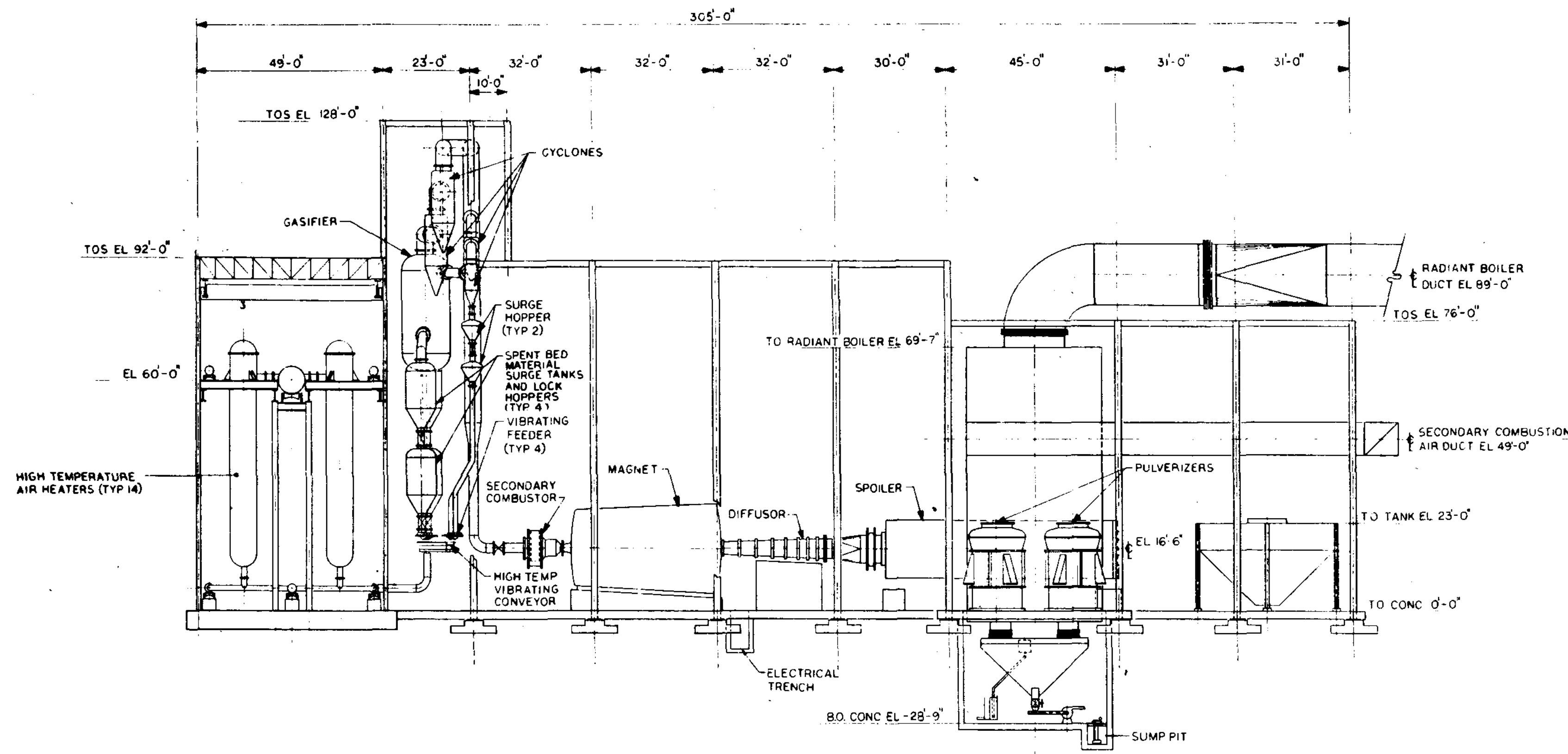
DWG. NO. L-22757

SHEET NO. S1-1

REV. B



PLAN-MHD AND HEAT RECOVERY BUILDINGS
HIGH TEMPERATURE AIR HEATERS (TYP 14)
ELECTRIC TRENCH TO INVERTER BUILDING
26'-0" ϕ DEWATERING BIN (TYP)
SEED SEPARATOR CYCLONES (TYP 32)
HEAT RECOVERY BUILDING
MHD BUILDING
CRANE RAIL
GASIFIER
DIFFUSOR
35'-0" ϕ RECIRCULATING AND SETTLING TANK (TYP)
MAGNET
SPOILER
ELEC. TRENCH
SECONDARY COMBUSTER
RADIANT BOILER
PULVERIZER
PLENUM
SUPER HEATER
REHEATER AND ECONOMIZER NO.1
AIR PREHEATER
F.D. FAN (BELOW)
ECONOMIZER NO.2
REVISIONS
ISSUED FOR CONCEPTUAL DESIGN
REVISED NOMENCLATURE
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
ERDA E.F. NO 77-C-01-2613
MHD CONCEPTUAL DESIGN
GENERAL ARRANGEMENT PLAN
GENERAL ELETRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.
1/16"=1'-0"
Stearns-Roger
C-19350
L 22757
GI-1



MHD BUILDING - ELEVATION LOOKING NORTH

II-5-20

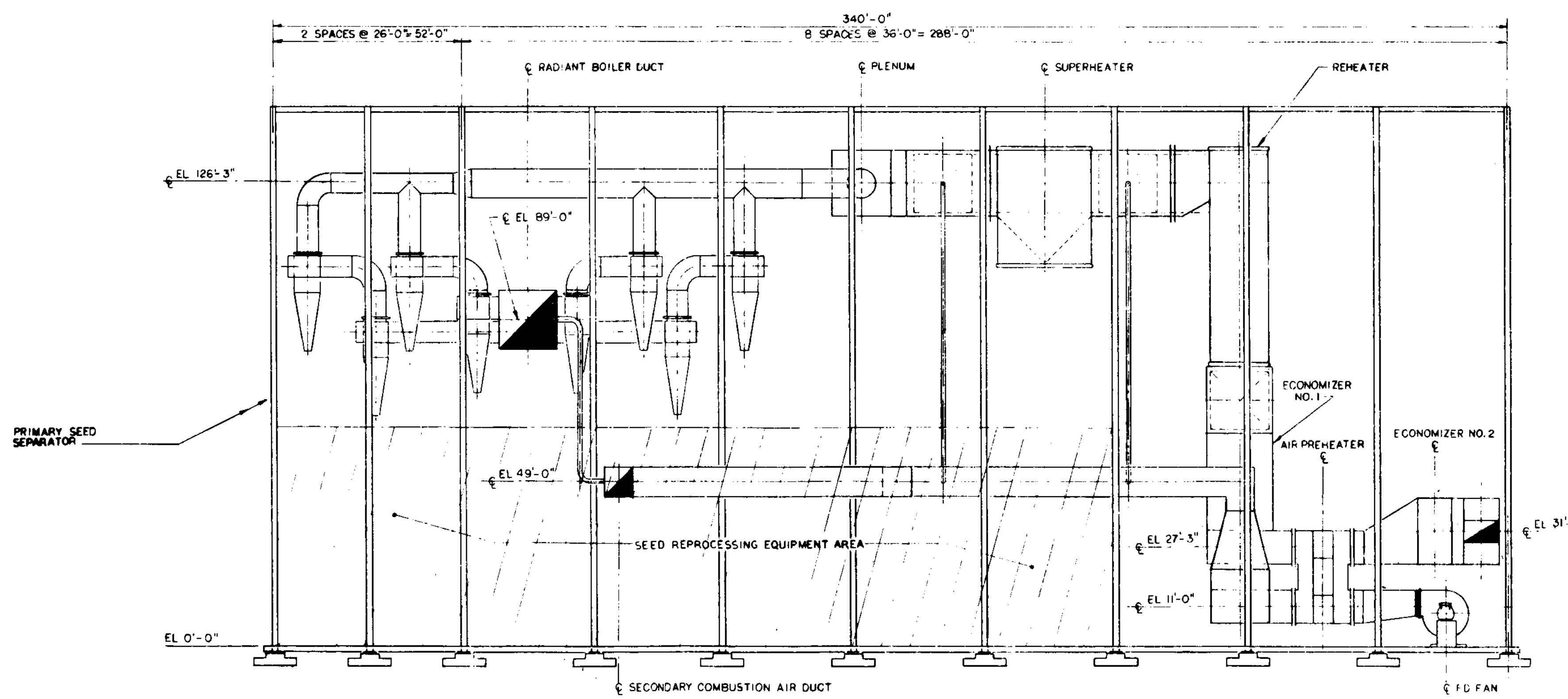
NO.	REVISIONS	DATE	BY	CHK	APPD
A	ISSUED FOR CONCEPTUAL DESIGN	12/21/77			

EDRA EF #77-C-01-2613
MHD ETF CONCEPTUAL DESIGN
MHD BUILDING ELEVATION

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

SCALE 1/16"=1'-0" | Stearns-Roger | ORDER NO. C-19350

DWG. NO. L-22757
SHEET NO. Gi-2
REV. A



SECTIONAL ELEVATION - HEAT RECOVERY BUILDING

II-5-21

NO	REVISIONS	DATE	BY	CHKD	APPD
A	ISSUED FOR CONCEPTUAL DESIGN	12/21/77	KJ		
B	REVISED NOMENCLATURE	2-2-77	KJ		

EDRA EF #77-C-01-2613
MHD ETF CONCEPTUAL DESIGN
SECTIONAL ELEVATION
HEAT RECOVERY BUILDING
GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

SCALE 1/16" = 1'-0"

Stearns-Roger

ORDER NO. C-19350

DWG. NO. L-22757

SHEET NO. G1-3

REV. B

COMPONENTS SCHEDULE

BUILDING DESCRIPTION	ACCOUSTICAL LOUVER	AIR CONDITIONING UNIT	AIR HANDLING UNIT	CHILLED WATER PUMP	CHILLED WATER UNIT	COOLING TOWER CIRC WATER PUMP	DUCTWORK AND ACCESSORIES	ELECTRIC BASEBOARD	ELECTRIC DUCT HEATERS
CONTROL ROOM AREA HVAC			TRANE HORIZ DRAW-THRU MOD 50 MED PRESSURE 28500 ACFM @ 3.5 W.G. SEA LEVEL S.P. 30 H.P. 2 REQ.D	ARMSTRONG SERIES 4080 2½E, CENTRIFUGAL, BASEMOUNTED, 240 GPM @ 75' HD, 7½ H.P. OPEN DRIP PROOF MOTOR ENCL. 2 REQ'D	TRANE MOD CGWA/1000E RECIP CHILLER, WATER COOLED CONDENSER 100 TONS, 85°F EWT (COND), 45°F LWT (EVAP) COMP KW = 86.1 2 REQ'D		ACCESSORIES SHALL BE GRILLES REGISTERS, FIRE DAMPERS VOLUME DMPRS, EXTRACTORS TOT WT 29,000 LBS		INDEECO MOD QUA SLIP IN TYPE W/AUTO AND MANUAL CUT-OUTS AND SAFETY INTERLOCKS
ADMINISTRATION AREA - HVAC			TRANE HORIZ DRAW-THRU MOD 25 MED PRESSURE 13750 ACFM @ 3.5 W.G. SEA LEVEL SP. 20 H.P.	ARMSTRONG SERIES 4300 2E CENTRIFUGAL, 120 GPM @ 75' HD, 5 HP OPEN DRIP PROOF MOTOR ENCL.	TRANE MOD CGWA/500 M RECIP CHILLER WATER COOLED CONDENSER 50 TONS, 85°F EWT (COND) 45°F LWT, (EVAP) COMP KW = 52.1		ACCESSORIES SHALL BE GRILLES REGISTERS, FIRE DAMPERS, VOLUME DMPRS, EXTRACTORS TOT WT 22,200 LBS	TRANE MOD ES FK, INTEGRAL T'STAT, CAP 250 W/FT. RESISTANCE HEAT 187 KW	
SEED PROCESSING AND HEAT RECOVERY BLDG HEATING AND VENTILATING	CONSTRUCTION SPECIALTIES MOD 6680 WITH AMERICAN WARMING & VENT DMPR MOD 7402 FOR 6" SP OR EQUAL - 750 FT² REQ EA. LOUVER TO BE WALL TYPE WITH MIN. LEAKAGE CONTROL DMPR. MOUNTED BEHIND								
COMPRESSOR BUILDING HEATING AND VENTILATING									
MHD BUILDING HEATING AND VENTILATING									
TRANSER BUILDING HEATING AND VENTILATING									
TURBINE GENERATOR BLDG. HEATING AND VENTILATING									
MAINTENANCE BUILDING HEATING AND VENTILATING		CARRIER MOD 51PC0383 ELEC HEATING 7,500 BTUH COOLING 9000 BTUH HEAT TO BE 208V, 3∅H, 2400 WATTS, FAN MOTOR 1/4 H.P.							
WATER TREATMENT BLDG. HEATING AND VENTILATING									
COAL SILO BUILDING HEATING AND VENTILATING									
PETRO CARB. PULV. HEATING AND VENTILATING									
INVERTOR CONVERTOR BLDG. AUXILIARY COOLING		EVAPORATIVE COOLERS: 2 REQ'D UNIT CONSISTS OF OF AIR WASHER, FILTERS, SUPPLY FAN, 48,000 CFM @ 1¾" S.P. @ S.L. TYP 25HP		ARMSTRONG CENTRIFUGAL BASEMOUNTED PUMP (4) REQ.D 216 GPM AT 30 FT OF HEAD 3 HP			ESTIMATED WT 14,016 LBS		

BUILDING DESCRIPTION	ELECTRIC UNIT HEATERS	FLOW CONTROL VALVE	GRAVITY AIR MOVERS	INTAKE LOUVERS	INTAKE RING AND PANEL FAN	RETURN AIR FAN	SUPPLY FAN	SUPPLY RECIRCULATING FAN	ROOF EXHAUSTER
CONTROL ROOM AREA HVAC						TRANE CENTRIFUGAL FAN MOD 44 AFSW 25,920 CFM @ 1.0 W.G. SEA LEVEL S.P. 2 REQ'D			
ADMINISTRATION AREA - HVAC		MICO CORPORATION APPROX 15 REQ							
SEED PROCESSING AND HEAT RECOVERY BLDG HEATING AND VENTILATING	MODINE MOD VE300 86 UNITS, 460/3/60 W/230V/1/60, 1075 RPM, TE/PSC MOTOR FOR 2575 CFM/40 KW CAP. DOWN BLAST TYPE W/DEFLECTORS & T. STATS 125 EA OR EQUAL 340 KW, TOTAL		SWARTWOUT CONTOURAMIC LOW SILHOUETTE TYPE VENTILATOR, UNIT 10'-0"x7'-6" W/MIN OF 40% FREE AREA ELEC. OPERATORS FUSIBLE LINKS & BIRDSCREENS 60 UNITS REQ @ 700 EA OR EQUAL.	CONSTRUCTION SPECIALTIES MOD 6940 DUAL COMBINATION TYPE, 6" DEEP FRAME ALUM CONSTRUCTION W/ .125 THK STORM-PROOF BLADES ELEC 2-POSITION OPERATORS W/ SPRING RETURN BIRD SCREEN, 10,000 FT² REQ, OR EQUAL.				HARTZELL MOD 60-02-5A05 HAA-54 6 BLADES @ 24° 460/3/60, 50,000 CFM @ ¾" S.P. W/ 20 H.P. 705 RPM, DOWN-BLAST ROOF MOUNTED TYPE W/ INTAKE HEAD, MODULATING O.S.A. AND RECIRC. DMPRS DUCT ASSY. W/ SERVICE GRATING AND PRE-FAB CURBS, 225 HP TOTAL, OR EQUAL	
COMPRESSOR BUILDING HEATING AND VENTILATING	MODINE MOD VE300 TWO UNITS 460/3/60 W/230/1/60, 1075 RPM ¼ HP, TE/PSC MOTOR FOR 2575 CFM, DOWN BLAST TYPE W/DEFLECTORS & T'STAT, 125 EA OR EQUAL 60 KW, TOTAL		SWARTWOUT CONTOURAMIC LOW SILHOUETTE TYPE VENTILATOR UNIT, 10'-0"x7'-6" W/MIN OF 40% FREE AREA, ELEC. OPERATORS FUSIBLE LINKS & BIRDSCREENS ONE UNIT REQ @ 700, OR EQUAL	CONSTRUCTION SPECIALTIES MODEL 6940 DUAL COMBINATION TYPE 6" DEEP FRAME ALUM CONSTRUCTION W/ .125 THK STORM-PROOF BLADES 180 FT² REQ'D OR EQUAL			AEROVENT MOD 54LA/2TA, TWO UNITS, TUBE AXIAL TYPE, DIRECT DRIVE W/VB, ISOLATORS 460/3/60 1750 RPM, 2 HP MOTOR W/24" BLADE FOR 9180 CFM @ ¾ S.P. 150 EA OR EQUAL 5 HP TOTAL		
MHD BUILDING HEATING AND VENTILATING	MODINE MOD VE300 70 UNITS 460/3/60 W/230/1/60, 1075 RPM ¼ HP TE/PSC MOTOR FOR 2575 CFM DOWN BLAST TYPE W/ DEFLECTORS & T'STAT 125 EA. OR EQUAL 2100 KW TOTAL		SWARTWOUT CONTOURAMIC LOW SILHOUETTE TYPE VENTILATOR UNIT, 10'-0"x7'-6" W/ MIN OF 40% FREE AREA ELEC. OPERATORS, FUSIBLE LINKS & BIRDSCREENS, 39 UNITS REQ @ 700 EA. OR EQUAL	CONSTRUCTION SPECIALTIES MOD 6940 E DUAL COMBINATION TYPE 6" DEEP FRAME ALUM CONSTRUCTION W/.125 THK STORM-PROOF BLADES, ELEC. TWO POSITION OPERATOR W/SPRING RETURN AND BIRDSCREEN, 3,650 FT² REQ'D OR EQUAL.			AEROVENT MOD 54A426 TA 2240 18 UNITS, 460/3/60, 870 RPM, 10 HP MOTOR W/54" BLADE FOR 48,200 CFM @ ¾ S.P. @ 780 EA 135 HP TOTAL OR EQUAL.		
TRANSER BUILDING HEATING AND VENTILATING	MODINE VE 50 460/3/60 W/230/1/60, 1050 RPM, 1/25 H.P. TE/SP MOTOR FOR 800 CFM DOWN-BLAST TYPE WITH DEFLECTOR & T'STAT, 50, OR EQUAL 5 KW TOTAL 1 REQ'D			CONSTRUCTION SPECIALTIES MOD 6940E DUAL COMBINATION TYPE 6" DEEP FRAME ALUM CONSTRUCTION W/.125 THK STORM-PROOF BLADES ELEC. TWO POSITION OPERATOR W/SPRING RETURN AND BIRDSCREEN 30 FT² REQ'D, OR EQUAL					AEROVENT MOD 30L-42BD53-1160-1.5 1½ HP, 1160 RPM MOTOR FOR 10,400 CFM @ .25 S.P. W/30" BLADE ROOF MOUNTED UP-BLAST, DIRECT DRIVE PROP VENTILATOR W/CURB.
TURBINE GENERATOR BLDG. HEATING AND VENTILATING	MODINE MOD VE300 460/3/60 W/230/1/60 1075 RPM ¼ HP TE/PSC MOTOR FOR 2575 CFM, 17 UNITS SINGLE STAGE 15 KW CAP, 12 UNITS TWO STAGE 30 KW CAP, DOWN-BLAST TYPE W/ DEFLECTORS & T'STAT 540 KW, TOTAL, OR EQUAL		SWARTWOUT CONTOURAMIC LOW SILHOUETTE TYPE VENTILATOR UNIT, 10'-0"x7'-6" W/ MIN OF 40% FREE AREA ELEC. OPERATORS, FUSIBLE LINKS & BIRDSCREENS, TEN UNITS REQ'D @ 700 EA OR EQUAL	CONSTRUCTION SPECIALTIES MOD 6940E DUAL COMBINATION TYPE 6" DEEP FRAME ALUM CONSTRUCTION W/.125 THK STORMPROOF BLADES, ELEC. TWO POSITION OPERATOR W/SPRING RETURN AND BIRDSCREEN 675 FT² REQ'D OR EQUAL			AEROVENT MOD 48A424, 7 UNITS 460/3/60, 870 RPM, 5 HP MOTOR W/48" BLADE FOR 30,650 CFM @ ¾ S.P. @ 400 EA 31.5 H.P. TOTAL OR EQUAL		
MAINTENANCE BUILDING HEATING AND VENTILATING	MODINE MOD VE300 460/3/60 W/230/1/60 1075 RPM ¼ HP TE/PSC MOTOR FOR 2575 CFM 8 UNITS 30 KW EA. DOWN BLAST TYPE W/ DEFLECTORS AND T.STATS, 240 KW OR EQUAL.			CONSTRUCTION SPECIALTIES MOD. 6940 E DUAL COMBINATION TYPE 6" DEEP FRAME ALUM CONSTRUCTION W/ .125 THK STORMPROOF BLADES, ELEC. TWO POSITION OPERATOR W/ SPRING RETURN AND BIRDSCREEN 240 FT² REQ'D OR EQUAL.					AEROVENT MOD. 30L24B, 1½ HP, 1160 RPM MOTOR FOR 10,400 CFM @ .25 S.P. W/30" BLADE ROOF MOUNTED UP-BLAST, DIRECT DRIVE PROP VENTILATOR W/ CURB. 4 EA
WATER TREATMENT BLDG. HEATING AND VENTILATING	MODINE MOD VE300 460/3/60 W/230/1/60 1075 RPM ¼ HP TE/PSC MOTOR FOR 2575 CFM, FIVE UNITS, @ 15 KW EA. DOWN BLAST W/ DEFLECTORS AND T'STATS, 75 KW TOT, OR EQUAL.			CONSTRUCTION SPECIALTIES MOD 6940E DUAL COMBINATION TYPE 6" DEEP FRAME ALUM CONSTRUCTION W/.125 THK STORMPROOF BLADES ELEC. TWO POSITION OPERATOR W/SPRING RETURN AND BIRDSCREEN 30 FT² [illegible] OR EQUAL.					AEROVENT MOD 30L/42BD-1160-2, 1½ HP, 1160 RPM MOTOR FOR 10,400 CFM @ .25 SP W/30" BLADES, ROOF MTD UP BLAST DIRECT DRIVE PROP VENTILATOR W/CURB
COAL SILO BUILDING HEATING AND VENTILATING	MODINE MOD VE50 460/3/60 W/230/1/60 1050 RPM, 1/25 HP TE/SP MOTOR FOR 800 CFM, 5 KW CAP DOWN BLAST W/ DEFLECTORS AND T'STATS OR EQUAL 1 REQ'D			CONSTRUCTION SPECIALTIES MOD 6940E DUAL COMBINATION TYPE 6" DEEP FRAME ALUM CONSTR W/.125 THK STORMPROOF BLADES ELEC TWO POSITION OPERATOR W/SPRING RETURN AND BIRDSCREEN 210 FT² [illegible]	AEROVENT MOD 30L220 DPP AR 1.5 HP, 1160 RPM, MOTOR FOR 7800 CFM @ .5 SP W/ 30 BLADE DIRECT DRIVE W/ GUARD AND INLET & DUST IGNITION PROOF MOTOR. 6 REQ'D				AEROVENT MOD 30L/42BD53-1160-1.5 1½ HP, 1160 RPM MOTOR FOR 10,400 CFM @ .25 S.P. W/30" BLADE, ROOF MTD UP BLAST, DIRECT DRIVE PROP VENTILATOR W/ CURB
PETRO CARB. PULV. HEATING AND VENTILATING	MODINE MOD VE300 460/3/60 W/230/1/60 1075 RPM ¼ HP TE/PSC MOTOR FOR 2575 CFM, 30 KW CAP EA. 11 UNITS REQ'D, DOWN BLAST W/DEFLECTORS AND T'STAT								AEROVENT MOD 42L 218D53-1160-2, 2 HP 1160 RPM MOTOR FOR 18,850 CFM @ .25 S.P W/ 42" BLADE, ROOF MTD UP BLAST, DIRECT DRIVE PROP, VENTILATOR W/ CURB.
INVERTOR CONVERTOR BLDG. AUXILIARY COOLING			CONSTRUCTION SPECIALTIES [illegible] 6" DEEP FRAME DUAL COMBINATION W/ BIRDSCREEN						HARTZELL TUBE-AXIAL FAN 36,000 CFM @ 2" W.G. T.S.P. @ S.L. 30 HP

NO.	REVISIONS	DATE	BY	CHK'D	APP'D
A	ISSUED FOR CONCEPTUAL DESIGN	2-7-78	JEU		

REFERENCE DRAWINGS

PRINT RECORD: DATE ISSUED / REVISION NO / FOR / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD: DRAWN JEU 2-7-78 / CHECKED / MECH. CK. / STRUCT. CK. / ELECT. CK. / PIPING CK. / APPROVED / APPROVED

DRAWING STATUS: ISSUED / DATE / PRELIMINARY / FOR COMMENTS AND/OR APPROVAL / APPROVED FOR CONSTRUCTION / REVISED & APPROVED FOR CONSTRUCTION / REV.

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE & OR REVISION NO.

ERDA # EF-77-C-01-2613
MHD CONCEPTUAL DESIGN
HVAC EQUIPMENT SCHEDULE

SCALE: NONE

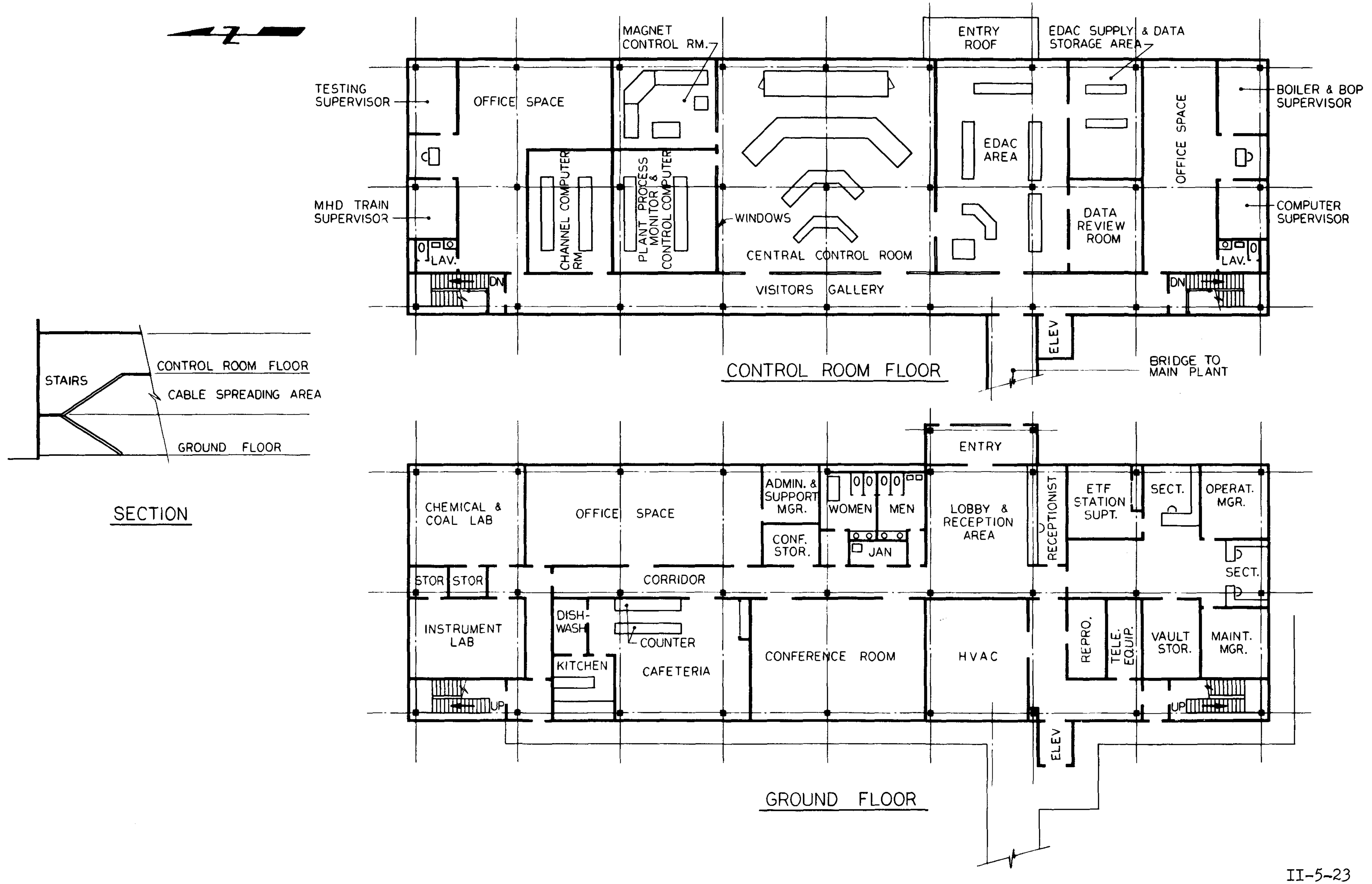
Stearns-Roger INCORPORATED

ORDER NO. C-19350

DWG. NO. L-22757

SHEET NO. M4-1

REV. A



II-5-23

NO.	REVISIONS	DATE	BY	CH'D	APP'D
A	ISSUED FOR CONCEPTUAL DESIGN	12/22/77	B.M.	B	
B	ADDED ELEVATOR	2-3-78	DW	B	

REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD: DRAWN B.M. 12/22/77; CHECKED; MECH. CK.; STRUCT. CK.; ELECT. CK.; PIPING CK.

DRAWING STATUS: ISSUED / DATE; PRELIMINARY; FOR COMMENTS AND/OR APPROVAL; APPROVED FOR CONSTRUCTION; REVISED & APPROVED FOR CONSTRUCTION; REV.

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED ABOVE. ALL PRINTS BEARING EARLIER DATE S/OR REVISION NO.

ERDA #EF-77-C-01-2613
MHD-ETF CONCEPTUAL DESIGN
GENERAL ARRANGEMENT
ADMINISTRATION BUILDING

GENERAL ELECTRIC COMPANY
I & SE DIVISION
SCHENECTADY, N.Y.

SCALE 1/16"=1'-0"

Stearns-Roger

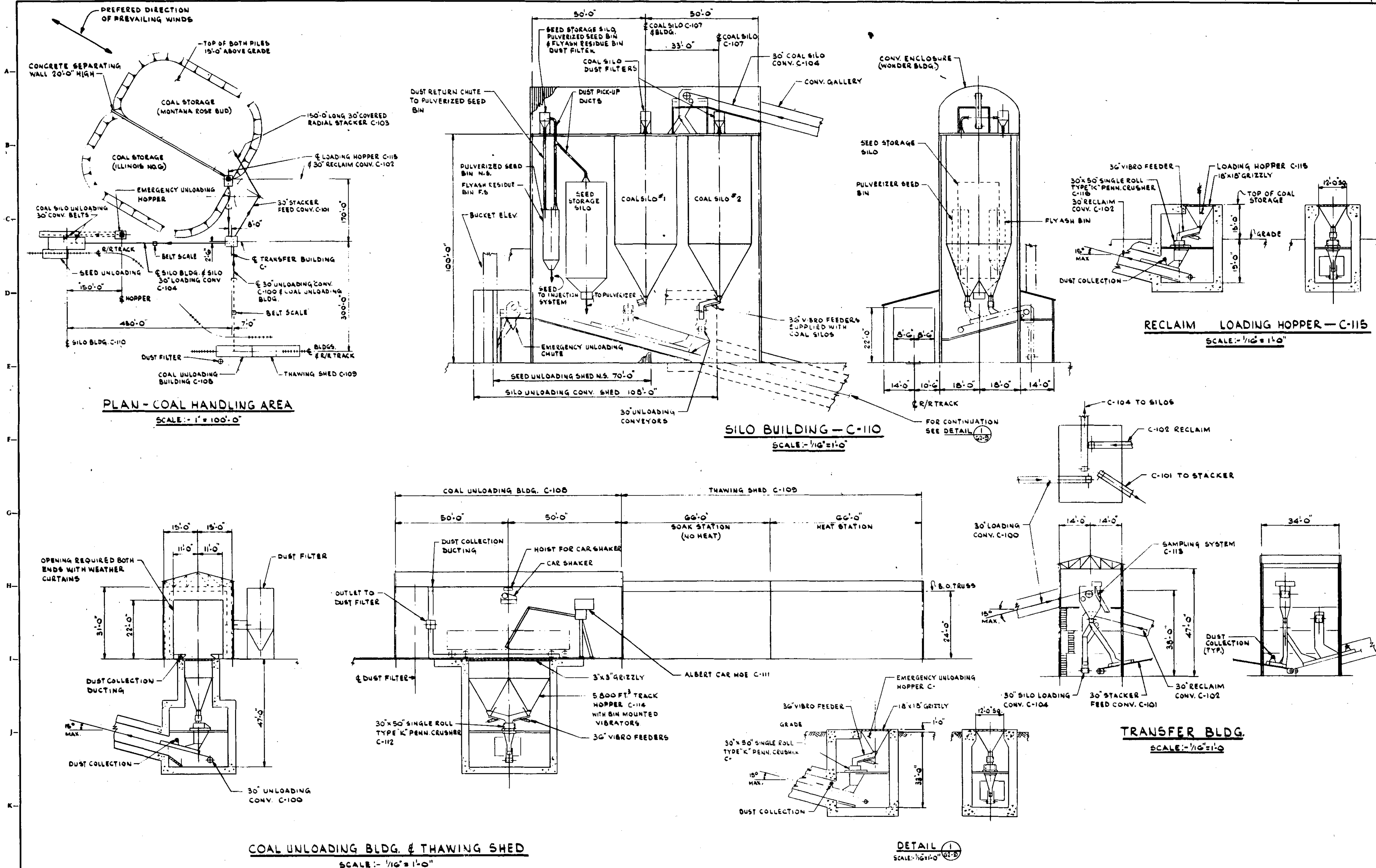
ORDER NO. C-19350

DWG. NO. L-22757

SHEET NO. G2-1

REV. B

Form No. 13373/2-51



NO.	REVISIONS	DATE	BY
A	FOR GENERAL ELECTRIC CO. REVIEW	6-16-77	J.L.
B	SEED STORAGE SILO CHGD., PULVERIZED SEED & FLYASH BINS ADDED	10-19-77	J.L.
—	EMERGENCY UNLOADING HOPPER ADDED		
C	REVISED PER CUSTOMER COMMENTS	11-21-77	J.L.

REFERENCE DRAWINGS

PRINT RECORD

Stearns-Roger INCORPORATED

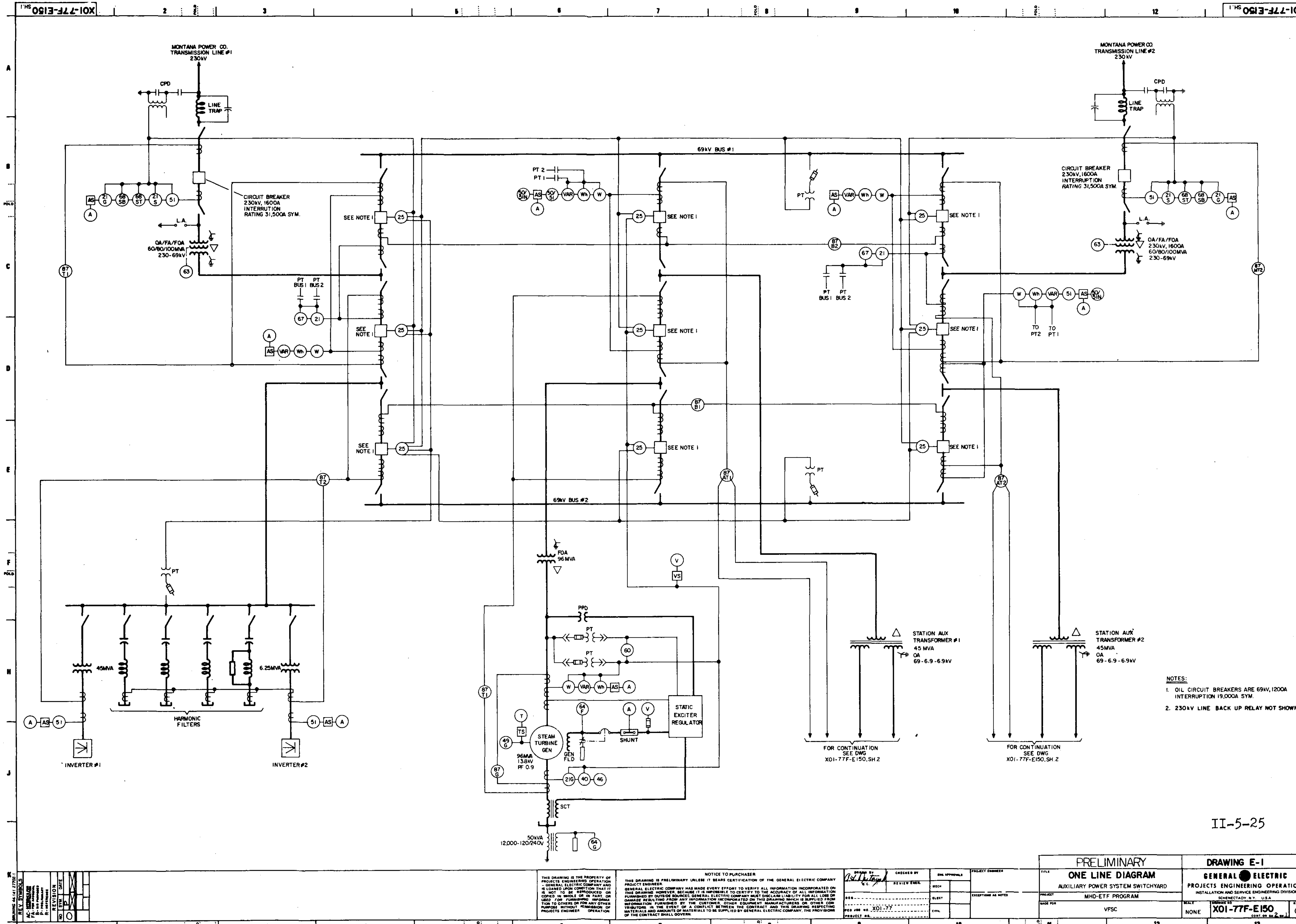
DRAWN J.L. 6-16-77

GENERAL ELECTRIC CO.
I & SE DIVISION
SCHENECTADY N.Y.

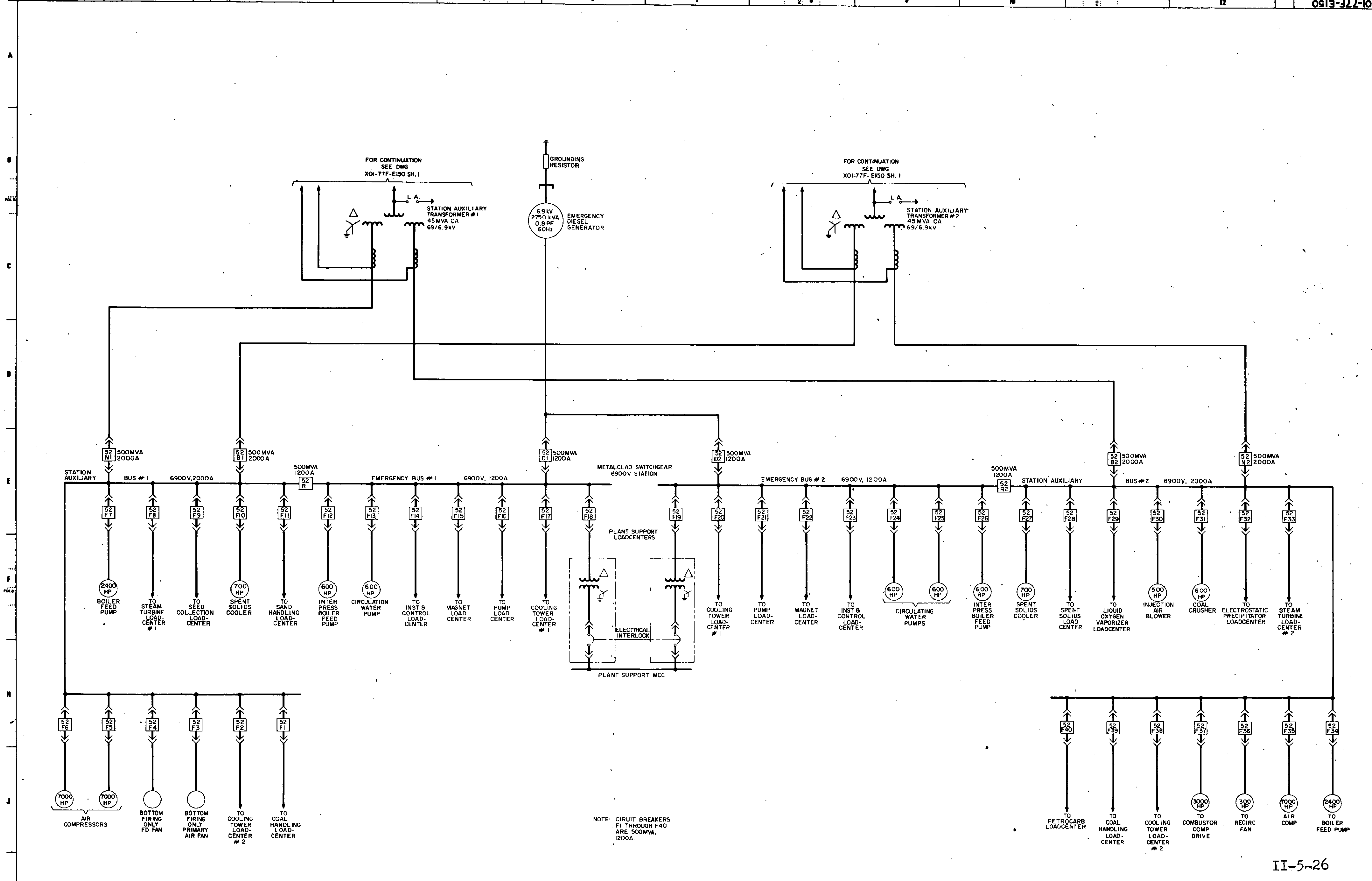
TITLE
MHD ENGINEERING TEST FACILITY
COAL HANDLING AREA
CONCEPTUAL DESIGN

SCALE AS NOTED ORDER NO. C-19350

DWG. NO. 22757
SHEET NO. G2-9
REV. C



MONTANA POWER CO. TRANSMISSION LINE #1 230kV
MONTANA POWER CO. TRANSMISSION LINE #2 230kV
CPD
LINE TRAP
CIRCUIT BREAKER 230kV, 1600A INTERRUPTION RATING 31,500A SYM.
L.A.
OA/FA/FOA 60/80/100MVA 230-69kV
OA/FA/FOA 230kV, 1600A 60/80/100MVA 230-69kV
69kV BUS #1
69kV BUS #2
SEE NOTE 1
PT BUS 1
PT BUS 2
TO PT2
TO PT1
FOA 96MVA
PPD
STATIC EXCITER REGULATOR
STEAM TURBINE GEN
96MVA 13.8kV PF 0.9
GEN FLD
SHUNT
SCT
50kVA 12,000-120/240V
45MVA
6.25MVA
HARMONIC FILTERS
INVERTER #1
INVERTER #2
STATION AUX TRANSFORMER #1 45 MVA OA 69-6.9-6.9kV
STATION AUX TRANSFORMER #2 45MVA OA 69-6.9-6.9kV
FOR CONTINUATION SEE DWG X01-77F-E150, SH.2
NOTES:
1. OIL CIRCUIT BREAKERS ARE 69kV, 1200A INTERRUPTION 19,000A SYM.
2. 230kV LINE BACK UP RELAY NOT SHOWN
PRELIMINARY
DRAWING E-1
ONE LINE DIAGRAM
AUXILIARY POWER SYSTEM SWITCHYARD
MHD-ETF PROGRAM
VFSC
GENERAL ELECTRIC
PROJECTS ENGINEERING OPERATION
INSTALLATION AND SERVICE ENGINEERING DIVISION
SCHENECTADY, N.Y. U.S.A.
NONE
X01-77F-E150
NOTICE TO PURCHASER
X01-77F-E150 SH.1



II-5-26

PRELIMINARY	DRAWING E-2
TITLE: ONE LINE DIAGRAM AUXILIARY POWER SYSTEM MEDIUM VOLTAGE DISTRIBUTION	GENERAL ELECTRIC PROJECTS ENGINEERING OPERATION INSTALLATION AND SERVICE ENGINEERING DIVISION SCHENECTADY, N.Y. U.S.A.
PROJECT: MHD-ETF PROGRAM	SCALE: NONE
MADE FOR: VFSC	XOI-77F-E150 REV 0

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NOTICE TO PURCHASER
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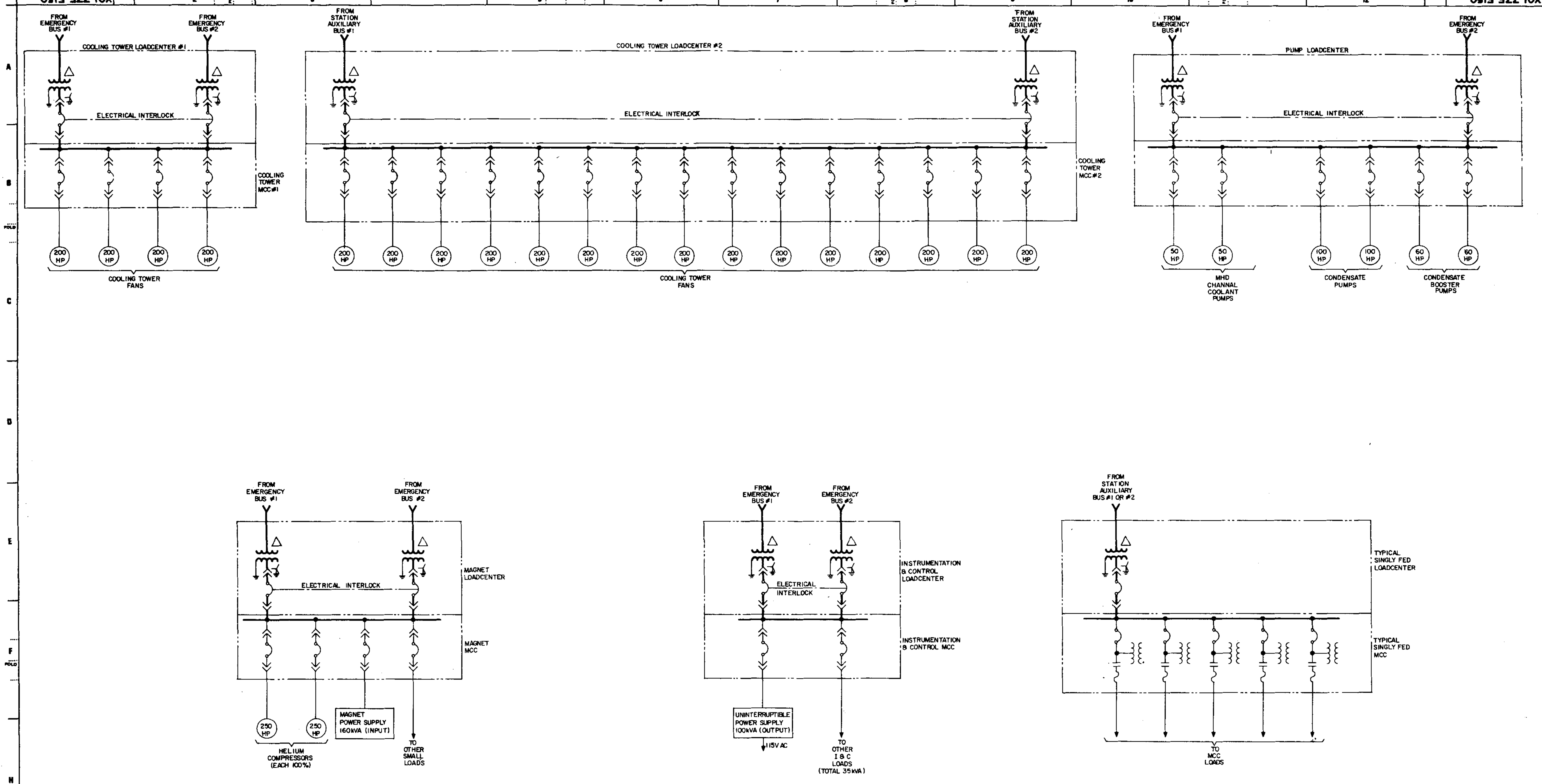
PED JOB NO XOI-77

XOI-77F-E150 SH.2



II-5-27

PRELIMINARY

DRAWING E-3

ONE LINE DIAGRAM

480V AC MOTOR CONTROL CENTERS

PROJECT: MHD-ETF PROGRAM

MADE FOR: VFSC

GENERAL ELECTRIC
PROJECTS ENGINEERING OPERATION
INSTALLATION AND SERVICE ENGINEERING DIVISION
SCHENECTADY, N.Y. U.S.A.

SCALE: NONE

DRAWING NO. XOI-77F-E150 REV. O

REQ. XO1-77

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