Consumers Power
POWERING MICHIGAN'S PROGRESS
Palisades Nuclear Plant: 27780 Blue Star Memorial Highway, Covert, MI 49043

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DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT
PRELIMINARY THERMAL ANNEALING REPORT, THERMAL ANNEALING OPERATING PLAN, SECTION 1.6, PROPOSED ANNEALING EQUIPMENT, AND SECTION 1.9, ALARA CONSIDERATIONS

At a meeting on June 6, 1995, we discussed with the staff our plan to anneal the Palisades reactor vessel (RV) during the refueling outage currently scheduled for May, 1998. In support of this effort, we plan to submit the final Thermal Annealing Report (TAR) in the third quarter of 1996 after the results of the Marble Hill reactor vessel annealing demonstration have been evaluated. The TAR will include the information recommended in Draft Regulatory Guide DG-1027, Format and Content of Application For Approval For Thermal Annealing of Reactor Pressure Vessels. To permit NRC review of the TAR to begin before the Marble Hill results are known, we will make a series of submittals of preliminary TAR sections as they are developed. This letter provides the second of those submittals.

Attachment 1 to this letter contains the Thermal Annealing Operating Plan Section 1.6, Proposed Annealing Equipment. Attachment 2 to this letter contains Section 1.9, ALARA Considerations. The attached information is presented in the format recommended by Section C.1 of DG-1027.

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SUMMARY OF COMMITMENTS

This letter contains no new commitments and no revisions to existing commitments.

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Attachments

ATTACHMENT 1

CONSUMERS POWER COMPANY
PALISADES PLANT
DOCKET 50-255

THERMAL ANNEALING REPORT

SECTION 1

THERMAL ANNEALING OPERATING PLAN

SECTION 1.6, PROPOSED ANNEALING EQUIPMENT

1.6 THERMAL ANNEALING EQUIPMENT

1.6.A Equipment Description

1.6.A.1 Heating Apparatus

The main components of the heating system include the heat exchanger, the inlet and outlet ducting for the high velocity gases, the burners, combustion air blowers, control equipment, and fuel source. The inlet for the combustion air and the exhaust of the high velocity gases are located outside of the containment building.

1.6.A.1.1 Heat Exchanger

The heat exchanger itself consists of a large multi-chambered cylindrical shell which will be positioned concentrically within the reactor vessel (RV) and supported by the RV flange. The exchanger will be segmented into multiple, independent heat control zones to control the RV temperature profile and maintain temperature homogeneity. The manner in which the exchanger is segmented, and the size of any given control zone, depend on the requirements for a particular reactor design. For the annealing at Palisades the heat exchanger is segmented into five zones. Three zones will be positioned within the band to be annealed on the reactor vessel. The remaining two zones of the heater are guard zones to control the axial temperature gradients in the reactor vessel beyond the annealing band.

Each zone will consist of a toroidal chamber with a rectangular cross section, an inlet duct and inlet distribution system, and an outlet duct. The independent zones will be stacked on top of each other to form the complete heat exchanger. This stack of toroidal zones will create a central core through which all of the inlet and outlet ducts will run. There will be an insulation barrier between each zone of the heat exchanger to thermally isolate each zone from adjacent zones. The exterior of the exchanger will be equipped with convection barriers to prevent gross air movement within the reactor vessel during the annealing cycle.

Individual heat exchanger zone dimensions must provide not only adequate heat input, but sufficient temperature control, such that there are no adverse effects from thermal gradients during the annealing cycle. For Palisades, zone dimensions were determined based on the RV geometry and early heat load estimates. They provide adequate clearance between the reactor vessel and the external instrumentation and stiffeners on the heat exchanger. These dimensions, shown in Table 1.6.A.1-1, were used in the thermal stress analysis described in Section 1.7, and their suitability has therefore been verified. The dimensions may be refined slightly as the mechanical design of the heat exchanger is finalized.

The fully assembled heat exchanger will not fit through the Palisades equipment hatch, and therefore some in-containment assembly will be required. The principle ingress and construction steps of the heat exchanger subassemblies are depicted conceptually in Figures 1.6.A.1-1 and 1.6.A.1-2. Two factors control the size of the heat exchanger subassemblies that may be brought into containment. First, the size of the equipment hatch limits the diameter of equipment that may pass through it to approximately 108 inches (144 inch hatch diameter minus approximately 30 inches for the transfer cart minus approximately 6 inches for clearance). The second factor is the opening of the truck bay hatch, which is approximately 12 feet by 24 feet. It is possible to bring a structure longer than this hatch into the refueling building by up-ending the structure as it passes through the hatch, but the length of a structure brought in by such a technique is further limited by the height of the crane in the refueling building.

It is currently intended to bring the entire core of the heat exchanger through the truck bay hatch and equipment hatch as a single unit. In order to do this, the size of the core section will be limited to approximately 108 inches in diameter and approximately 25 feet in length. The heat exchanger will be up-ended from the truck bay (if necessary), lifted into the refueling building, re-rigged, re-oriented and transferred into position on the equipment hatch transfer cart. The heat exchanger core will then be moved into containment where it will be lifted to the lay down area by the polar crane. At the lay down area, the heat exchanger core will be up-ended onto temporary work legs and assembly will begin. First, the zone internal distribution piping will be assembled to the core, as required. These connections will be made with bolted flanges, other mechanical connections such as Dresser or Victaulic couplings, or may be entirely welded. The outer shell will then be assembled to the heat exchanger. Once the shell assembly is complete, any required instrumentation, convection barriers, etc. will be attached.

The assembled heat exchanger will then be suspended from the reactor vessel top cover (RVTC) by a stainless steel truss/hanger structure. (The RVTC is described in more detail below.) This truss will connect to the top of the heat exchanger at several points on the inner diameter of the core and outer diameter of the toroidal shell. The truss and heat exchanger will then connect to the RVTC. At this point, any duct connections required below the RVTC would be made. The inlet and outlet ducts will penetrate the center of the RVTC and continue upward to the level of the operating deck where they will turn toward the duct entry and exit points to containment.

Because the exchanger will be assembled inside containment, the unit will include appropriately designed joints. Two types of joints will be required: seal joints and non-seal joints. Non-seal joints are those where a small amount of leakage is tolerable, such as between zones. Seal joints are those where no leakage is tolerable. All joints which serve as a pressure boundary between the heat exchanger and the surroundings are seal joints. Further, almost all of the heat exchanger joints fashioned during assembly inside containment will be structural joints, meaning that they will be required to transmit pressure and/or dead loads. In addition to leak tightness and structural integrity, joint design must consider factors such as ease of assembly and disassembly, schedule impact, and ALARA. Bolted and gasketed mechanical connections will be used wherever they prove acceptable. For the heat exchanger, all seal joints will require seal welding to be performed during the assembly process. As a result, overall joint design will combine the benefits of bolted connections (rapid assembly and strength) with the benefits of seal welding (leak tightness).

Based on the analysis described in Section 1.7, the peak required heat loads, zone inlet temperatures, and flow rates were estimated for each zone of the heat exchanger. The peak requirements are not expected to exceed those shown in Table 1.6.A.1-2. Based on the expected operating temperatures, the exchanger will need to be constructed from stainless steel. Grade 304 stainless will be used for the majority of the exchanger, although certain higher temperature components may be constructed from Grade 310.

There are no specific code requirements which directly apply to the heat exchanger and ducting design. In the absence of a directly applicable construction code, the design and fabrication of the heat exchanger will generally be in accordance with ASME Section VIII, Division 2. However, ASME Section VIII, Division 2 code requirements for certain weld joint configurations and examinations, third party inspection, data reports and stamping will not apply.

1.6.A.1.2 Ducting

The inlet ducting will carry the hot air and products of combustion from the burners to the heat exchanger, and the outlet ducting will return those gasses to the outside environment. The routing of the inlet and outlet ducts inside containment is described in Section 1.6.A.2. Based on this routing and on the performance parameters described above, 10 inch diameter duct will be used. If, as a result of the final heat exchanger design or slight variations in the duct routing, flow losses become excessive, then larger duct sizes can be accommodated.

The selection of ducting material is dependent on the peak operating temperature of the duct. Grade 304 stainless will be used for all of the exhaust duct runs and the majority of the inlet duct, although certain higher temperature components may be constructed from Grade 310 stainless or refractory lined pipe.

The supports for the ducting inside containment will be pipe stands resting on the operating deck floor wherever possible. A beam or structural platform across the reactor cavity will be used if required to support the last length of the horizontal duct run. Support of the vertical ducts from the heat exchanger will be provided by the RVTC and lift rig. Support of the ducting outside of containment may potentially require structural ties into the spent fuel pool building, in addition to floor supports. Thermal expansion of the duct will be accounted by appropriately designed pipe hangers, saddles, movable supports and strategically placed bends in the duct routing.

In the absence of a directly applicable construction code, the design and fabrication of the ducting will generally be in accordance with ANSI B31.3. A complete thermal and structural analysis will be performed to ensure the integrity of the ducting. This analysis will account for the operating temperatures of the duct, and all existing loads on the duct, including dead weight of the duct and insulation, flow induced vibration loads, reactions due to duct supports, and thermal expansion loads.

The ducting will be brought into containment in sections. Mechanical joints will be made with couplings, rather than welded connections. Several types of mechanical couplings are under consideration, although currently, it is expected that most connections will be made using bolted flanges. Although pressure loads will be negligible, to handle the high temperature environment, Class 150 flat-face weld-neck flanges with full penetration welds will be used. Using full face flanges will minimize the potential for bolting and temperature induced distortion. The flanges and bolts will be well insulated to minimize the temperature difference between the bolting and the flanges. Various gasketing materials are under examination, all of which are suitable for service up to 2000°F. A combination of coupling types may be employed since the design and assembly requirements differ depending on where the joints are being made. For example, ALARA concerns may result in the use of mechanical couplings at locations in the vicinity of the cavity, while bolted flanges may be desirable overall.

To minimize thermal losses within the ductwork, and to provide protection of personnel and adjacent equipment, the ductwork will be well insulated. Depending on the peak operating temperature of the particular section of duct, and on the proximity to adjacent equipment or personnel routes, additional protective measures will be used. To prevent adverse effects on adjacent structures, spacing (standoffs) and additional insulation between the ductwork and adjacent structures will be used if required. To provide additional personnel protection, temporary barriers may be erected to prevent personnel contact with the ductwork insulation.

Ductwork insulation will be mechanically protected from abrasion as required. This may be accomplished by encasing the insulation with high temperature cloth or metallic foil, or by jacketing the insulation with sheet metal. Consideration shall be given to maximize decontamination ability of the ductwork insulation. Refer to Section 1.9.D, for discussion of waste and decontamination issues.

1.6.A.1.3 Gas Control Trains

Gas control train, gas train, or simply train, is the name given to the console which houses all the gas valves, electrical relays, temperature controllers, flame failure unit, lights and switches, etc., which enable the operator to control the gas flowing to the burner. The gas control train is shown schematically in Figure 1.6.A.1-3.

The gas control train design meets all applicable safety and performance requirements of the American Gas Association Code. In addition, all control train electrical wiring (including interconnections between trains and related equipment, such as burners and blowers) is designed to meet the applicable requirements of NFPA 58, Standard for the Storage and Handling of Liquefied Petroleum Gases, NFPA 79, Electrical Standard for Industrial Machinery, and NFPA 70, National Electrical Code.

There will be one complete gas train for each zone, plus an available spare. In the event of a train malfunction which cannot be quickly resolved, the outlet connections can be changed from the bad train to the spare train. Should a portion of a gas train malfunction, such as a second stage regulator, the gas hoses can be transferred to the regulator module from the spare gas train and the burner quickly restarted. The defective train can then be repaired and put back into standby mode.

The basic operation of the train is as follows. First, the fuel gas is regulated down to a lower pressure, for better temperature control. Second, the burner is lit at a pilot rate, while monitoring of the flame and other necessary safety features for any nonconformance is performed. Third, the main gas supply line is opened. Lastly, the motorized control valve is used to control volume of gas flowing to the burner and hence, the temperature of the hot gases leaving the burner. The operation of the gas train is explained in detail below.

The fuel gas enters the regulator module of the train from the supply manifold at 15-20 psig. Upon entering the train, the fuel gas flows through a strainer fitted upstream of the regulator, to prevent damage to the regulator seat caused by particulates (NFPA 58 Paragraph 2-5.5). The fuel gas then enters the second stage regulator where it is regulated down to 3-5 psig. There is a pressure relief valve fitted downstream of the second stage regulator, in case the regulator malfunctions (NFPA 58 Paragraph 3-2.6.1, Exception 4). The vent from this relief valve will be routed away from any source of ignition (NFPA 58 Paragraph 3-2.6.5). Pressure gauges show the inlet pressure to the regulator and the outlet pressure. From the regulator module of the train, gas flows into the control module.

Various safety features are incorporated into the control train such that out-of-spec conditions are immediately sensed. These include the following:

- An ultraviolet flame sensing eye, mounted in the burner. This is connected to a flame-failure unit on the gas train. In the event of flame-out, the flame failure unit will energize a flame safety relay interlock circuit, which automatically and instantaneously closes all fuel flow solenoids. This stops all fuel flow to the burner. In addition, the flame safety relay interlock circuit energizes audible and visual alarms on the gas train.

- A low combustion air pressure switch, connected to the flame safety relay interlock circuit.

- A low fuel pressure limit switch, connected to the flame safety relay interlock circuit.

- A high fuel pressure limit switch to detect fuel pressure upstream of main manual reset shut-off valve prior to start-up, connected to the flame safety relay interlock circuit.

- A high fuel pressure limit switch to detect fuel pressure downstream of main manual reset shut-off valve, connected to the flame safety relay interlock circuit.

With the above safety features, the flame failure unit will only allow the burner to be ignited if the following conditions exist:

- There is combustion air pressure at the burner.

- Gas pressure is not too low.

- Gas pressure is not too high.

If all three conditions are satisfied, then the burner can be lit, at the pilot rate. The operator would press the start button to start the flame failure unit initiation and, after a purge, the ignition light will come on. Pushing and holding this button lifts the pilot solenoid. Simultaneously, ignition voltage is generated by an electronic unit mounted on the burner. This voltage is supplied to a spark plug mounted within the burner.

When the burner lights, the flame is detected by the UV eye mounted in the burner. There is a delay period, during which the flame failure unit determines whether the flame is stable or not, and then a flame lit indicator appears. The flame strength signal is displayed on the meter to assist the operator in making adjustments. Should the burner not light after approximately 10 seconds, the pilot solenoid will close, the spark will stop, and the lockout light will come on. A further attempt to relight can be tried by pushing the reset button.

When the burner lights, the operator must manually open a reset valve. This also triggers a switch to open the second blocking valve, in the main gas line. At this point, gas is now being supplied to the main line, and to the motorized control valve which controls gas flow to the burner. The motorized valve is controlled by a microprocessor based digital temperature controller.

The gas trains are designed for control flexibility. The controls can be operated in one of three ways:

- Manual (percent opening): The operator increases or decreases the percent opening of the valve.

- Semi-automatic (process variable vs. set point): The operator changes the set point of the selected control thermocouple. This requires the decision as to which thermocouple will be used as the control.

- Fully-automatic (process variable vs. a programmed set point): The operator programs the temperature controller so that the selected thermocouple will follow the program. This also requires the decision as to which thermocouple will be used as the control.

These options provide the operator with the best control method to suit a given set of circumstances.

1.6.A.1.4 Blowers

Combustion air is supplied from high pressure blowers. There will be one blower per zone, plus a spare unit, to be available should one blower stop operating. Changing over to the spare involves moving the end of the air hose from the bad blower to the spare and changing the control train power supply. Each blower is equipped with a combination fused disconnect and starter unit. A manually operated damper controls the volume of air being supplied to the burner.

1.6.A.1.5 Burners

The gas burners will be of the nozzle mixing type, meaning that the air and gas only mix after entering the burner. The advantage of this system is that the gas and air flows to the burner can be varied, yet a stable flame can be achieved, even with very high excess air rates.

The burner is lit by direct spark ignition via an electronic spark generator mounted on the burner. This is done at a low gas flow rate and a high air flow rate. This high excess air minimizes the concentration of unburned fuel in the burner during ignition.

The burner is connected, via quick connect fittings and hose, back to the low air pressure switch mounted in the control train. This is a safeguard against loss of air to the burner, such as that due to a disconnected air hose or the fan inlet being inadvertently blocked. The burner is also fitted with an ultraviolet flame sensing eye as discussed in Section 1.6.A.1.3.

1.6.A.1.6 Gas and Air Flow Metering

The gas metering will be accomplished using venturi meters. Multiple flow pressure gages will exist so that the operator can select from one scale to another to achieve greater accuracy. Inlet gas temperature will also be measured to enable adjustment of the flow for temperature variation.

The volume of air flow will be measured using a pitot static tube. Inlet air temperature will also be measured to enable adjustment of the flow for temperature variation.

1.6.A.1.7 Fuel Source and Delivery

Normally, the fuel source options for the gas trains are an on-site piped-in supply of natural gas, a temporary storage supply of liquefied or compressed natural gas (LNG or CNG), or a temporary storage supply of liquefied petroleum gas (LPG), or more specifically propane. Because an on-site natural gas supply is not available at Palisades, options are limited to a temporary supply of either LPG, LNG, or CNG. Because of availability issues, and the relative complexities associated with LNG or CNG, the fuel source for the annealing will be a temporary storage supply of propane.

Storage and handling of propane on site will be in accordance with all applicable portions of National Fire Protection Association Standard NFPA 58, Standard for the Storage and Handling of Liquefied Petroleum Gases. Also, portions of NFPA 54, National Fuel Gas Code, will be utilized, although that code does not strictly apply to portable LPG systems not connected to fixed fuel piping systems (NFPA 54, Paragraph 1.1.1b (1)).

Figure 1.6.A.1-4 is a schematic of the propane fuel delivery system. The propane will be stored in liquid form in LPG road tankers. A fuel docking station (manifold) will provide docking for up to two road tankers. The tankers will connect to the docking station using standard high pressure liquid hoses. From the tankers, the liquid will flow to a bank of electrically heated vaporizers, which will supply the latent heat of vaporization to change the liquid into a vapor.

Immediately after the vaporizers is a first stage regulator, to reduce the gas pressure prior to delivery to a manifold which will serve each of the gas control trains. Other than the tanker hoses, all of the above piping will be rigid.

From the manifold, gas will be supplied to the control trains. There will be a control train for each of the heat exchanger zones. From the control trains, gas will flow to the gas measurement systems and then to the burners. Interconnecting downstream of the gas train supply manifold will be done using high pressure LPG hoses.

1.6.A.1.7.1 LPG Storage

The total propane requirement for any on-site tests and the actual annealing is expected to be between 75,000 and 100,000 gallons. The liquid propane will be supplied from road tankers rather than permanent tanks since, unlike fixed tanks, the road tankers can be removed from site should an emergency situation occur. The road tankers comply with ASME Section VIII Division 1 for unfired pressure vessels, and with DOT hazardous materials regulations (NFPA 58 Paragraph 6-3.1.2).

A tanker docking arrangement will be constructed so that when one tanker is almost empty, a second tanker can be connected up and the changeover effected, without any stoppage to the fuel supply. Tanker connections will be done using the LPG standard high pressure liquid hoses on the tanker, normally used to supply liquid propane into permanent tanks. These are designed for a working pressure of 350 psig (NFPA 58 Paragraphs 2-5.1.2 and 6-3.3.1). The isolation valves at the docking station will be suitable for a pressure of 250 psig minimum (NFPA 58 Paragraph 2-4.5.2(b)), and shall be ball type, for fast closing.

Each road tanker is fitted with an external pressure relief valve set for 250 psig and an excess flow valve. The excess flow valve will immediately stop flow of the liquid propane should any of the propane lines be ruptured. Note that a rupture of either the vapor or the liquid lines will cause a rapid increase in demand, with the resultant increase in flow detected by the excess flow valve. Thus the entire system, between the tankers and the control trains, is protected (NFPA 58 Section 2-3.3: Container appurtenances for cargo service).

The road tankers come in several sizes, up to 19,000 gallons. The size of the road tanker selected will be a compromise between the volume of gas stored on site, and the number of tanker moves onto site. Obviously, a larger volume tanker will reduce the number of movements, but with a subsequent increase in volume on site at any one time. The preferred option is for the largest available tanker, since this choice will require the minimum number of tankers being moved onto the site and the minimum number of "hook-ups".

The specific storage location will be selected based on the safety evaluation being performed to address the issue of storage of flammables on site. Several storage locations for the fuel are under consideration, including to the east of containment and the spent fuel building (either inside or outside of the security fence). The fuel docking station will be located at least 50 feet from any building (NFPA 58 Table 3-2.2.2). Open flames, cutting or welding, portable electrical tools, and extension lights capable of igniting LPG will not be permitted within 15 feet of the fuel storage containers (NFPA 58 Table 3-7.2.2 (A), (C), and (D)).

During LPG transfer operations (container filling or tanker switch-over), the following additional precautions will apply. Internal combustion engines, except for those on the delivery vehicle used explicitly to drive transfer pumps or compressors, will not be permitted to operate within 15 feet of the point of transfer (NFPA 58 Paragraph 4-2.3.2 (a)). Open flames, cutting or welding, portable electrical tools, and extension lights capable of igniting LPG will not be permitted within 25 feet of the point of transfer (NFPA 58 Paragraph 4-2.3.2 (b)). Unless the equipment is shut down, intakes for any air moving equipment shall be at least 50 feet from the point of transfer (NFPA 58 Paragraph 4-2.3.4 (a)).

1.6.A.1.7.2 Propane Liquid Line

The liquid lines to the vaporizers shall be of rigid pipe with all pipe and fittings being SCH 80 minimum, suitable for a working pressure of 250 psig (NFPA 58 Paragraphs 2-4.2 & 2-4.4). The liquid will be delivered to the four vaporizers via a manifold. After assembly, but prior to use, this line will be pressure tested at not less than it's normal operating pressure, using nitrogen or another inert gas as the testing medium (NFPA 58 Paragraph 3.2.10). Leak detection shall consist of soap and water solution (NFPA 54 Paragraph 4.1.5b). Any leaks found will be repaired and then the piping will be retested.

The piping will be painted safety yellow. It shall be well supported and protected, by barriers, to prevent mechanical damage (NFPA 58 Paragraph 3-2.10).

1.6.A.1.7.3 Electric Vaporizers

The electric vaporizers are treated as indirect fired units (NFPA 58 Paragraph 3-6.7) and are constructed in accordance with the applicable provision of ASME VIII Division 1 for a design pressure of 250 psig. They are each fitted with a pressure relief valve to relieve at this same pressure. There will be a bank of these units (tentatively four total) with one being a spare. In the event of problems with any of the primary units, isolating valves on the inlet and outlet will allow the unit to be isolated for repair or replacement.

The units are fitted with a control system to guard against malfunctions as follows:

- Automatic temperature controlled inlet solenoid, to ensure that the electrical elements are operational and up to temperature before allowing liquid into the vaporizer.

- Automatic temperature control of the heating elements.
- Over temperature protection, which will automatically shut the unit down, should the temperature of the liquid go too high.
- Protection to prevent liquid propane passing through to the vapor line, by closing the liquid inlet solenoid valve, if the liquid temperature falls too low (NFPA 58 Paragraph 2-5.4.2 b).
- Indicator lights for various unit functions and audible alarms upon problem detection. These indicators and alarms will be monitored as part of the periodic job walks described in Section 1.6.A.1.9.2.
- An outlet pressure gauge shows that the unit is working correctly.

The vaporizers will have an ASME code plate showing the date of manufacture, the outside surface area, heat exchange surface area, vaporizer capacity in gallons/hr, and the heater rating in kW/hr (NFPA 58 Paragraph 2-5.4.2 a).

Open flames or other sources of ignition shall not be permitted within 15 feet of the vaporizers (NFPA Table 3-7.2.2 (F)).

1.6.A.1.7.4 First Stage Regulator

To have good pressure regulation, a single regulator will be used instead of individual regulators on each of the vaporizers. A second identical regulator will be fitted in parallel with the first, to provide a back up should the first regulator become inoperable. Isolating valves will facilitate changing from one regulator to the other, without interruption of the annealing cycle, to be able to carry out maintenance. The regulators are UL approved and are designed to operate with up to 250 psig inlet pressure. Installation of the first stage regulator directly after the vaporizers will keep the length of high pressure vapor pipe run to a minimum. The regulator outlet pressure will be reduced to a variable 15-20 psig and the pressure will be shown on an outlet pressure gauge.

1.6.A.1.7.5 Gas Piping and Gas Train Supply Manifold

This piping will supply gas from the vaporizers to the first stage regulator and from the first stage regulator to the gas control train supply manifold. All pipe and fittings will be SCH 80 minimum, suitable for a working pressure of 250 psig. Construction standards, pressure testing, and protection of the piping are identical to that described for the propane liquid lines.

1.6.A.1.7.6 Gas Hoses

These hoses will supply gas from the gas train supply manifold to the gas trains themselves, from the gas trains to the burners. The normal pressure to these hoses is 15-20 psig maximum, and the propane delivery system is limited to 250 psig due to the pressure relief valves upstream. LPG hoses rated at 350 psig will be used and certified that they have been tested at twice their rated pressure, or 700 psig.

1.6.A.1.8 Electrical Supply

Maximum power requirements for each of the various pieces of equipment are as follows. Each propane vaporizer will require 3 phase, 480V, 100 amps per phase supply. Although one unit is a spare, power will be connected to all units, for rapid change over if required. Furthermore, the power supplies will be sized such that all units can be used simultaneously, to support troubleshooting and repair activities.

Each of the blowers will require 3 phase, 480V, 120 amps per phase supply. As with the vaporizers, the power supplies will be sized so all units can be used simultaneously to support troubleshooting and repair activities.

A 120V, 5A single phase supply will be provided by step-down transformers on the blowers for each of the gas control trains. Each train will support a single strip chart temperature recorder. In addition to the strip chart recorders, it is estimated that the combustion system data acquisition system requirements will not exceed a single phase, 120V, 20A stabilized supply.

A standby supply will be available for all equipment in the event that the primary supply fails. Note that the combustion air blowers are subject to correct phase connection, for correct rotation and the phases between the two different supplies will be matched at the distribution board changeover switch, and tested prior to start-up of the annealing cycle.

1.6.A.1.9 Personnel Safety

Inherent in this discussion of the heating system design is a recognition that adherence to industry recognized standards is a key aspect to safe operation. Wherever possible, the foregoing discussion referred to any applicable standards which covered a particular facet of the design and construction of the heating system. The following discussion focuses on additional, operational controls which enhance the safe operation of the system.

1.6.A.1.9.1 Training

The various parameters that must be monitored and controlled (temperatures, gradients, ramp rates, burner output, heat exchanger output, air flow measurements, inlet/outlet temperatures, etc.), and the ultimate safe operation of the heating system, will be the responsibility of the heating system operators and on-site project engineers. Each heating system operator at the Palisades site will have a minimum of 2000 hours of on-site combustion heat treating experience. Each will be certified, at a minimum, as having successfully completed combustion technician training per the combustion vendor's training program. In addition, all technicians will undergo training and qualification on procedures and equipment specific to the Palisades annealing project.

The plant fire brigade is currently trained to fight fires involving flammable gases. This training will be upgraded to include training on the hazards specific to the annealing project, such as, but not limited to: tank truck and docking emergencies, control station emergencies, and piping hazards. Nationally recognized standards will be used to develop all class room training and hands-on fire fighting evolutions.

1.6.A.1.9.2 Continuous Monitored Operation

Although the control trains are equipped with automatic control and safety features, standard practice dictates that the combustion equipment will be manned on a 24 hour per day basis, from ignition of the burners until all lines are free of fuel and the gauges show zero pressure.

In addition to process control, standard practice includes periodic checks of the overall system throughout the cycle. These "job walks" will be performed on a periodic basis as part of the written procedure for the annealing, and will include a written log describing any encountered problems (or stating all normal). Walkdown activities include, but are not limited to: visual duct and duct support checks, duct expansion checks, insulation integrity checks, exhaust vent checks, fuel source level, vaporizer operation checks, regulator operation checks, pressure gauge checks, gas train and burner checks, and fuel leak checks using gas detectors. Adequate personpower will be supplied such that these activities do not interfere with the ongoing annealing process control.

1.6.A.1.9.3 Air and Gas Measurements

The air and gas flow instrumentation system designed specifically for this heating system allows direct measurements of the air and gas going to each burner. In addition to process control, this system has the added safety benefit of ensuring that the combustion process is always operating with an excess air condition. Thus, no unburned propane (from operating gas rich) can be present in the ductwork, refer to Section 1.6.A.1.9.6 for a detailed discussion.

1.6.A.1.9.4 Leak Detection

Portable gas detectors (sniffers) will be employed to periodically check all of the lines and fittings for leaks. These detectors are designed to identify flammable gas concentrations well below the lower explosive limit. These checks will be made once a shift, as a minimum.

Note that fixed gas detectors may also be employed. However, their usefulness is limited in this application, for while they provide continuous coverage, they cannot provide complete coverage of the fuel piping system. They would therefore not substitute for the portable detector. Experience has shown that portable units provide the most effective overall means of detection. As a second line of defense, it should be noted that propane and natural gas have sufficient odorant added to be detectable by smell, again well before the lower explosive limit is reached

1.6.A.1.9.5 Other Standard Practices

Many of the most important safe work practices specific to combustion are part of the combustion vendor's standard practices taught to combustion technicians at all levels. These include items such as the wearing of proper personnel protective clothing and hearing protection, proper test firing procedures, and proper practices in the event of a delay between testing and firing (safe standby condition).

1.6.A.1.9.6 Products Of Combustion

The burner exhaust composition has been reviewed from the standpoint of flammability of the material flowing within the ductwork and the potential safety hazards associated with the potential for propane within the ductwork.

When burners are being operated slightly oxidizing (i.e., at low excess air, say 10%), then the products of combustion consist of carbon dioxide, water vapor, oxygen, nitrogen and some NO_x. The latter is formed by the high flame temperature oxidizing a small portion of the nitrogen present in the combustion process. During the annealing process, however, the heating system burners will always be operated under high excess air conditions. Under these excess air conditions (particularly at the start of heating, when there is the highest air to gas ratio), there exists a chilling of the combustion reaction at the edge of the flame envelope. The flame edge is cooled down, below the temperature necessary to enable the combustion reaction to proceed to completion, such that intermediate reaction products are now present. These products contain some carbon monoxide and some aldehydes. However, they are present in only a few parts per million, well below the lower flammability limit for any of these constituents. Under no circumstances can the products of combustion or intermediate products of combustion pose a flammability hazard. This is because under no circumstances can they be present in high enough concentrations such that they are flammable or explosive.

The only flammable material which could ever enter the ductwork under any circumstances is the fuel gas itself. This can only occur under three conditions: operating gas rich, start-up, or flame failure conditions.

Operating gas rich conditions is considered a highly abnormal condition for this equipment. Operating gas rich is not feasible in this application, due to the administrative measures taken to verify excess air conditions and the normal operation of the equipment as described above and below.

Under start-up conditions, the design of the electronic ignition mechanism precludes significant amounts of fuel from entering the ductwork as discussed in the gas train and burner descriptions. Fuel is introduced only after the ignition spark exists; the moment a combustible mixture is reached, ignition occurs, and thereafter the burner is operating normally.

Under flame failure conditions, the standard safety features of the train preclude significant amounts of fuel from entering the ductwork as discussed in the gas train description. During all but an actual flame failure (e.g., during UV eye failure, loss of a blower, loss of power, etc.), the burner is lit when the solenoids shut down, and the flame goes out only after all combustibles are burned. Thus, no fuel enters the ductwork. During an actual flame failure, the amount of fuel introduced is limited to that which flows subsequent to flame failure but prior to the solenoids closing, a duration of approximately four seconds. During this time, based on the peak operating conditions described in Section 1.6.A.1.1, the total propane flow would be approximately 2 cubic feet of vapor. During that same four seconds, approximately 133 cubic feet of air will flow to the burner. Upon leaving the burner, the resultant mixture will have a propane content of approximately 1.5 percent. This is below the lower flammability limit for propane, and the mixture is therefore not flammable. The limits of flammability for propane in an air/gas mixture are between 2.37% and 9.5% gas by volume. Inherent in the burner's design as an excess air burner is the ability to maintain combustion during very high excess air conditions. This requires a combustion chamber to which the air is delivered in stages, such that the limits of flammability are maintained only within a discrete area of the chamber. Immediately downstream of this area, there is total mixture with the remainder of the air that has been supplied to the burner. Because the flow rate of propane relative to the total flow rate of air results in a non-flammable mixture once it exits the burner, there will never be a flammable mixture within the ductwork as a result of flame failure during the annealing, even at peak demand conditions.

1.6.A.2 General Plant Layout

The decision regarding control equipment location and duct routing is made considering numerous, often competing, factors. Thus the selected layout is a balance between various criteria. Considerations common to the control equipment and ducting include: minimizing impact on plant operation (such as that due to obstructed crane movement or personnel and equipment ingress/egress); minimizing impact on outage schedule and overall duration; ALARA considerations; minimizing relocation of existing equipment and structures (such as moving existing support trailers to accommodate equipment); minimizing temporary modifications to plant (i.e. removal of obstructions such as railings). Considerations specific to control equipment location include: maximizing accessibility of the location for placement of equipment, and for ready access for operators, fuel deliveries, and fire fighting equipment; minimizing routing of fuel supply near combustible materials and structures; maximizing overall space availability for equipment, and proximity of various control components to each other, to simplify annealing operations. Considerations specific to inlet and outlet ducting include: minimizing potential heat load on adjacent equipment and structures; minimizing the overall effective length of duct (and therefore pressure and thermal losses); minimizing complexity of ducting supports. In addition, the exhaust routing must consider the potential effect on adjacent structures due to heat load, and on the plant HVAC system and other air intake structures.

Considerations of these factors has led to the following plan for equipment layout. Although it is possible that this plan may be modified due to as yet unforeseen considerations, any changes to the described layout will include consideration of the rationale/criteria described above.

It is currently planned that the annealing vaporizers, regulators, burners, blowers, and controls will be located to the east of the spent fuel building in the corridor area bounded by the spent fuel building, the administration building, the security fence, and the currently located support trailers. A ground supported platform will be erected directly against the east side of the spent fuel building, to support the burners at the elevation of the inlet ducts. The gas trains and other control equipment may also be located on this platform. The vaporizers and regulators will be located at ground level. The fuel supply will also be located to the east of the spent fuel building, refer to Section 1.6.A.1.7.1 regarding the fuel supply.

From the burner platform, the inlet ducts will enter the east side of the spent fuel building. The lines will enter the building, run west to the hatch, then roughly southward into the containment equipment hatch. After entering the hatch, the lines will run across the operating deck, then downward toward the reactor vessel. The exhaust ducting will be routed back up to the operating deck, then out through the equipment hatch. From there the lines will turn upward and westward, and will exit through the west wall of the spent fuel building, preferably below the bridge crane rail.

1.6.A.3 Controls and Instrumentation Including Redundancy

Section 1.5.B contains a description of the method of instrumentation used during the annealing, including that which is directly applicable to control of the annealing process. Section 1.5.C describes the instrumentation accuracy and reliability, including redundancy. Section 1.6.A.1.3 describes the gas control trains themselves. Finally, Section 1.6.A.4 describes the temperature data acquisition equipment which will be used during the annealing. Refer to those sections for a description of the control and instrumentation hardware.

Section 1.5.D.1 includes a description of the overall control methodology that will be used during the annealing process. Refer to that section for a description of how the control and instrumentation hardware is used during the anneal.

1.6.A.4 Equipment for Measuring and Recording Temperatures and Temperature Profiles

To meet the data display and recording needs for the annealing, a computerized data acquisition system will be employed. The system will provide real time monitoring of all measured temperatures and all calculated gradients, ramp rates, etc. as required. Data will be obtained at a rate appropriate to fulfill the objectives described in Sections 1.5 and 2.1. In addition to data storage and logging, extensive display and operator interface features exist, such as alarming and reporting functions, which aid the operator during the annealing. To the extent that the frequency of measurement required for analysis and record keeping differs from the frequency provided for operator feedback and process control, the display of the data may be updated at an interval different than that at which it is stored.

As with all of the annealing equipment, adequate spares will be supplied such that a failure of a particular data acquisition system component can be quickly rectified. For protection during loss of power, the data acquisition system will be connected to an uninterruptable power supply, so that continued operation can be maintained while changeover to backup power takes place. The data acquisition system will be calibrated in accordance with Quality Assurance requirements.

1.6.A.5 Support Equipment

1.6.A.5.1 Reactor Vessel Top Cover

The reactor vessel top cover (RVTC), supports the heat exchanger assembly and provides the radiological shielding and airborne contamination control interface for the dry reactor vessel. The reactor vessel is covered using steel plate and structural beam framing. The RVTC is supported above the RV flange in the stud hole area using a thermal insulating pad. The steel cover plate provides some shielding with additional shielding made from steel plates, modular panels filled with lead or using lead blankets as required. The temperature of the RVTC will be kept well below the RV annealing temperature by the use of thermal insulation and the cooling effects of the refueling cavity contamination control air movers. The RVTC assembly will be positioned on the RV flange at two stud hole locations. Thermal insulation is attached to the RVTC underside.

The structural beam framing also provides support for the inlet and exhaust ducting for the heat exchanger. The RVTC framing is a three armed structural beam frame connected in the center with a ring girder. The ring girder opening allows the ducting and insulation to pass through the RVTC from the heat exchanger to the operating deck. The ring girder frame carries the dead load and provides lateral support for the ducting, insulation and cylindrical shielding. The ducting is externally insulated with thermal insulation. In addition the ducting will be shielded using two semi-circular cylindrical segments extending from the RVTC up towards the operating floor deck approximately 6 feet, to block any radiological streaming out of the dry reactor vessel. The RVTC penetrations for the piping and instrumentation will be packed with insulation to provide an airflow barrier for airborne contamination control.

It is important to assure that the heat exchanger is positioned in the center of the reactor vessel. For installation of the heat exchanger into the reactor vessel the clearance of the RV guide pins in the alignment bushings is approximately 0.25 inch on the diameter. The positioning and alignment of the heat exchanger is achieved during assembly using the heat exchanger fabrication tolerances. This includes using a template for the location of the lift lugs on both the heat exchanger and RVTC framing. Provisions to allow for thermal growth of the heat exchanger supports and RVTC will be made. Thermal barriers will be used to reduce the thermal loads on the structure and associated heat loss.

1.6.A.5.2 Heat Exchanger Assembly Lift Rig

The main lift rig components are the three structural support beams including the ring girder in the center and the three lift legs using lift rods and turnbuckle assemblies. The lift legs are connected using standard shackles at both ends. The lift legs are staggered through the ducting from the heat exchanger. The three lift legs are connected to the polar crane main hook using a main link block and a saddle pin assembly. The lift rig will be removed from the RVTC after heat exchanger assembly installation.

The lift rig and support frame components are designed for the heat exchanger equipment and integral shielding lift load. The RVTC, lift rig and/or components will be load tested in accordance with the requirements of the ANSI/ASME NQA-2b-1987, Part 2.15 to provide for safe handling of the annealing heat exchanger assembly. The total lift height of the heat exchanger including the lift rig and RVTC is approximately 43 Feet 9 inches which is within the 46 feet 9 inch Palisades polar crane lift height available.

1.6.A.5.3 Reactor Vessel Drainage/Purge System

An auxiliary RV drainage system will be used to drain the reactor vessel from below the RV nozzles. This system will route any water in the RV bottom to the plant drain system in the refueling cavity fuel transfer pit. The RV drainage system consists of a submersible pump within a pipe integrated into the heat exchanger assembly. After the reactor vessel is drained, the piping used will be reconfigured to allow connection to a filtered ventilation system. The reactor vessel will then be heated to approximately 250°F and held to dry. Any steam from residual moisture in the reactor vessel will be removed. The reactor vessel may be vented in this manner throughout the annealing process. Refer to Section 1.5.D.4 for system functional description.

1.6.A.5.4 Nozzle Thermal Barriers

The nozzle thermal barriers are designed to restrict the amount of heat transfer from the heat exchanger inside the reactor vessel through the PCS piping during the annealing. The nozzle thermal barriers will be remotely installed in and removed from the inlet and outlet nozzles of the Palisades reactor vessel. Without the thermal barriers in the nozzles, the six RV nozzle openings provide a significant escape path for the generated heat, the mechanism for escape being the free convective heat transfer down the pipes. Since free convection depends on mass transfer, the nozzle thermal barriers will significantly reduce the amount of air flow from the reactor vessel into the PCS piping. An additional consideration is to reduce the heat transfer via radiation from the heat exchanger and conduction through the nozzle thermal barriers which in turn could set up convection in the air on the backside of the barrier. Because the nozzle thermal barriers will be installed while the reactor vessel is flooded, the design will permit drainage of water through the barrier when the reactor vessel is drained and reflooded.

1.6.A.6 ALARA Provisions and Shielding Configurations

Video and lighting systems will be utilized during the annealing program to monitor any work being performed in the refueling cavity such as heat exchanger assembly installation into the reactor vessel to assure proper fit up, assembly, installation and disassembly of equipment.

During periods of the annealing operation when the reactor vessel is dry with the annealing furnace in place, the activated portions of the RV wall and cladding can produce significant radiation levels in the refueling cavity as well as at other locations in the reactor containment building. In order to reduce these radiation levels to acceptable levels shielding will be incorporated in the design of the RVTC. The RVTC with its shielding will provide sufficient radiation shielding after the installation of the annealing heat exchanger into the reactor vessel to help minimize personnel exposure during supporting activities, refer to Section 1.9, ALARA Considerations.

1.6.A.7 Protection of Instruments and Equipment From Temperature Effects During Annealing

At various points during the annealing preparations it will be necessary to remove the plant equipment and components that interfere with or may be affected by the annealing process, i.e. RV guide pins and sleeves, stud hole plugs, reactor cavity seal, RV wall surveillance capsules, etc. Any other equipment, component, or structure that may be affected by the annealing operation that is not removable may require protection such as supplemental cooling or insulation, refer to Section 1.3, Equipment, Components, and Structures Affected by Thermal Annealing.

1.6.A.7.1 Biological Shield Supplemental Cooling

Biological shield supplemental cooling will be forced circulation within the reactor cavity annulus. The thermal models include the effects of the air circulation.

Ventilation ducts within the annulus and a cover for the reactor cavity access tube flange will be installed. The cover will be ducted to a suction fan to draw negative pressure uniformly around the reactor cavity annulus. The ventilation system will be filtered to capture any potential airborne activity.

Zone Description	Height Including Insulation	Shell Outer Diameter
Upper Guard Zone	50 inches	152 inches
Upper Annealing Zone	50 inches	152 inches
Middle Annealing Zone	50 inches	152 inches
Lower Annealing Zone	50 inches	152 inches
Lower Guard Zone	29 inches	148 inches

TABLE 1.6.A.1-1 Heat Exchanger Individual Zone Dimensions

Zone Description	Heat Flux (Btu/hr ft^2)	Zone Inlet Temp (°F)	Flow Rate (SCFM)
Upper Guard Zone	3000	1600	2000
Upper Annealing Zone	1600	1350	2000
Middle Annealing Zone	1600	1350	2000
Lower Annealing Zone	1600	1350	2000
Lower Guard Zone	3000	1600	2000

TABLE 1.6.A.1-2 Heat Exchanger Peak Required Performance Parameters

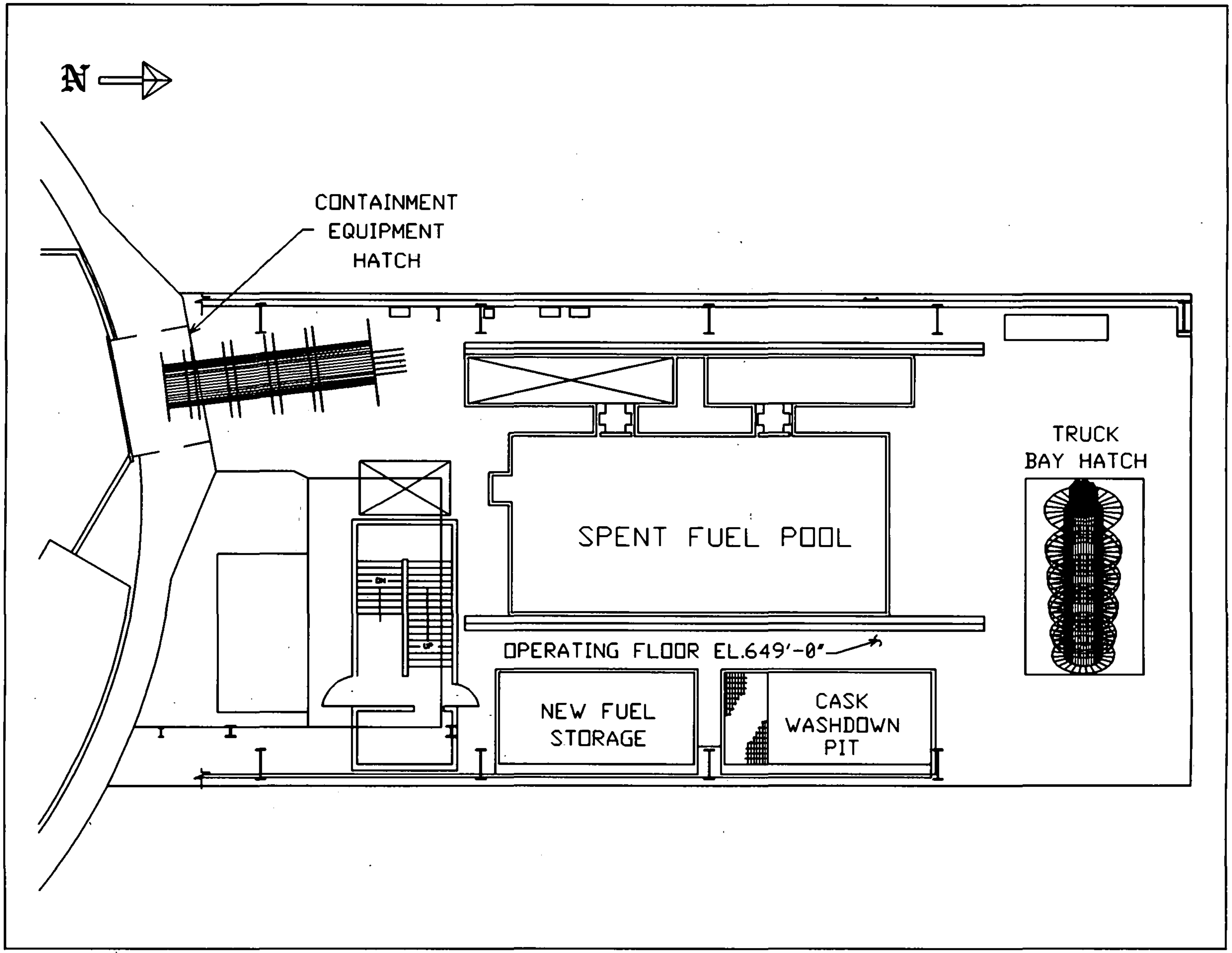

Figure 1.6.A.1-1 Heat Exchanger Core Ingress Into Containment (Conceptual)

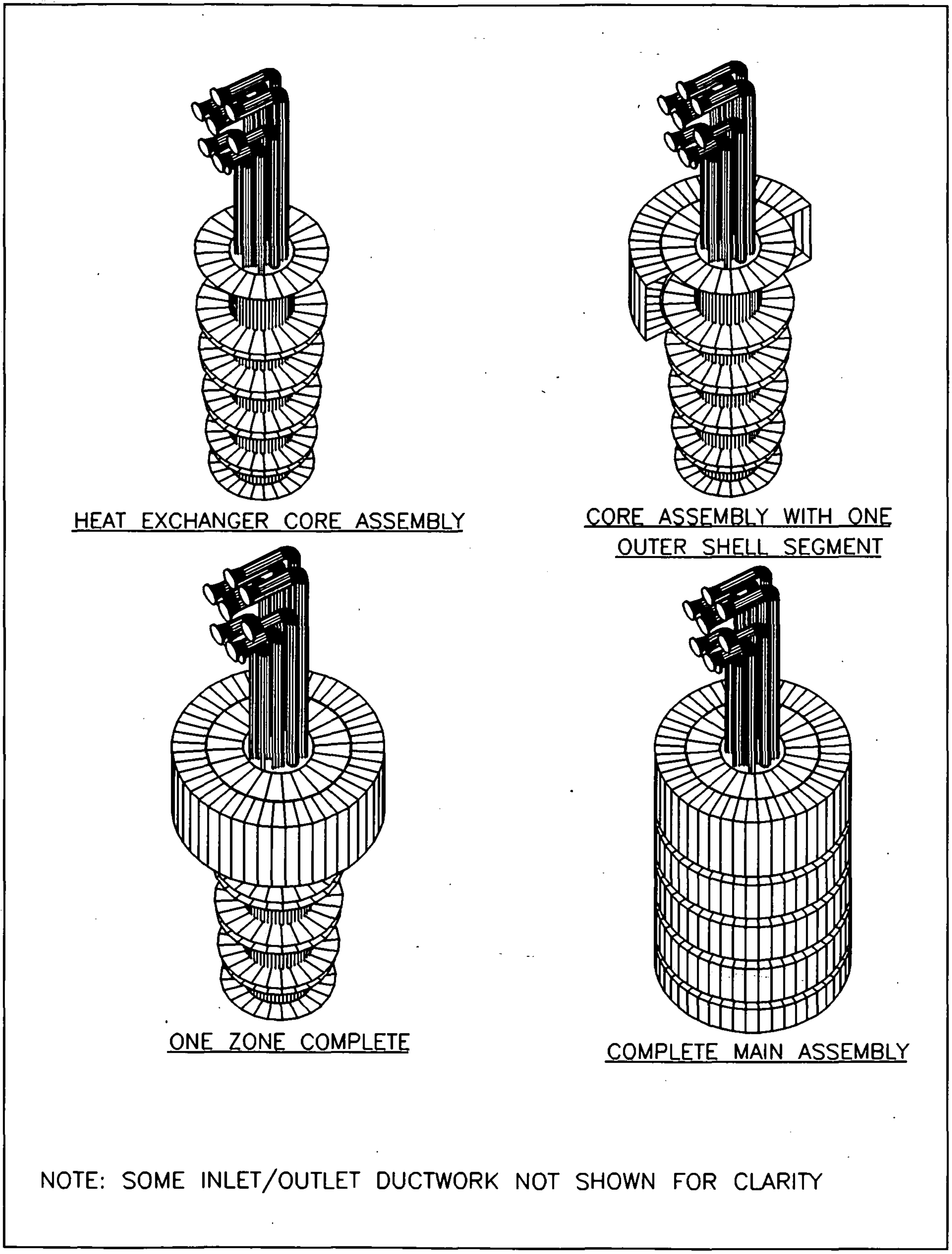

Figure 1.6.A.1-2 Heat Exchanger Assembly (Conceptual)

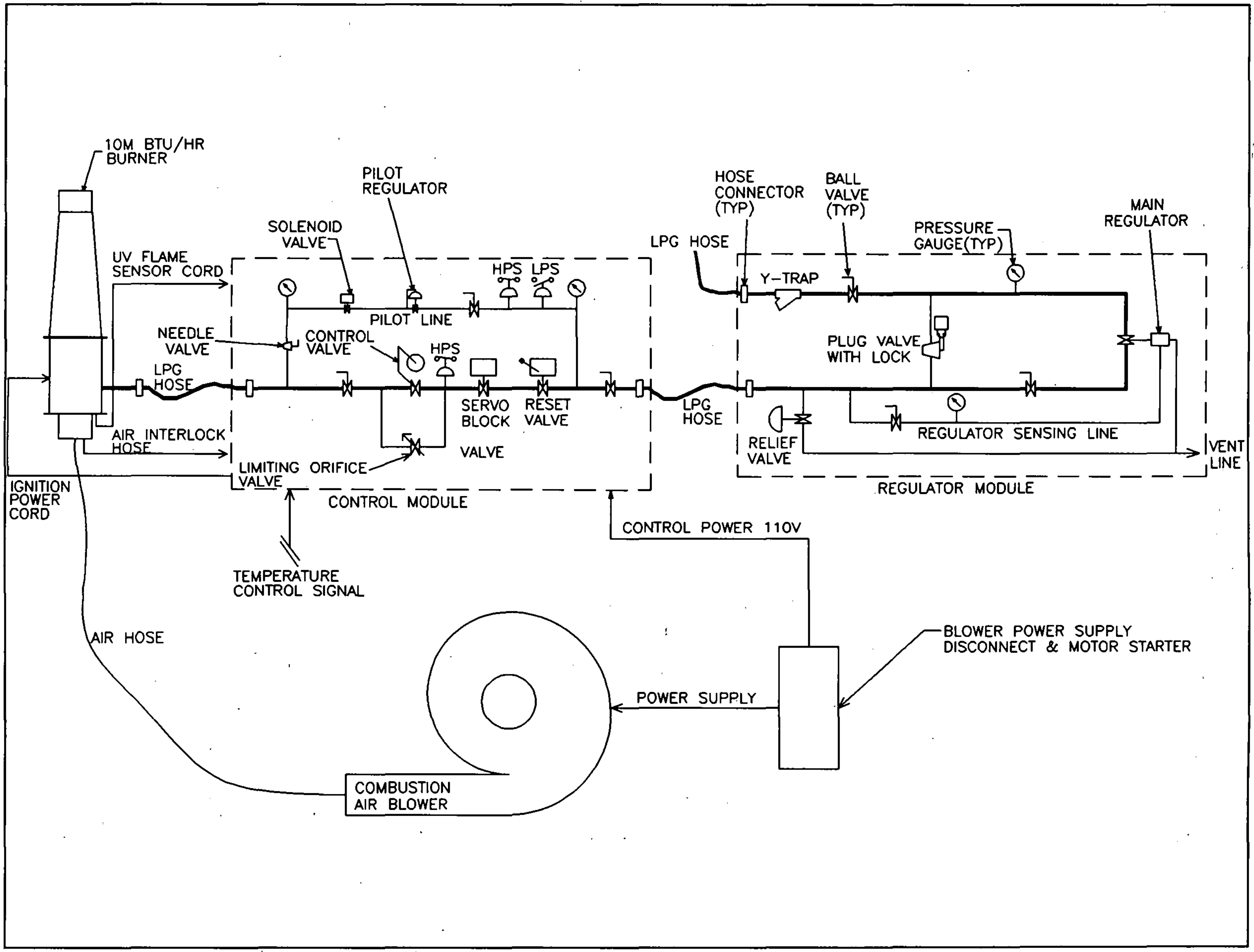

Figure 1.6.A.1-3 Gas Control Train

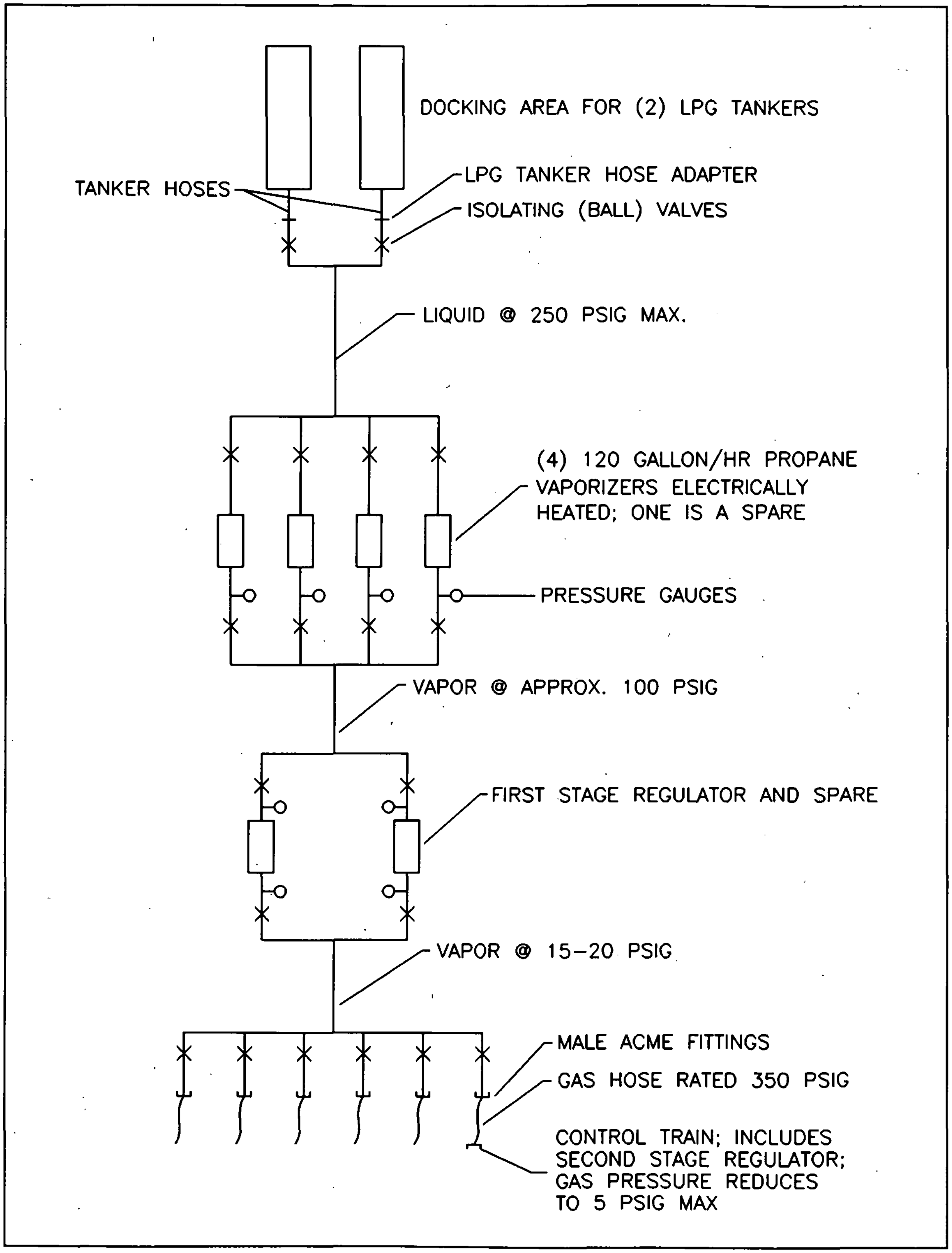

Figure 1.6.A.1-4 LPG Fuel Delivery System Schematic

ATTACHMENT 2

CONSUMERS POWER COMPANY
PALISADES PLANT
DOCKET 50-255

THERMAL ANNEALING REPORT

SECTION 1

THERMAL ANNEALING OPERATING PLAN

SECTION 1.9, ALARA CONSIDERATIONS

1.9 ALARA CONSIDERATIONS

1.9.A Description of Steps to Minimize Occupational Radiation Exposure

The Palisades reactor vessel (RV) annealing will be performed while minimizing occupational radiation exposure during all phases of the project. In accordance with the principles outlined in 10CFR20 workers occupational radiation exposures will be kept as low as reasonably achievable (ALARA). During the site activities, available techniques that will reduce worker radiation exposure and limit the possible spread of airborne contamination will be incorporated into processes and procedures. Some of these ALARA techniques include reducing the worker's time of exposure, using shielding where practical, securing and containing the work area, using specialized tooling when possible and maximizing the worker's distance from the radiation areas. The setup of equipment and the performance of the annealing will utilize personnel that have experience in design, maintenance and repair operations in a radioactive work environment which can be drawn upon to minimize radiation exposure.

1.9.A.1 Tooling, Equipment and Procedures

The tooling and equipment to be utilized during the Palisades annealing effort will be designed to facilitate efficient assembly, disassembly and repair, thus precluding unnecessary maintenance time in high radiation areas.

Long-handled underwater tools will be used for activities such as:

- Installation and removal of the nozzle thermal barriers.
- Underwater visual inspection and acquisition of the pre-anneal and post-anneal measurements inside the reactor vessel; refer to Section 2.2.
- Miscellaneous tasks to maximize the amount of tasks performed with the cavity flooded.

For lifting and storage of the RV internals, shielding will be designed and utilized to reduce exposure to acceptable levels. A specially designed shielded enclosure will be used for the dry storage of the upper guide structure and core support barrel, refer to Section 1.3.F. This shielding is being designed for underwater installation and ease of decontamination.

Activities that will enhance the ability to keep radiation exposure as low as reasonably achievable include:

- Assembling as much of the annealing equipment outside of containment as possible.

- Training and qualifying personnel and tooling using representative mock ups.

- Designing the heat exchanger assembly with shielding to minimize exposure, refer to Section 1.6.A.5.1.

- Using remote tooling to install some external temperature measurement devices and internal instrumentation as an alternate to external instrumentation to eliminate the need to manually remove primary coolant system piping penetration biological shield block material and RV insulation for instrument installation.

Procedures will be used for all the annealing program tasks. ALARA reviews for the tasks will ensure that radiological guidelines are incorporated into the procedures.

1.9.A.2 Training

Training will be prepared for the major site annealing project tasks. Personnel qualifications will be completed prior to commencing on-site work. Maximum advantage will be taken of the Marble Hill annealing demonstration project to find additional ways to enhance the equipment, processes, and procedures. Lessons learned during the Marble Hill annealing demonstration project will be incorporated into the Palisades annealing project. Since much of the same equipment is planned to be used, any upgrades to the systems which could reduce radiation exposure will be considered for incorporation after the demonstration.

For certain annealing project tasks, as part of the pre-outage effort, personnel assigned will undergo training on qualified mock-ups while simulating the field conditions and protective clothing restrictions expected to be encountered. This mock-up training is extremely critical in reducing the amount of time required to perform a task, thus saving worker exposure. Where practical, the actual annealing project equipment and simulated environments will be used in order to minimize risk of error, familiarize the crew with equipment features, and to develop ALARA work practices.

1.9.A.3 Exposure Estimates for the Annealing Project

The shielding design and radiation exposure estimates will be based on the dose readings of the reactor vessel and internals packages obtained during the 1995 refueling outage. The shielding thicknesses and material selections are based on component dose rates and the target work area dose rates. The annealing project ALARA engineer will work with personnel to plan the annealing activities described and develop the annealing ALARA plan which includes the radiation dose estimates for the project. Initial annealing projected dose estimates are approximately 200 rem excluding other outage scope tasks and support. A final report with the actual radiation exposure for the completed annealing effort will be prepared.

The ALARA plan will be updated based on the Marble Hill annealing demonstration project experience. Consumers Power's personnel will be observing the Marble Hill annealing demonstration project to assist in improving the application at Palisades. A critique will be held after the annealing demonstration project.

1.9.B Equipment and Procedures to Monitor/Control Airborne Contamination

Airborne radioactive materials will be controlled in accordance with ALARA principles during the annealing process.

The RV internals will be enclosed by shielding while in dry storage. An air mover with a high efficiency particulate air filter (HEPA) and carbon adsorber will be utilized to control any airborne contamination that results from the drying out of the internals.

After the installation of the shielding for the RV internals and the subsequent refueling cavity drain down it will be necessary to perform some limited decontamination primarily in the RV area. It is not practical to fully decontaminate or tent the entire refueling cavity for the annealing process. This decontamination will be of sufficient effectiveness to allow entry into the refueling cavity without the use of respirators. The use of air mover unit(s) with suction hoses set over the edge of the refueling cavity will create an air flow into the cavity. The use of high temperature HEPA filters will be used if the expected temperatures in the refueling cavity could potentially cause a problem for the HEPA filters.

The biological shield supplemental cooling will be forced circulation in the annulus region between the reactor vessel and biological shield. A HEPA filter system will provide protection to and mitigate any potential for an airborne activity event associated with annulus cooling during annealing operations, refer to Section 1.6.A.7.1.

The design of the heat exchanger assembly RV top cover (RVTC) precludes any escape of airborne activity into the containment atmosphere. The RVTC cover plate interface with the RV flange will provide a barrier against any convective air flow from the reactor vessel during annealing. The RVTC penetrations for the piping and instrumentation will be packed with insulation to preclude any escape of airborne activity into containment. The RVTC in conjunction with the RV drainage/purge system, described in Sections 1.6.A.5.3 and 1.9.C.2, will provide adequate protection against any potential airborne activity.

Evaluations will be performed of any openings in the primary coolant system piping such as steam generator bowls during the annealing heat-up, soak and cool-down periods for potential impact on RV purge system. Engineering controls (temporary closures, HEPA filtration and/or ventilation) will be utilized as needed to minimize potential of airborne contamination in the containment building.

1.9.C Precautions for Unique Radiological Issues

Several unique radiological issues have been identified and addressed for the safe completion of the RV annealing, including, the following:

1.9.C.1 Reactor Vessel Internals Removal and Storage

At the completion of the core removal, the core support barrel (CSB) will be removed and set on storage pads at the West end of the refueling cavity. The upper three feet of the CSB will remain out of the water. This situation affects the dose rates during the pre and post annealing inspections, and heat exchanger assembly and testing. Shadow shielding will be established on the west side of the cavity prior to the removal of the CSB as has been utilized during previous refueling outages.

Later, it will be necessary to set the upper guide structure (UGS) into the CSB. This will require the lifting of the UGS from its normal refueling storage position at the east side of the cavity over the fuel handling machine support frame and setting it into the CSB. This lift will require that the lower section of the UGS be removed from the water and all shielding that the water provides will be lost for a short period of time until the UGS is nested back into the CSB. It is planned to lift the UGS into the CSB while minimizing dose to personnel. The use of shielding during the lift and storage of the UGS into the CSB will be necessary. Temporary shadow shielding will be supplied where necessary to maintain dose rates as low as reasonably achievable.

Radiation dose to personnel during the dry lift of the UGS will be minimized by the use of cameras for the positioning of the UGS into the CSB and a water shield with plexiglass viewing port for the crane director and heavy loads personnel. The location for this shielded viewing port may be on top of the steam generator secondary platform (north). This will provide additional shielding from the direct shine imparted from the lower section of the UGS. The crane operator will have temporary shielding for radiation protection during the critical lift. Non-essential personnel will be cleared from containment.

Once the UGS is set, the RV internals will be enclosed and shielded. Cavity water level will be then lowered to the RV flange level. Personnel entry into the refueling cavity will be necessary to perform various tasks, i.e. remove the stud hole plugs, remove the reactor cavity seal, etc. While the RV internals are removed, the dose rate at the cavity work location near the shielded RV internals and the reactor vessel is anticipated to be 500 mrem/hr. The use of temporary shadow shielding or remote tooling will be employed as appropriate during the removal and reinstallation of reactor cavity seal, stud hole plugs, etc. The storage area shielding design and construction will be such to minimize any potential for streaming. Refer to Section 1.3.F for the RV internals shielding enclosure design.

During the annealing process while the RV internals are stored, operating floor dose rates are anticipated to be 60 mrem/hr. Plans will be made to have as much work on the operating floor as practical completed prior to or deferred until the completion of the annealing to reduce the number of personnel affected by the elevated radiation levels. The personnel hatch will be utilized to minimize entries made through the equipment hatch due to both ALARA and personnel safety concerns.

1.9.C.2 Reactor Vessel Draining and Drying

The heat exchanger assembly will be lowered into the cavity and set into the reactor vessel as the water level in the reactor vessel is reduced. Close communications will be maintained during all activities in general and specifically during the reactor vessel drain down. Heat exchanger assembly installation activities will be working in conjunction with the reactor vessel drain down and should a problem develop it will be necessary to start/stop water movement in a timely manner.

A purge system of the reactor vessel and piping will be provided. The purge system will be used during the annealing process to maintain the RV internal pressure at atmospheric. This is required to allow the moisture in the reactor vessel to escape during the start of heatup. This system will passively filter and exhaust to the containment ventilation system during the anneal heat-up, soak and cool down. Refer to Section 1.6.A.5.3 for the RV drainage/purge system design.

1.9.C.3 Heat Exchanger Assembly Installation & Removal

Dose to personnel during the installation and removal of the heat exchanger assembly will be minimized by the use of cameras for the positioning of the heat exchanger assembly into the reactor vessel and a water shield with plexiglass viewing port for the crane director and heavy loads personnel. The location for this shielded viewing port may be on top of the steam generator secondary platform (north). This will also provide additional shielding from the direct shine imparted from the drained reactor vessel and the dose rates near the RV internals storage area.

After setting the heat exchanger assembly onto the RV flange it will be necessary to complete the installation and set-up of the heat exchanger assembly support equipment. During the annealing preparation and reassembly process while the RV internals are removed, the dose rate in the cavity work location near the shielded

RV internals and the RVTC is anticipated to be 500 mrem/hr. The use of temporary shadow shielding or remote tooling will be employed as appropriate during the removal and reinstallation of guide pins and sleeves, etc. Refer to Section 1.6.A.5 for the heat exchanger RVTC and lift rig design.

1.9.C.4 Instrumentation Installation

The experience gained and techniques developed for thermocouple installation in the reactor cavity annulus during the 1995 refueling outage were beneficial in minimizing personnel dose. The use of a full size representative mock up of the working area and simulated conditions during the extensive operator training program facilitated tool development and enhanced task proficiency. This same approach will be utilized in the annealing instrumentation design and preparations for installation in the reactor cavity annulus, primary coolant system piping loop areas and other high dose tasks.

1.9.D Steps to Minimize Radioactive Waste

It is the intent to remove virtually all the equipment which is brought to the Palisades site for the annealing program at the completion of the effort. Much of this equipment will never enter any contamination areas. The exceptions to this include the heat exchanger assembly, ducting, RV dimensional inspection tooling, internals shielding and temporary storage stand components, instrumentation and any miscellaneous equipment brought into containment to support the annealing. This equipment will be decontaminated or shipped off-site as low specific activity (LSA).

1.9.D.1 Radioactive Waste Processing and Shipping

The RV annealing project will result in the generation of radioactive material. With the exception of some minor equipment that will arrive as LSA the majority of the equipment that will be used in the containment building will be arriving clean and upon the completion of the annealing sequence will need to be decontaminated to levels for free release or will have to be shipped off site LSA. It is not practical to assume that equipment decontamination will be completely effective and preparations will be made to ship the majority of equipment as LSA.

The greatest potential for generation of radwaste results from any insulating material brought into the contaminated areas. The use of high temperature materials to wrap the insulation and minimize its potential for contamination is being evaluated. If it is assumed that all of the insulating material used becomes contaminated, a conservative estimate of the volume is 1300 cubic feet, uncompressed. Any supplemental insulation required to protect equipment, components, and structures will be in addition to this volume. Because this material is virtually all fibrous insulation, it is estimated that the compressed volume is 1/3 to 1/5 the uncompressed volume. This material will be removed from site upon completion of the annealing effort for burial.

Radwaste to be left on site will be limited to standard personnel anti-contamination clothing, rags and selected instruments after the annealing process is complete.

1.9.D.2 Radioactive Materials Decontamination

Decontamination of all exposed readily accessible surfaces of equipment, tooling, and shielding will be necessary such that smearable contamination levels are less than 100,000 dpm/100 cm^2 and dose rates are within applicable DOT transportation limits. Whenever possible, the equipment will be made of non-porus material and/or painted prior to arrival as this would assist in the decontamination effort. The heat exchanger will be disassembled and decontaminated. All material being removed from the equipment hatch will be decontaminated or wrapped, with smearable contamination levels on the outside of the wrapping less than 1000 dpm/100 cm^2.

Planning and preparation of decontamination methods and areas will facilitate the expeditious disassembly and removal of equipment from the radiologically controlled areas while minimizing the potential for personnel radiation exposure and contamination.