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Dalwyn R. Davidson
VICE PRESIDENT
SYSTEM ENGINEERING AND CONSTRUCTION

August 31, 1982

Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Perry Nuclear Power Plant
Docket Nos. 50-440; 50-441
SER Open Item - No. 16
Fire Protection for the PGCC System

Dear Mr. Schwencer:

This letter and its attachment is provided in response to your letter dated June 9, 1982, regarding the CO_2 fire protection system for the PGCC in the control rooms. Our responses include the concerns raised in the meeting with the NRC staff held on July 27, 1982, in Bethesda, MD.

We believe that the CO_2 fire suppression system design for the Perry PGCC, described herein, provides for adequate fire protection without unduly compromising the control room habitability for the operators. We have fully considered the concerns expressed by the Advisory Committee on Reactor Safeguards and the NRC staff, performed extensive system evaluations and incorporated system design modifications to provide further assurance that operations of this fire suppression system will not cause any adverse effects or safety concerns nor impair the operators ability to maintain safe shutdown conditions.

We hope that with these responses, the outstanding issue (#5) of CO_2 fire suppression for the PGCC can be resolved. If you have any questions or to aid in your review, we would be willing to meet with the Chemical Engineering Branch (CMEB) staff to discuss these responses. Your prompt attention to this response is appreciated.

Very truly yours,

Dalwyn R. Davidson

Dalwyn R. Davidson
Vice President
System Engineering and Construction

DRD:mb

cc: Jay Silberg, Esq.
John Stefano
Max Gildner
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B002

281.11 Describe the carbon dioxide extinguishing system for the control room, include piping diagrams, wiring diagrams, component drawings. Describe the normal system operation for fire suppression and describe the features between the carbon dioxide storage tanks and the control room. Describe the seismic design of the carbon dioxide system.

RESPONSE

The carbon dioxide system for the Power Generation Control Complex (PGCC) subfloor consists of several components. The major component is the $1\frac{1}{4}$ ton storage tank, which is located outdoors and will contrain 1000 pounds of liquid at 0°F and 300 psi. It is kept at this temperature by means of a refrigeration unit and by insulation around the tank. The remaining system components are responsible for transmitting the carbon dioxide to the hazard. They consist of the piping, master and selector valves, pilot valves, nozzles, electric manual release stations, control panel and associated wiring.

System components are listed for use by Underwriters Laboratories and are installed in accordance with NFPA Standard 12 "Carbon Dioxide Extinguishing Systems."

PGCC CARBON DIOXIDE SYSTEM OPERATION

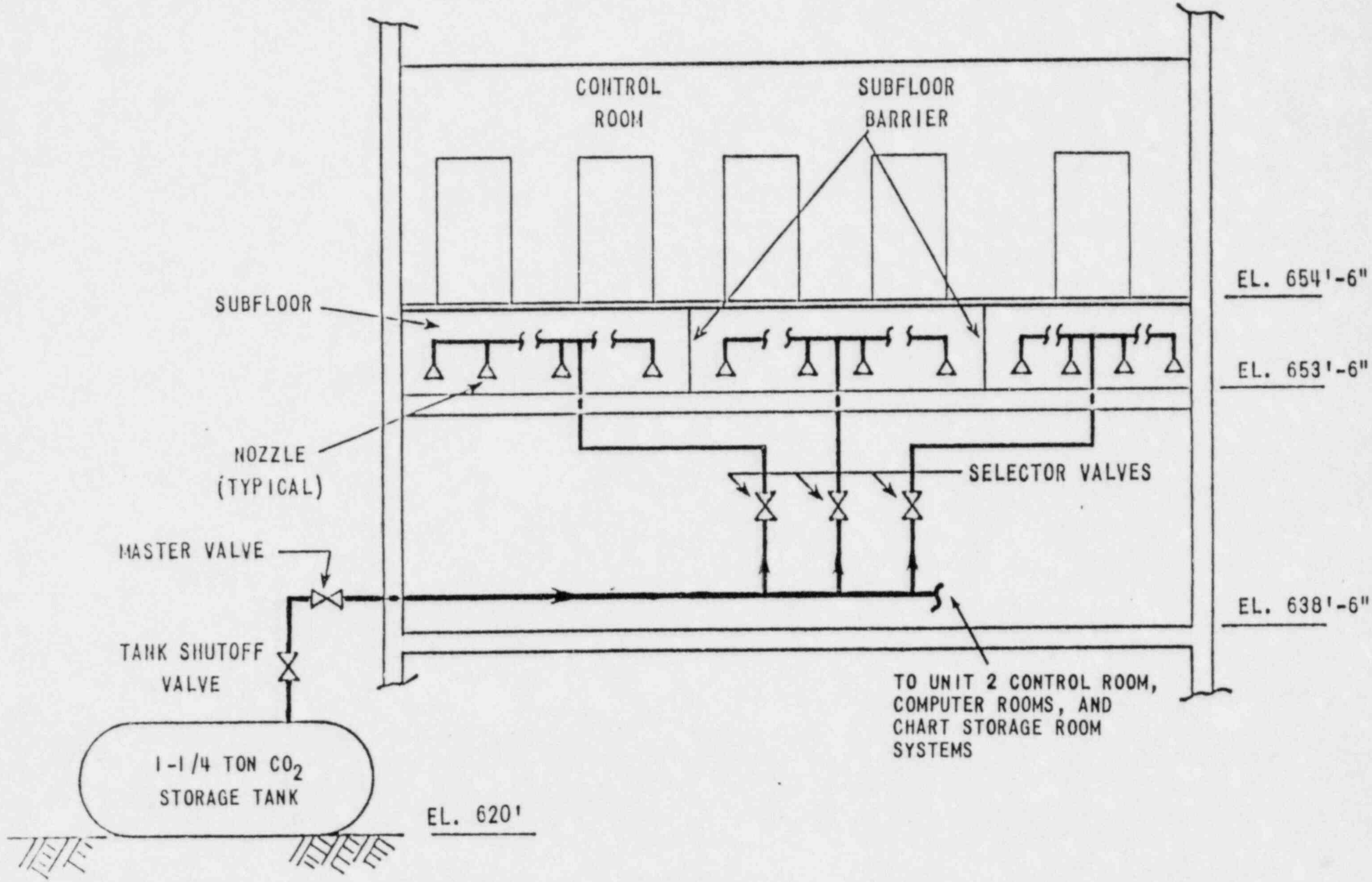
The carbon dioxide systems for the PGCC are operated electrically by thier respective electric manual release stations located in the control rooms. Operation of the electric-manual release station sends a signal back to the local panel which actuated a timed release of carbon dioxide to the hazard area. The design sequence will flow approximately 250 pounds of carbon dioxide based on design concentrations and volume of the protected area. This is a conservative quantity and contains a safety factor of three based on the largest hazard. This design approach is in accordance with requirements of NFPA Standard 12. Should the acceptance tests prove it to be necessary, the timer sequences may be adjusted to ensure that the design concentration is achieved as required.

Both the master valve and the selector valve operate by the same principle, they are both closed until the pilot valve (located adjacent to its associated master or selector valve) is actuated. This actuation of the pilot valve allows the pressure in the piping to enter the piston chamber of the master or selector valve and force the piston into the open position to permit the flow of carbon dioxide through the valve. The piping network consists of several selector valves located downstream of the single master valve. The opening of a particular series of master and selector valves will allow carbon dioxide to flow into an individual hazard area and extinguish the fire.

The system can be operated manually upon loss of power. Upon loss of power, the master valve opens automatically allowing the carbon dioxide to flow to each selector valve. Each selector valve can be operated manually by opening the associated pilot valve lever located in a cabinet with a break glass cover. These cabinets are located in the hallway below the control room. The selector valve will then continuously discharge carbon dioxide until the lever is returned to its original position.

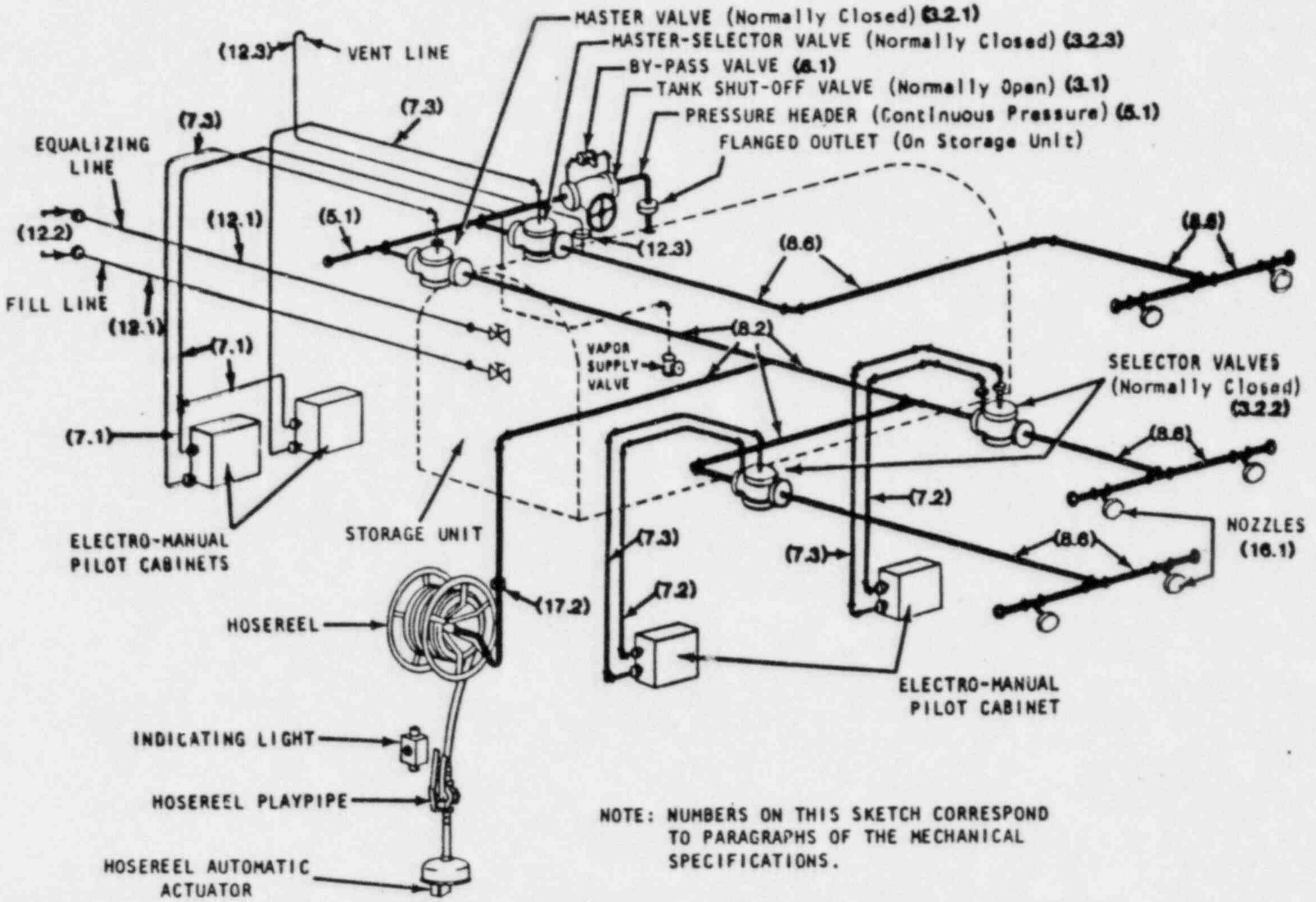
There are no requirements for seismic design for the fire suppression systems. Piping diagrams, wiring diagrams and components are attached.

PGCC SUBFLOOR
CO_2 FIRE EXTINGUISHING SYSTEM

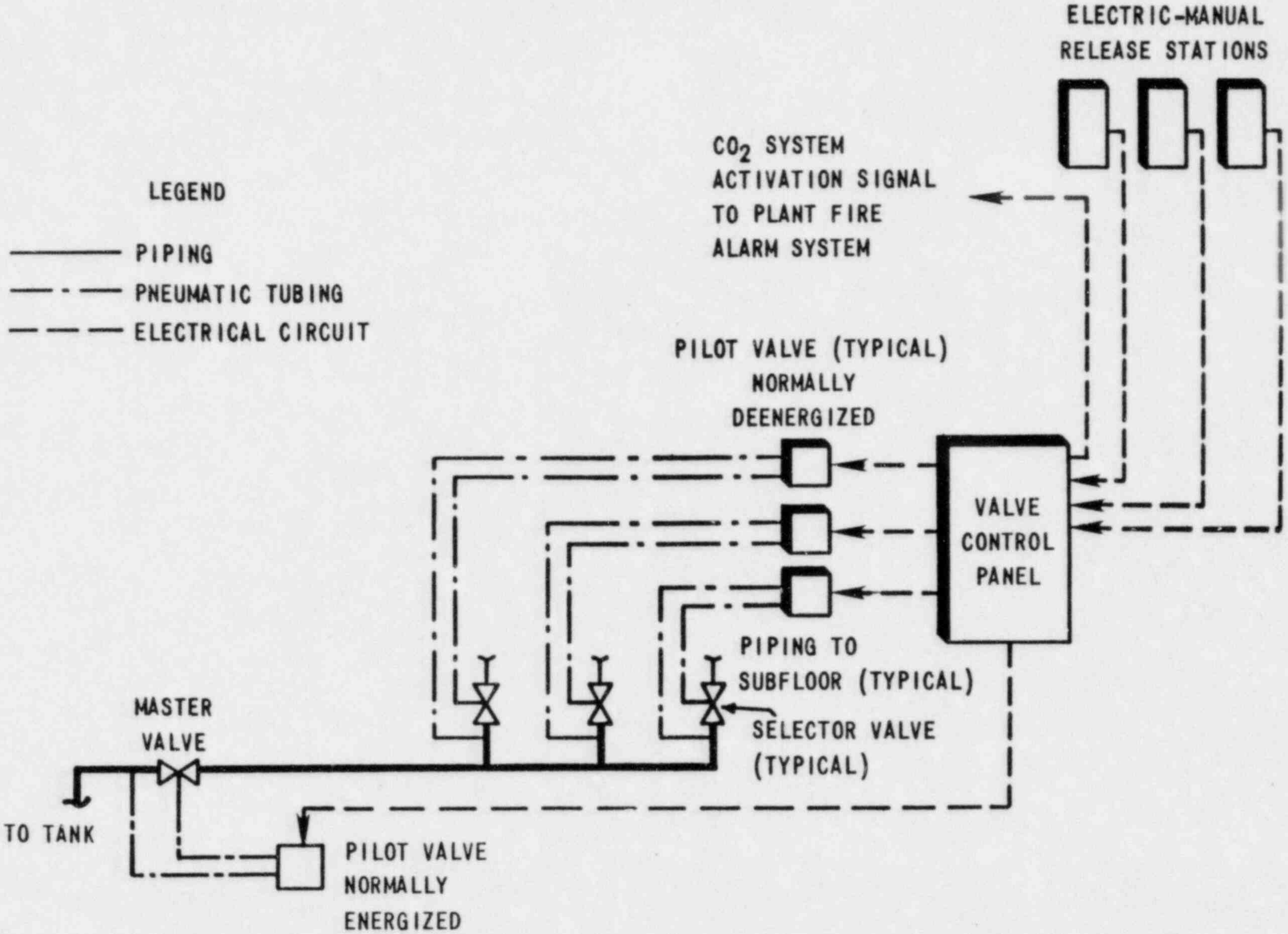


Attachment to 2811.11

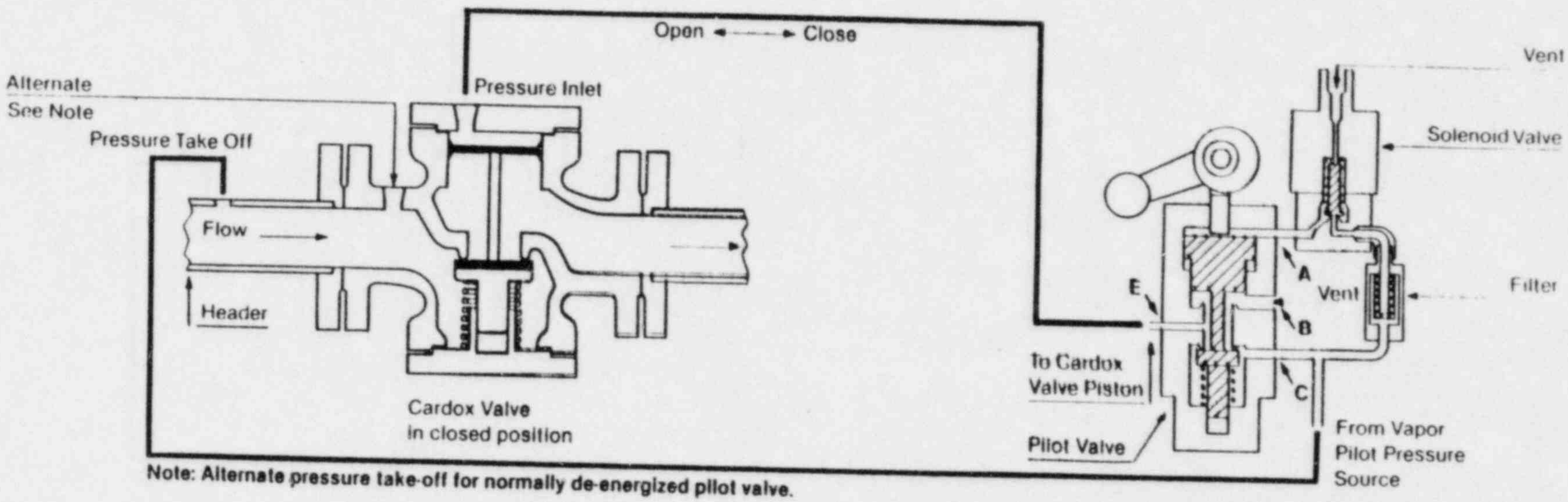
TYPICAL PIPING ARRANGEMENT



CO_2 SYSTEM CONTROLS

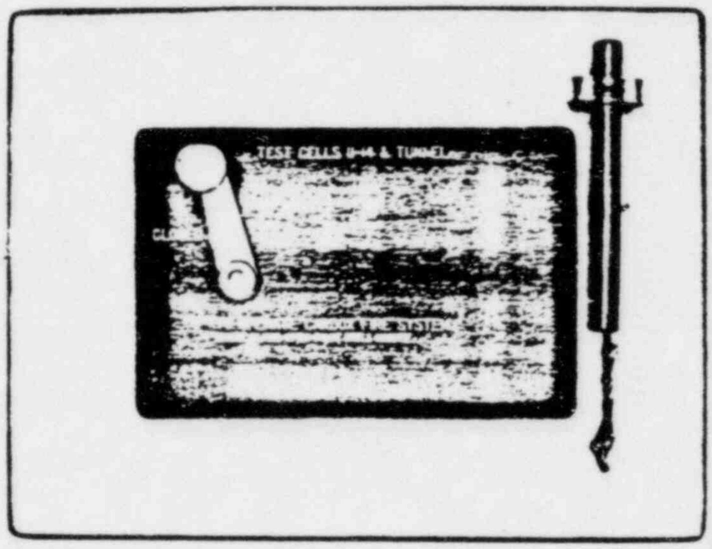


SELECTOR VALVE

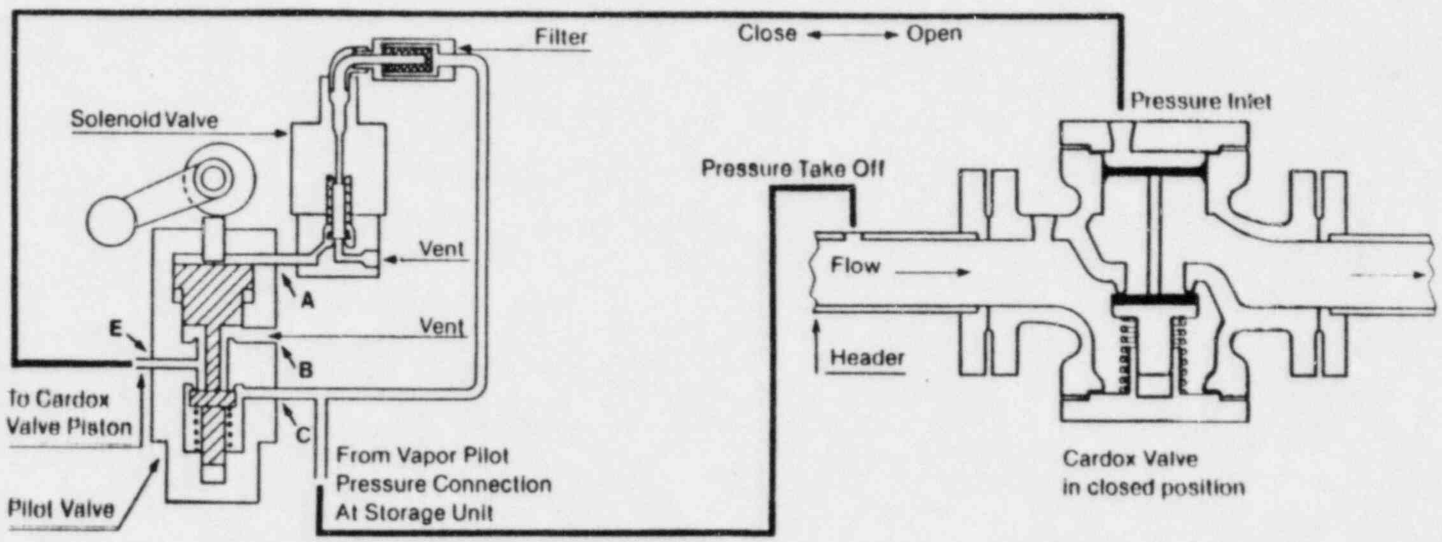


Electro Manual Pilot Valve (Normally De-Energized)

Pilot Valve Cabinet



MASTER VALVE



Electro Manual Pilot Valve (Normally Energized)

PUSHBUTTON STATIONS

Positive Manual-Electric Operation

281.12 Provide a description of the control room oxygen content monitors. Describe how they function to detect the presence of carbon dioxide and state the response time of the monitors.

RESPONSE

Each control room is provided with three ENMET Corporation, ISA-30 oxygen monitors. There is one monitor in each fire suppression area at columns CCB/02, CCB/03 and CCB/04. Each oxygen monitor consists of a monitor-alarm unit and remote sensing unit. The monitor-alarm unit, factory set to alarm at 19.5% oxygen (21% being normal O_2 in air), is mounted approximately 12" above the floor where, following discharge, the carbon dioxide concentration would be the greatest and oxygen concentration would be the least.

The sensor unit detects oxygen in the atmosphere by means of a micro-fuel cell which is essentially an oxygen powered battery. Like a battery, the cell is componsed of two electrodes and an electrolyte. Oxygen in the atmosphere being sampled, diffuses through a Teflon membrane into the cell. An oxidation-reduction reaction takes place with the electrodes and electrolyte. This produces an electrical current when connected to an external load, such as the alarm-monitor unit.

The output of the cell is directly related to the amount of oxygen in the atmosphere being sampled. In the absence of oxygen there is essentially zero output from the cell. In the presence of 100% oxygen there is a maximum output of the cell, with a very linear characteristic curve in between 0 and 100%.

The alarm-monitor unit takes the output of the fuel cell, conditions it, and uses it to operate the alarms, meters etc., so as to function as a complete, self-contained unit.

Carbon dioxide, when injected into a room as a liquid expands to approximately 9 cubic feet per pound (NFPA 12, A-2-1). As it expands, air and carbon dioxide are forced out of the openings in the room so that the pressure in the room remains in equilibrium. The highest concentration of carbon dioxide will occur when air, consisting of oxygen and nitrogen, alone is displaced from the room, and no carbon dioxide is lost. The increase in carbon dioxide concentration by volume in the room would reduce the oxygen concentration by a like amount. As the oxygen level changes it is reflected in the reading on the oxygen monitors. Thus, the carbon dioxide level in the room can be monitored.

The response time of the oxygen monitor is a function of the oxygen concentration in the room, the lower the concentration the faster it will alarm. A concentration of 10% oxygen (dangerous) would send the unit into alarm in a few seconds while any oxygen concentration of 19% (no effect) would take 30 to 40 seconds. Because carbon dioxide is heavier than air, any CO_2 leakage into the control room will settle out at floor level. The carbon dioxide level will tend to build up from the floor over a period of time, operators will be alerted by the oxygen monitors in sufficient time to take the appropriate action.

281.13 Describe the effect of a carbon dioxide discharge on the instrumentation and electronic components, e.g., spurious signals or component failures. Discuss how these effects affect plant operation and safe shutdown capability.

RESPONSE

Carbon dioxide wher discharged produces two effects which could result in spurious signals in electronic equipment. The first effect is produced when the low temperature liquid CO_2 impinges directly upon the electronic components. The second effect is the electrostatic charges which are produced from the discharge of liquid carbon dioxide under certain conditions. These charges could, if allowed to build up, produce sparks and possibly damage sensitive equipment.

The effects listed above should not pose a problem to plant operation or prevent the safe shutdown of the plant. Nozzles in the PGCC subfloor are of metal construction and connected to metal floor modules which are all tied together and connected to plant ground (per NEDO-10466) which will dissipate any electrostatic charges which may be produced. The placement of the nozzles will prevent spurious signals caused by the low temperature. They are located in the PGCC subfloor cable ducts, and do not direct the liquid carbon dioxide on or near any of the electrical equipment components. Any of the carbon dioxide that gets in the electrical cabinets will be in the gaseous state which will have no affect on the equipment or its output, since in this state CO_2 has little cooling ability.

281.14 Discuss the effect of an inadvertant discharge and leakage of carbon dioxide in the control room on operators. Discuss the acceptability of 3-4 percent carbon dioxide concentration into the control room in light of the concentration limit of 1 percent stated in Regulatory Guide 1.78, "Assumption for Evaluating the Habitability of a Nuclear Power Plant Control Room during a Postulated Hazardous Chemical Release."

RESPONSE

Inadvertant discharge or leakage of carbon dioxide into the control room are very low probability events given the CO_2 system design. The system is manually initiated, to prevent inadvertant discharge from spurious detection signals. Leakage is not a problem since the system is only pressurized up to the master valve.

Operation of the single largest PGCC subfloor carbon dioxide system will flow 250 pounds of carbon dioxide in a normal discharge cycle. This quantity is quite conservative and includes a safety factor of three times the quantity required for extinguishment. This system, if accidently discharged would result in a control room atmosphere containing less than 1% carbon dioxide (as required by regulatory guide 1.78) based on uniform mixing of the carbon dioxide and assuming no loss of carbon dioxide through leaks or through the HVAC system.

Because of the design of PGCC subfloor modules, numerous nozzles were required to provide uniform distribution of carbon dioxide in the subfloor. They are oriented so that the carbon dioxide is dispersed horizontally down the longitudinal channels. If there were any leakage (to the room through the cabinet or because of removed floor panels) the carbon dioxide which would be released into the control room would not mix uniformly with the atmosphere; instead it would naturally tend to stay near the sub-floor, because it is 1.5 times as heavy as air. This would produce the same overall concentration, but be less hazardous to personnel since there would be only a small highly concentrated layer near the floor, and little concentration elsewhere in the room.

281.15 Discuss the effect on the control room of a continuous discharge of carbon dioxide upon the failure of the selector valve to close after it has been activated.

RESPONSE

To effect a continuous discharge, both the master and selector valves would have to fail. The possible effects on the control room if both the master and selector valve fail to close after operation are also discussed separately in the other responses. Any spurious effects which could result from a continuous discharge are discussed in the response to question 281.13. The possibility of overpressurization in the PGCC subfloor is discussed in question 281.16.

Under a continuous discharge, a concentrated layer of carbon dioxide would continue to spread across the entire floor of the PGCC and increase in depth until action was taken to halt the flow. Operators will be alerted to the problem almost immediately by the discharge alarms and/or oxygen monitor-alarm units, and be able to take steps to shut the system down.

The amount of CO_2 which will be released by one design discharge is less than that required to produce a 1% concentration in the control room. Any set of events which could produce a continuous discharge of CO_2 would only produce a maximum concentration of 5.4% (assuming the entire tank discharged). This would be sufficient to cause the oxygen monitors to alarm, which in turn will alert operators to take the appropriate action such as donning air packs. At this concentration there will not be any effects on the operators, since the oxygen concentration would still be greater than 19%.

The only areas that the 1¼ ton storage tank will be designed to protect are the PGCC subfloor areas, the computer room subfloors and the chart storage room. The amount of CO_2 stored in the tank will be restricted to 1000 lbs. This is enough to provide two discharges for the largest hazard. After discharge tests are performed for each of the systems, it is believed that less than 1000 lbs of CO_2 will be needed for two discharges in the largest hazard. Therefore, for calculation purposes of determining CO_2 concentration in the control room, this number is considered conservative.

The 5.4% concentration is a conservative number because of several factors. All carbon dioxide in the tank will not be discharged to the room even under a continuous discharge; additional carbon dioxide will remain in the piping and in the subfloor section in which the discharge took place. This concentration is based on the assumption that the carbon dioxide will be evenly mixed throughout the entire control room. This is conservative since carbon dioxide is heavier than air and the concentration of the carbon dioxide which does enter the control room will not be uniformly distributed. The majority of the carbon dioxide will form a highly concentrated layer near the floor and relatively little will mix with the control room atmosphere. This concentrated layer is what will cause the oxygen monitors to alarm, and alert the operator to action.

281.16 Discuss the resulting pressures and potential for lifting floor panels and the affects on instrument cases due to pressure buildup within the PGCC underfloor closed spaces. State the pressures that will be reached in the PGCC underfloor spaces after a single and also continous discharge of carbon dioxide.

RESPONSE

A calculation was performed to determine the effects of CO_2 discharge pressures in the PGCC subfloor. Maximum differential pressures produced following a continuous discharge were calculated to evaluate if that pressure could lift floor panels or affect equipment. The subfloor CO_2 pressurization analysis assumed a maximum flow rate per module of 20.6 lb. m/min. with a vent area of .1 ft^2 per module.

Based on the flow path and the area of the lateral and longitudinal raceways and the typical values of cable fill in those raceways, the differential pressure within the floor section modules for a continuous CO_2 discharge is expected to be approximately 0.025 psid. This value is less then the deadweight of the floor panels of 0.05 psi, therefore, the floor panels will not lift during a CO_2 discharge. In addition, the floor panels are held down by a quick release latch mechanism which will provide additional holding capacity. The added resistance provided by the latching mechanism was not used in the overpressurization calculations since the weight of the panels is sufficient to keep them in place during a carbon dioxide discharge.

An additional concern was raised in the July 27 meeting regarding the need to seal the control room panels and equipment cabinents from the subfloor area for housekeeping purposes. Floor seals are not required for the CO_2 system as presently configured.

281.17 Provide test data which verifies that carbon dioxide is capable of extinguishing deep-seated fires.

RESPONSE

As stated in NFPA-12, paragraph 2-2.3, deep-seated fires can be extinguished by a total flooding carbon dioxide system. The concentration must be maintained until the surface fire is extinguished as well as the time it takes for the material to cool to a point where reignition cannot take place. The optimum concentrations and the minimum soak holding times for deep seated fires have not been established in any one specific set of tests, but, have been developed over a period of years of practical test work. These values, when properly applied, have proved effective over the years in extinguishing deep seated fires, with carbon dioxide.

The flooding factors used for the PGCC suppression system design are based on a 34% concentration of carbon dioxide in accordance with the requirements of NFPA 12 for surface fire hazards. This concentration for a subfloor fire is consistent with the discussions with the CMEB staff in our July 27, 1982 meeting and the results of the General Electric PGCC fire tests (NEDO-10466-A), which demonstrated that the PGCC design configuration prevents a serious fire from developing by restricting oxygen availability. The staff position at the Perry ACRS Full Committee meeting on July 8, 1982 (p.51), stated a 5% Halon concentration (surface hazard concentration) was adequate to extinguish a fire in the PGCC subfloor. Finally, Perry utilizes Tefzel cable and has a fire detection system in the subfloor section which will provide early warning. This allows the fire to be extinguished before it becomes deep seated.

281.18 Provide a detailed cost breakdown of the additional $2,000,000 you indicate it will cost to design and install a Halon 1301 fire suppression system to replace the present CO_2 system.

RESPONSE

The preliminary cost estimate provided in our letter is based on scrapping our existing CO_2 system, which is presently installed, and installing the Halon system design described in the NEDO-10466-A. This would involve the individual sealing of all floor modules, and a separate Halon system for each floor module. Each Halon system would have its own storage bottles, piping, nozzles, detectors and control panel. Each would be designed to provide a 20% Halon concentration and hold time of 20 minutes. Cost considerations included two units, completely replacing piping and equipment already installed, extensive sealing requirements and additional components and controls for the Halon system. A detail of these costs is provided in attachment I.

ATTACHMENT 1

PROVIDING AN INDIVIDUAL HALON SYSTEM FOR EACH MODULE AND INDIVIDUAL STORAGE CYCLINDERS FOR UNIT 1 ENTIRELY

Item	Mat. $	Install & Labor $	Eng. & Design $	Total $
Pipe, Ftgs., Valves, Hgrs., Equip., Panels, Halon Gas	384,000	185,000	56,000	625,000
Removal of CO_2 Systems	- -	45,000	- -	45,000
Additional Hardwire, #16 Ga., STP, 1900 LF, Inc. 96 Junction Boxes	6,500	34,500	45,000	86,000
6 Core Drillings, Floor El. 644'-0"	- -	4,000	- -	4,000
Silicon Foam Seal, Ends of 20 Modules at Termination Cabinents, 2" Thk. x 12" W 20'-0" Lg., 4 CF/Module				28,000
Seal of Lateral Duct at Annunciator Cabinents and Between Modules as Well as End Sealing of Transition Duct at Modules				100,000
Fire Protection Eng.	- -	- -	9,000	9,000
Subtotal Cost				897,000
Contingency @ 10%				89,000
Total Cost Unit 1 (1982 Price)				986,000
Total Cost Both Units				$ 1,972,000