June 21, 1991

Docket No. 50-255

Mr. Gerald B. Slade
Plant General Manager
Palisades Plant
Consumers Power Company
27780 Blue Star Memorial Highway
Covert, Michigan 49043

Dear Mr. Slade:

SUBJECT: APPENDIX R EXEMPTION FOR PALISADES PLANT (TAC NO. 71852)

Consumers Power Company letter dated October 4, 1985, supplemented by letter dated August 8, 1990, requested an exemption from the separation criteria of 10 CFR Part 50, Appendix R, Section III.G.2.d, for the pressure and level transmitters in the Containment Air Room. This request would exempt certain Containment Air Room instrumentation from the minimum 20-foot separation criteria for redundant instrumentation. Consumers Power Company analyzed the probability and the effects of a fire in the Containment Air Room, and stated that the underlying purpose of Appendix R is met when considering the particular design and circumstances of the room.

The staff has reviewed the information supplied by Consumers Power Company and has independently assessed the layout and combustible loading in the Containment Air Room. The staff has determined that Consumers Power Company has adequately addressed the potential for and the impact of a fire in the Containment Air Room, and grants the Exemption request to 10 CFR Part 50, Appendix R, Section III.G.2.d for the Containment Air Room.

A copy of the Exemption is being forwarded to the Office of the Federal Register for publication.

Sincerely,

original signed by

L. B. Marsh, Director
Project Directorate III-1
Division of Reactor Projects III/IV/V
Office of Nuclear Reactor Regulation

Enclosure:
Exemption

cc w/enclosure:
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AD/PD31:DRP	D/PD31:DRP345				
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CP-1

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5/7 /91	5/29/91	5/29/91	6/4/91	6/5/91

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

June 21, 1991

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Division of Reactor Projects III/IV/V
Office of Nuclear Reactor Regulation

Enclosure:
Exemption

cc w/enclosure:
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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
CONSUMERS POWER COMPANY	)	Docket No. 50-255
	)	
(Palisades Plant)	)	

EXEMPTION

I.

The Consumers Power Company, (the licensee) is the holder of Facility Operating License No. DPR-20, which authorizes operation of the Palisades Plant at a steady-state power level not in excess of 2530 megawatts thermal. The facility is a pressurized water reactor located at the licensee's site in Covert Township, Van Buren County, Michigan. The licensee provides, among other things, that it is subject to all rules, regulations, and orders of the Nuclear Regulatory Commission (the Commission) now or hereafter in effect.

II.

On November 18, 1980, the Commission published a revised Section 10 CFR 50.48 and a new Appendix R to 10 CFR Part 50 regarding fire protection features of nuclear power plants (45 FR 76602). The revised Section 50.48 and Appendix R became effective on February 17, 1981. Section III of Appendix R contains 15 subsections, lettered A through O, each of which specifies requirements for a particular aspect of the fire protection features at a nuclear power plant. One of these 15 subsections, III.G, is the subject of this exemption request. Specifically, Subsection III.G.2.c and d provides that, "...where cables or equipment, including associated non-safety circuits that could prevent

operation or cause maloperation due to hot shorts, open circuits, or shorts to ground, of redundant trains of systems necessary to achieve and maintain hot shutdown conditions are located within the same fire area...inside noninerted containments..., one of the following means of ensuring that one of the redundant trains is free of fire damage shall be provided:

d. Separation of cables and equipment and associated non-safety circuits of redundant trains by a horizontal distance of more than 20 feet with no intervening combustibles or fire hazards;"

III.

Consumers Power Company's (CPCo) letter dated October 4, 1985, requested an exemption from the separation criteria of 10 CFR Part 50, Appendix R, Section III.G.2.d, for the pressure and level transmitters in the Containment Air Room. Following staff review and deliberations with CPCo, the licensee submitted a January 11, 1989, letter proposing Appendix R compliance for the Containment Air Room using post-fire safe shutdown methodology similar to that methodology which could be used after a Main Steam Line Break (MSLB) inside containment. If used as an Appendix R compliance strategy, this methodology would have required exemptions from two other Appendix R criteria (III.G.3 and III.L.2).

After further review, the staff determined that neither the October 4, 1985, nor the January 11, 1989, exemption request contained enough substantiation to allow an exemption. CPCo then decided to install fixed suppression to bring the area into compliance with Section III.G.2, committing to install the suppression system during the 1990 Refueling Outage. During the engineering and design phase of the project, questions arose concerning the

potential for the suppression system actuating during several postulated transients, resulting in the potential for large volumes of water being sprayed into the containment air room and draining to the containment sump. Intricate shutoff controls of the fire water system were evaluated, resulting in significantly higher project costs than previously estimated. Following extensive discussions between the licensee and the staff, it was decided that if CPCo further analyzed the effect of a fire using state-of-the-art methods and could conclude that a credible worst-case fire would not prevent post-fire safe shutdown, the staff would reevaluate CPCo's October 4, 1985, exemption request.

CPCo reanalyzed the effect of a Containment Air Room using methodology approved by the National Institute of Standards and Technology. This reanalysis was submitted to the staff by CPCo letter dated August 8, 1990, in support of the original request that the Containment Air Room redundant instrumentation be exempted from the minimum 20-foot separation criteria of 10 CFR Part 50, Appendix R, Section III.G.2. This request was made under the provisions of 10 CFR 50.12(a)(2)(ii) in that application of the requirements of Appendix R, Section III.G.2.d, is not necessary to achieve the underlying purpose of the rule when considering the particular design and circumstances of the Containment Air Room.

IV.

The purpose of Section III.G.2 to Appendix R is to ensure that redundant components of a safety system, required to achieve and maintain post-fire hot shutdown, are protected in such a way that at least one such component will remain free of damage which could prevent the completion of the safety

function. One such means of protecting these redundant safety components is provided for in Section III.G.2.d, that is, separate the components by at least 20 feet without intervening combustibles or fire hazards. The following discussion summarizes Consumers Power Company's basis for an exemption from the requirements of Section III.G.2.d for the Containment Air Room.

Containment Air Room

The Containment Air room is an oddly shaped room on the lowest level of containment (590' elevation). The room has a 13½ foot high ceiling, extending up to 34 feet in the vicinity of the metal staircase in the northeast corner of the room. Total room volume is approximately 14,420 cubic feet. The walls, floor, and ceiling are constructed of poured reinforced concrete. There are two unrated, but substantial, steel doors in the room that lead to other areas of containment. The room is well ventilated by natural circulation supplemented by forced circulation. Fire protection equipment maintained operable in the room includes three smoke detectors which have automatic control room alarm functions, a fire hose at the top of the stairs, adjacent to the personnel air lock, and two fire extinguishers.

The room is essentially the containment electrical penetration room, which contains process monitoring instrumentation for the pressurizer and steam generators. The instruments of concern are located on the east wall opposite the 480V pressurizer heater load centers and are listed below:

Equipment Under Consideration

Steam Generator "A" Pressure (PT-0751 A, B, C, and D); Steam Generator "B" Pressure (PT-0752 A, B, C, and D), Steam Generator "A" Level (LT-0751 A, B, C, and D; LT-0757 A and B; LT-701; LT-702) Steam Generator "B" Level (LT-0752 A, B, C, and D; LT-0758 A and B; LT-703; LT-704) Pressurizer Level (LT-0101 A, B;

LT-0102; LT-0103) Pressurizer Pressure (PT-0101 A, B; PT-0102 A, B, C, and D, PT-0104 A and B; PT-0105 A and B).

The licensee's original exemption request, dated October 4, 1985, listed five additional instruments that were not discussed in the licensee's most recent evaluation of the effects of a worst case fire in the Containment Air Room. The staff discussed this discrepancy with the licensee. Pressurizer level instruments LT-0102 A, B, C, and D were removed by modification in 1987, leaving two sets of redundant indication; LT-0101 A and B, and LT-0102 and 0103. Also, according to the licensee, pressurizer level instrument LT-0105 should not have been referenced in the original submittal since it is a non-environmentally qualified instrument used primarily for mid-loop indication and not necessary for safe shutdown.

Assumptions

Consumers Power Company fire protection engineers based their reanalysis of a Containment Air Room Fire on the following assumptions:

1. A cable tray fire is the only type of fire that needs to be considered for the following reasons:

   Access to this area is severely limited during operations. Personnel entering containment dress and undress outside of containment. There are no "step-off" pads and no discarded anti-contamination clothing inside of containment during operation. Everything is stored or discarded outside of containment when the plant is operating.

   Strict administrative controls dictate that all loose material be removed from containment prior to start-up to prevent containment sump plugging and transient fires.

Since controls are in place to remove the risk of transient fires during operation and the only major fixed combustible is cable, a cable tray fire is the only fire that needs to be considered.

2. Fires that occur during plant operations are considered worst case since that is the time the instruments would be needed to safely shut down.
3. A worst-case fire involves the cables in one channel of cable trays only. By the use of cable tray fire stops and other protective features and controls, it can be assumed that one train of instrumentation circuits will be free of fire damage for anticipated fires inside containment. This position is documented in an Appendix R exemption request dated July 23, 1985.
4. Narrow range (0-100%) steam generator level indication is sufficient for safe shutdown. This is acceptable because a loss-of-coolant accident (LOCA) or main steam line break (MSLB) is not considered to be occurring at the same time as a fire.
5. Level indication in one steam generator is sufficient for safe shutdown. (Again, because a LOCA or MSLB is not occurring simultaneously.)

The validity of these assumptions is discussed in Section V.

Likelihood and Type of a Potential Fire

The licensee's fire protection engineers researched self-initiated cable tray fires and found that for #12 AWG cables currents of from 120 to 130 amperes were required to induce open flaming. In full-scale testing, the intense period of fire activity persisted for between 40 and 240 seconds after

which rapid reduction to self-extinguishment of the fire was observed. In no case involving electrically initiated fire in rated low flame spread cables was propagation of the fire beyond the tray of fire origin observed.

In other tests conducted, locked rotor amperes (LRA) were applied to test cables to judge their impact on target cables. One of the design criteria for the test program was that the worst-case electrically induced fault would be on a motor feeder circuit, because the majority of large loads, and the more potentially damaging ones, are motor loads. The most credible worst-case fault would be the sustained application of LRA to the test cables. This type of fault was selected because it is a typical condition, it can be postulated as having an extended duration, and its magnitude is large enough to cause damage to the fault cable and adjacent cables. To select the test cable, typical plant cable feeder sizes were tabulated along with the corresponding maximum LRA for each feeder and the corresponding motor pigtail conductor size. Based on preliminary screening test data, a relationship was developed between LRA duration and fusing (open circuit) of the motor pigtail conductors. Using this relationship in conjunction with data obtained from the screening tests, the worst-case fault cable was selected and was used in the subsequent configuration tests. The selected worst-case cable was the cable with the highest temperature at the time its corresponding motor pigtails fused (open circuited).

The tests demonstrated that when ignition occurred, the fire never propagated to an adjacent target cable even when both were touching. The fires that occurred were self-extinguishing when the electrical fault was interrupted. The amount of smoke created by the overload was extremely dense and would be readily detected by the plant fire detection system.

Although, the most likely type of fire would be a small self-extinguishing fire that would generate a lot of smoke, CPCo personnel assumed a much worse fire for the purpose of analysis (one which would be most likely initiated by an external source). Using accepted heat release equations, the fire of analysis burns for fifteen minutes and generates 2674.1 KW of heat.

This fire of analysis represents over 68 feet of 12-inch wide cable tray with 50% fill. The assumed total volume of combustibles for this fire of analysis exceeds the volume of either right or left channel trays in the Containment Air Room. This is considered a worst-case fire. A slower burning fire is more likely, however, a slower fire would not produce as high a temperature as a faster fire.

The worst-case fire data was then used in a fire modeling program called Hazard I developed by the National Institute of Standards and Technology. Two models were run; the first placing the fire in the center of the Containment Air Room, the second, against a wall near the stairway at a height of 9.8 feet. The Hazard I model separates the air in the rooms into upper and lower thermal layers. In the main part of the room, equipment below elevation 601'4" will be in the cooler part of the room. In the stairway, equipment below elevation 607' will be in the cooler part of the room.

The majority of instruments in the Containment Air Room are environmentally qualified (EQ) and will be exposed to the lower thermal layers in the event of a fire in the room. (The four instruments not environmentally qualified will be discussed in Section V.) Temperatures seen in the lower layers of a fire in the room and stairway (126°F) are significantly lower than

the temperature the EQ instruments are qualified for (408°F). Therefore, the licensee maintains that the instruments will operate satisfactorily in the event of a worst-case fire in the room.

Finally, after assuming the type and location of a worst-case fire in the Containment Air Room, the licensee assessed the impact this fire would have on instruments the operators would need to safely shutdown the plant. Two instrument matrices were developed. The first lists right and left channel instruments, showing the distance between the redundant instrumentation. The second matrix shows instrument elevation relative to the hot thermal layer of gases that will be experienced in a worst-case fire. The licensee reviewed the effects of a fire initiating in either the right or left channel cable trays, and the resulting impact on redundant instrumentation in the room, and concluded that sufficient instrumentation is available to the operators to safely shut down the plant. The licensee's discussion of various fire scenarios has been incorporated in the staff's evaluation in the following section.

V.

The staff has reviewed the information supplied by the licensee and has had numerous discussions with Consumers Power Company concerning the design and circumstances of the Containment Air Room. Additionally, staff personnel have toured the Containment Air Room on several occasions, noting instrument and cable tray locations and independently assessing the combustible loading in the room.

The staff agrees with the licensee's determination that a cable tray fire is the most probable fire considering the design of the room and the strict

administrative controls preventing the local storage of loose combustibles. Written guidance in three procedures call for the removal of transient combustibles from safety-related areas such as the Containment Air Room. An Administrative Procedure on plant housekeeping requires a thorough containment inspection for unnecessary debris and material which could pose a fire threat. Particular attention is drawn to the 590' level of containment (the Containment Air Room Level).

The staff also accepts the licensee's assumption that a worst-case fire involves one channel of cable trays during plant operation. A previous Appendix R exemption (dated July 23, 1985) recognizes the use of cable tray fire stops and other protective features, thereby assuming that one train of instrumentation circuits will be free of fire damage for anticipated fires in containment. Instrumentation in the Containment Air Room is necessary to safely shut down the plant. Therefore, a fire during plant operation is considered to be worst case, even though transient combustible material control is much tighter during plant operation than in an outage situation where room access and maintenance (and, therefore, combustible material) would be more prevalent.

The likelihood of a fire in the Containment Air Room during operation is remote. External sources of ignition are unlikely due to:

1. The administrative controls covering combustible material in safety-related spaces, and
2. The controls over access to containment during operation (e.g., access is limited, material is discarded outside containment, and flammable liquids are not brought into containment).

Therefore, the staff concurs with the licensee that the most probable fire would be a self-initiated cable tray fire.

Consumers Power Company analyzed a cable tray fire that lasted for fifteen minutes and which consumed 11.4 cubic feet of cable. There are two cable trays present in the room. The right tray contains the larger total volume of cable at 7.62 cubic feet. The licensee, therefore, conservatively input a larger combustible loading into the fire model (approximately 150 percent of the combustible material present in the larger tray). Also, although a slower burning fire is considered more likely due to the nature of self-initiated cable tray fire scenarios, the licensee was conservative in assuming a relatively fast burning fire for the fire of analysis. A slower fire would not produce as high upper and lower room air temperatures as this model provided and, therefore, would not have as significant an impact on room instrumentation. This relatively fast burning fire is, therefore, considered the worst-case fire for the room.

The Hazard I model does not provide a totally realistic assessment of air temperatures in a room during a fire. The model basically separates the room into upper layer temperatures ("Hot Gases") and lower layer temperatures ("Cooler Gases"). However, the model, (which is approved by the National Institute of Standards and Technology) is a useful tool in determining operability of instruments remaining in the "cool gas" region.

The lower layer height ("cool gas region") starts at approximately the 601.5' elevation in the Containment Air Room and the 607' elevation in the adjoining stairway. These elevations correspond to approximately two feet below the ceiling elevation in the main room and seventeen feet below ceiling level in the stairway region. Lower layer air temperatures in both regions are

calculated to be below 56°C (132.8°F) for the duration of the fire (as compared to upper layer air temperatures in the 400°C range (approximately 750°F)).

The licensee chose a location for the fire of analysis to be at a height of 9.8 feet in the center of the room. Staff review of drawings supplied by the licensee show the lower cable tray at a height of approximately 8.4 feet, or 1.4 feet below the assumed fire location. The licensee was questioned concerning this apparent non-conservative selection of fire location. Consumers Power Company responded that a fire location roughly corresponding to the actual cable tray locations was chosen. A value of 3 meters (9.8 feet) was selected simply because it was a round number. The Hazard I model was re-run using the more conservative fire height corresponding to the lower instrument tray. The reanalysis had minor affects on the thermal layer heights and temperatures. The upper layer region was expanded by five inches. This lowering of the "Hot Gas" region did not envelope additional instrumentation; the majority of instruments are still located approximately two feet below the upper layer "Hot Gas" region. Room air temperatures experienced a "trade-off" as fire location was lowered. Upper air temperature decreased approximately 50°F and lower air temperature increased 11°F. This reanalysis, and its effect on fire parameters, is acceptable.

The safety-related instruments in the Containment Air Room were reviewed to verify adequate instrumentation would be available to safely shut down the plant. Not only was instrument elevation reviewed relative to the "Hot Gas" region, but also process tubing and cabling elevations. All but four of the thirty-eight instruments located in the room are EQ, which means they have been tested to operate properly in temperatures up to 408°F. The temperatures

calculated for the lower air layer are significantly lower than such accident scenario temperatures; therefore, it is appropriate to assume instrument operability for lower air layer instruments.

The licensee states that the four instruments which are not EQ are qualified for temperatures up to 160°F. This rating, although much lower than the EQ rated instrumentation, still provides adequate margin to the highest temperatures seen in the lower air layer. Additionally, all instruments have steel noncombustible cases surrounding them, which to a certain degree act as radiant energy shields. All wiring is run in conduit from cable trays. The cases and conduit assist in blocking the radiant energy from the fire to the instrument of concern.

The following discussion addresses the operator's ability to safely shut down the plant with available instrumentation in the case of either a right or left cable fire. Instruments that have conduit, process tubing, or the instruments themselves located in the "Hot Gas" region are, in general, not credited for operation.

Steam Generator Pressure

For a right channel cable tray fire, left channel steam generator pressure instruments are available for both steam generators (PT-0751C and PT-0752C).

For a left channel cable tray fire, PT-0751D and its cables are located in the hot layer. However, the corresponding instrument for Steam Generator B (PT-0752D) is not affected. Since steam generator pressure would be the same in both steam generators, PT-0752D can be used as sufficient indication for steam generator pressure.

Steam Generator Level

For a right channel cable tray fire, left channel steam generator level instruments are available for both steam generators (LT-0751C and LT-0752C). Wide range steam generator level is available using LT-0757A and LT-0758A.

For a left channel cable tray fire, the cables for LT-0751D are located in the hot layer. In addition, wide range steam generator level instruments LT-0757B and LT-0758B have cables that extend into the hot layer in the stairwell area.

Regarding the wide range steam generator level instruments, the licensee states that during normal shutdowns, steam generator levels do not usually go below the narrow range instrumentation. Therefore, shutdown can be accomplished without wide range steam generator level indication.

Regarding LT-0751D, the corresponding instrument for Steam Generator B, LT-0752D, located a minimum of 15 feet from LT-0751D, is not affected by the fire. In addition, the operators have other indications as to the adequacy of the Steam Generator function; e.g., primary coolant temperatures, main steam flows, and feedwater flow.

Pressurizer Pressure

For a right channel cable tray fire, left channel wide range and narrow range pressurizer pressure instruments are available (PT-0104A and PT-0105A).

For a left channel cable tray fire, right channel wide range and narrow range pressurizer pressure instruments are available (PT-0104B and PT-0105B).

For a right channel cable tray fire, left channel pressurizer level instrument LT-0102 has instrument tubing that extends into the hot layer. There is a possibility that the water in the process tubing will flash to steam since the upper layer temperature is above the saturation temperature at this

pressure. However, it is expected that the heat will be conducted away by the tubing during the short period of time the process tubing is exposed to the hot layer. This is based on several considerations:

1. Only a short section of the tubing (approximately 2 feet) is in the "Hot Gas" layer.
2. The section of tubing in the hot layer is mounted on the wall, thus its temperature will more closely approximate the wall temperature.
3. The tubing is only in the hot layer for approximately 1 minute.
4. The upper layer air temperature is only above saturation for a maximum of 200 seconds.

Even if some flashing would occur, it is expected that transmitter accuracy would recover after approximately one minute as the hot layer rises. In addition, LT-0101A is available to provide pressurizer level indication should LT-0102 fail.

For a left channel cable tray fire, right channel pressurizer level instrument LT-0103 has cables that extend into the hot layer. LT-0101B is available to provide pressurizer level indication should LT-0103 fail. This provides adequate information to safely shut down the plant.

A plant review and walkdown of the control room panels was conducted by the NRC staff to ensure that all instrumentation credited to be available for safely shutting down the plant is readily accessible by the operators. The results of this review were acceptable.

The licensee has shown that sufficient instrumentation is available to safely shut down. However, two issues were not addressed in the licensee's evaluation which have the potential to complicate a shutdown. Both of these issues were discussed with the licensee. First, the impact of having certain

instruments out-of-service for maintenance was not addressed. It is possible, especially in the case of pressurizer level, to have a backup instrument (that is being relied on for indication in the event of a worst-case fire), out-of-service for maintenance. In such an instance, the operator would have to rely on secondary indications (e.g., charging flow, core exit thermocouples) to assist in assessing proper plant parameters. The licensee responded that the combination of Technical Specification Limiting Conditions for Operation, coupled with a high priority for returning control room indications to service, will result in a negligible probability that necessary instrumentation will not be available if needed. The staff reviewed the Technical Specification limits on removing instrumentation from service. Also, a review of the work order history for pressurizer level instruments LT-0101 A and B was conducted by the licensee for the time period from 1986 to present. No work orders were found indicating these instruments were inoperable during power operation. Additionally, the licensee does have an approved procedure for performing a safe shutdown in the event containment instrumentation is unreliable; Emergency Operating Procedure (EOP) 9.0, "Functional Recovery." The NRC staff finds the licensee's response acceptable.

Secondly, the control room operator's ability to recognize and assess the effects of a fire in the Containment Air Room was not adequately addressed in that no procedural guidance is available. The staff reviewed the licensee's procedure entitled "Fire Which Threatens Safety Related Equipment," ONP25.1, and found that it does not address a fire in the Containment Air Room. The licensee committed to address a Containment Air Room fire in both this procedure and Emergency Maintenance Procedure PFM-E-1, "Emergency Post Fire

Maintenance Guideline Repair Procedure in a Safe and Expedient Manner." These procedures were updated prior to start-up from the recent refueling outage. The NRC staff finds this acceptable.

VI.

Consumers Power Company has shown that based on the amount and type of combustibles, and type of ignition source, a fire in the Containment Air Room is extremely unlikely. If a fire were to occur it would most likely be a small self-extinguishing fire that would generate dense smoke. If a much larger fire were to occur, the licensee has analyzed for its effect on safety-related instrumentation in the room and shown that sufficient instruments would be operable to safely shut down the plant. The staff agrees with the licensee's determination and considers the Containment Air Room configuration, coupled with the administrative controls to minimize combustibles and provide procedural guidance to operators in case of fire, acceptable.

Accordingly, the Commission has determined pursuant to 10 CFR 50.12(a), that (1) this exemption as described in Section IV is authorized by law, will not present an undue risk to the public health and safety, and is consistent with the common defense and security, and (2) special circumstances are present for this exemption in that application of the regulation in this particular circumstance is not necessary to achieve the underlying purposes of Appendix R to 10 CFR Part 50. Specifically, the underlying purpose of Appendix R, Section III.G.2.d is to assure that a suitable complement of safe-shutdown equipment will be available, post-fire, to achieve and maintain hot shutdown of the reactor. The analysis of worst-case fire in the Containment Air Room indicates

that instrumentation will be capable of performing their post-fire shutdown role without additional fire protection enhancements. Therefore, the Commission hereby grants the Exemption request identified in Section IV. above.

Pursuant to 10 CFR 51.32, the Commission has determined that the granting of this Exemption will have no significant impact on the environment (55 FR 50063).

This Exemption is effective upon issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

John A. Zwolinski, Acting Director
Division of Reactor Projects III/IV/V
Office of Nuclear Reactor Regulation

Dated at Rockville, Maryland
this 21st day of June 1991